**International Journal of Dental Sciences**
**www.dentaljournal.in**
**E-ISSN: 2663-4708**
**Received: 09-07-2026; Accepted: 09-08-2026; Published: 24-08-2026**
**Volume 8, Issue 3, 2026, Page No. 235-238**

# Root canal instrumentation in primary teeth: Current concepts, clinical considerations and future perspectives

**Dr. Jesmi Heikrujam[1], Dr. Dinesh Rao[2], Dr. Sunil Panwar[3]**
[1] Department of Paediatric and Preventive Dentistry, Pacific Dental College and Hospital, Debari, Udaipur, Rajasthan, India
[2] Professor and Head, Department of Paediatric and Preventive Dentistry, Pacific Dental College and Hospital, Debari, Udaipur, Rajasthan, India
[3] Professor, Department of Paediatric and Preventive Dentistry, Pacific Dental College and Hospital, Debari, Udaipur, Rajasthan, India

**Abstract**
**Background:** Pulpectomy is an important treatment modality for primary teeth with irreversible pulpitis or pulpal necrosis, with the objective of eliminating infection while retaining the tooth until its physiological exfoliation. Root canal instrumentation is a critical component of pulpectomy because effective cleaning and shaping facilitate disinfection and obturation. However, instrumentation of primary teeth is challenging because of their complex root canal anatomy, thin dentinal walls, pronounced root curvature and physiological root resorption.
**Aim:** This narrative review discusses the anatomical considerations influencing root canal instrumentation in primary teeth and critically reviews conventional hand instrumentation and contemporary nickel–titanium (NiTi) rotary and reciprocating systems, with emphasis on their clinical advantages, limitations and relevance to paediatric endodontic practice.
**Main findings:** Stainless-steel hand files remain useful because of their tactile feedback, controlled manipulation and ability to negotiate narrow and complex canals. However, conventional hand instrumentation is relatively time-consuming and may result in greater dentine removal in certain situations. NiTi rotary systems provide greater flexibility, improved shaping efficiency, reduced instrumentation time and more predictable tapered canal preparations. Several in *vitro* and ex *vivo* studies have reported comparable cleaning efficacy between hand and rotary techniques while demonstrating a significant reduction in instrumentation time with rotary systems. Nevertheless, rotary instrumentation has limitations, including cost, the need for specialised training, reduced tactile feedback and the possibility of leaving fins, isthmuses and other irregularities inadequately instrumented.
**Conclusion:** Neither hand nor rotary instrumentation can be considered universally superior for all primary teeth. Contemporary clinical practice should adopt a case-specific approach that combines appropriate hand instrumentation with rotary or reciprocating systems when indicated. Future developments should emphasise minimally invasive preparation, preservation of dentine, improved flexibility and instrument designs specifically adapted to the anatomy of primary teeth.

**Keywords:** Primary teeth, pulpectomy, root canal instrumentation, hand files, nickel-titanium, rotary instrumentation, paediatric endodontics

## Introduction

Pulpectomy is indicated for primary teeth with irreversible pulpitis or pulpal necrosis when the tooth is considered restorable and preservation of the primary tooth is desirable. The procedure aims to eliminate infection, control inflammation and maintain the tooth in function until physiological exfoliation. [1,2]

Root canal preparation is one of the fundamental components of pulpectomy. Effective cleaning and shaping facilitate microbial reduction, removal of infected tissue and subsequent obturation of the prepared canal system. [3] However, instrumentation of primary teeth differs considerably from that of permanent teeth because of their distinctive anatomy and physiological changes.

Primary teeth have relatively thin dentinal walls, large pulp chambers, long and slender roots and pronounced root divergence. Primary molars may also exhibit accessory canals, lateral canals, fins, isthmuses and complex interconnections. [4,5] Physiological root resorption further alters the apical anatomy and makes working-length determination and instrumentation more challenging. [6]

These anatomical characteristics create a delicate balance between adequate debridement and preservation of the remaining root structure. Excessive instrumentation may weaken the tooth or increase the risk of perforation, whereas inadequate preparation may leave infected tissue and debris within uninstrumented areas. [7]

Traditionally, primary-tooth pulpectomies have been performed using hand-operated stainless-steel instruments. The introduction of nickel–titanium (NiTi) instruments has subsequently provided an alternative approach, particularly because of their flexibility and ability to maintain the original canal configuration. [8] The use of rotary and reciprocating systems has also reduced instrumentation time, which may be particularly beneficial in paediatric patients.

This review discusses the evolution of instrumentation techniques in primary teeth, compares conventional hand and NiTi rotary approaches, and highlights the clinical factors that should guide instrument selection.

## Anatomical Considerations Influencing Instrumentation

The anatomy of primary teeth is a major determinant of the difficulty of root canal preparation. Primary molars generally have long, slender and divergent roots, while their

root canals may exhibit considerable variation in number, shape and configuration. [4]

The mesial roots of primary molars demonstrate particularly complex canal morphology. Accessory canals and interconnections may be present, and physiological root resorption progressively modifies the apical anatomy. [4,5] Consequently, a root canal that appears relatively simple on a two-dimensional radiograph may contain complex three-dimensional anatomical features.

Physiological root resorption presents an additional challenge because the apical foramen may become irregular and its position may change during the exfoliative process. [6] Accurate working-length determination is therefore essential to prevent over-instrumentation and overfilling, particularly because the developing permanent successor is located in close proximity to the roots of primary teeth.

These anatomical characteristics emphasise the importance of conservative instrumentation. The objective should not be to enlarge the canal unnecessarily but to achieve adequate debridement while maintaining the original radicular anatomy and preserving dentine.

**Conventional Hand Instrumentation**

Hand instrumentation remains an important component of paediatric endodontic practice. Commonly used instruments include barbed broaches, reamers, K-files and Hedström files. [7]

K-files are commonly used for canal negotiation, patency and mechanical preparation. Their principal clinical advantage is the tactile feedback they provide, allowing the operator to appreciate changes in canal anatomy and resistance during instrumentation. This can be particularly useful in narrow, curved or anatomically complex canals.

Hedström files have more aggressive cutting characteristics and are primarily effective during the withdrawal stroke. They may be useful for removing residual tissue from canal walls and irregular areas that may not be adequately contacted by rotary instruments.

**Advantages of hand instrumentation**

- Excellent tactile feedback.
- Useful for canal negotiation and glide-path establishment.
- Greater control in narrow and severely curved canals.
- Relatively inexpensive.
- Does not require an endodontic motor.

**Limitations**

- Relatively longer instrumentation time.
- Greater operator dependence.
- Limited flexibility of stainless-steel instruments.
- Increased potential for canal transportation and procedural errors in curved canals.
- Potential for greater dentine removal when excessive instrumentation is performed. [7,9]

Thus, although hand instrumentation remains indispensable, its limitations have encouraged the development and adoption of engine-driven NiTi systems.

**Nickel–Titanium Rotary Instrumentation**

The introduction of NiTi rotary instrumentation represented an important development in endodontics. NiTi instruments possess greater flexibility and superelasticity than conventional stainless-steel instruments, allowing them to negotiate curved canals while maintaining a more centred preparation. [8]

The use of NiTi rotary instruments in primary teeth was described by Barr *et al*., after which several systems specifically designed or adapted for paediatric endodontics were introduced. [8]

Rotary instruments differ in their tip size, taper, cross-sectional design, rake angle, radial lands, helical angle and pitch. These design characteristics influence cutting efficiency, flexibility, debris removal and canal-centering ability.

**Major advantages**

NiTi rotary instrumentation may:

- Reduce instrumentation time.
- Improve shaping efficiency.
- Produce a more uniform tapered canal.
- Reduce operator and patient fatigue.
- Facilitate more predictable obturation.
- Maintain canal centricity in curved canals.
- Improve treatment efficiency in children with limited cooperation. [10-12]

The reduction in treatment time is particularly relevant in paediatric dentistry because shorter procedures may improve patient cooperation and reduce fatigue.

**Evidence Comparing Hand and Rotary Instrumentation**

Several studies have compared hand and rotary instrumentation in primary teeth.

Silva *et al*. evaluated the cleaning capacity and instrumentation time of manual K-files and ProFile .04 rotary instruments in deciduous molars. No significant difference in cleaning capacity was found between the two techniques in the cervical, middle or apical thirds. However, rotary instrumentation required substantially less time, with mean instrumentation times of 3.46 minutes compared with 9.06 minutes for manual instrumentation. [13]

Similarly, Nazari Moghaddam *et al*. compared K-files with the FlexMaster rotary system in primary molars. Cleaning efficacy was broadly comparable in the middle and apical thirds, while hand instrumentation showed better cleaning in the coronal third. Nevertheless, rotary instrumentation was significantly faster. [14]

Kummer *et al*. evaluated dentine removal and instrumentation time using manual K-files and Hero 642 rotary instruments. Manual instrumentation resulted in greater dentine removal, whereas rotary instrumentation required significantly less time. [15] These findings are particularly relevant in primary teeth, where preservation of the thin remaining dentinal walls is important.

Other comparative investigations have similarly demonstrated that rotary instrumentation can provide efficient canal preparation without necessarily compromising cleaning efficacy. [16,17]

Collectively, these findings suggest that the principal advantage of rotary instrumentation may be efficiency rather than universally superior cleaning. This distinction is important because cleaning remains dependent on irrigation, instrument design, canal anatomy and operator technique.

**Rotary Systems Used in Primary Teeth**

Several rotary and reciprocating systems have been developed for paediatric endodontics. These include systems specifically designed for primary teeth as well as systems originally developed for permanent teeth and subsequently adapted for paediatric use.

The Kedo-S system was among the early rotary systems specifically designed for primary root canals. Subsequent generations incorporated heat-treated NiTi alloys, controlled-memory technology and modified cross-sectional designs. [18]

Other systems used in primary teeth include Prime Pedo, DXL-Pro Pedo, Pro-AF Baby Gold, Baby Blue, Pedo Flex, Endogal Kids, Reciproc Blue and other contemporary systems. [19]

The development of shorter instruments, controlled tapers and heat-treated alloys reflects the need to accommodate the smaller dimensions and complex curvature of primary canals.

However, the availability of numerous commercial systems should not lead to indiscriminate instrument selection. The instrument should be selected according to canal dimensions, curvature, degree of root resorption, treatment objectives and operator experience.

**Reciprocating Instrumentation**

Reciprocating systems represent a further development of engine-driven instrumentation. Instead of continuous rotation, the file moves through alternating clockwise and counter-clockwise movements.

Single-file reciprocating systems may reduce the number of instruments required and consequently simplify the instrumentation sequence. They may also reduce treatment time and instrument manipulation.

However, the use of reciprocating instruments does not eliminate the need for appropriate canal negotiation, irrigation, working-length control and careful evaluation of root morphology. The developing permanent tooth and the thin roots of primary teeth necessitate conservative instrumentation irrespective of the movement kinematics used.

**Advantages and Limitations: Hand versus Rotary Instrumentation**

| Feature | Hand instrumentation | Rotary/reciprocating instrumentation |
|---|---|---|
| Tactile feedback | Excellent | Relatively reduced |
| Flexibility | Lower with stainless steel | Higher with NiTi |
| Instrumentation time | Longer | Generally shorter |
| Canal shaping | Operator dependent | More uniform and predictable |
| Canal negotiation | Excellent | Usually requires initial hand negotiation |
| Cost | Lower | Higher |
| Operator training | Familiar and relatively simple | Requires specific training |
| Curved canals | More difficult | Better suited to curvature |
| Dentine preservation | Technique dependent | Often favourable with conservative systems |
| Risk of instrument separation | Present | Present; requires careful use |
| Clinical application | Essential adjunct | Useful when appropriately indicated |

The evidence does not support the complete replacement of hand instruments by rotary systems. Rather, the two approaches should be considered complementary.

**Clinical Considerations in Instrument Selection**

Instrument selection should be based on the individual tooth rather than on the assumption that one instrumentation system is superior in all situations.

**1. Canal anatomy**

Narrow, highly curved and partially calcified canals may initially benefit from hand-file negotiation because of the tactile control provided.

**2. Root resorption**

The degree and pattern of physiological root resorption should be assessed before instrumentation. Excessive preparation in resorbing roots may increase the risk of perforation or damage to the developing successor.

**3. Preservation of dentine**

Primary teeth possess thinner dentinal walls than permanent teeth. Conservative preparation is therefore essential. Instruments with controlled or progressive taper may help reduce unnecessary dentine removal.

**4. Working-length control**

Because the apical anatomy of primary teeth changes with physiological resorption, working length should be carefully established and regularly controlled. Radiographic assessment may be supplemented by electronic methods when appropriate. [6]

**5. Irrigation**

Instrumentation alone cannot adequately clean all anatomical irregularities. Effective irrigation is therefore essential to complement mechanical preparation and remove debris from areas that instruments cannot reach. [20]

**6. Operator experience**

Rotary systems require appropriate training and familiarity with the specific instrument's design, recommended speed, torque and sequence. Incorrect use may result in instrument separation, canal transportation, perforation or excessive dentine removal.

**Current Concept: A Combined Approach**

The most clinically appropriate approach may not be a strict choice between hand and rotary instrumentation.

**Hand files remain valuable for:**

- Initial canal negotiation.
- Working-length determination.
- Establishment of patency.
- Glide-path preparation.
- Management of difficult anatomical areas.

Rotary or reciprocating systems may subsequently be used for efficient canal shaping when the canal anatomy permits.
Furthermore, residual tissue or debris may remain within fins, isthmuses and other irregularities even after rotary preparation because rotary instruments tend to remain centred within the main canal. [7] Therefore, effective irrigation and, when indicated, supplementary hand instrumentation Remain important.
A combined, conservative approach may consequently provide the advantages of both techniques while reducing their individual limitations.

**Future Perspectives**

The future of paediatric endodontic instrumentation is likely to focus on minimally invasive preparation and preservation of primary tooth structure.
Contemporary developments include heat-treated NiTi alloys, controlled-memory instruments, variable and progressive tapers, reciprocating systems and single-file approaches. These developments aim to improve flexibility, reduce cyclic fatigue, minimise unnecessary dentine removal and shorten treatment time. [18,19]
Future instruments should be designed specifically around the anatomical characteristics of primary teeth rather than simply adapting adult endodontic systems. Smaller dimensions, increased flexibility, controlled taper and tooth-specific designs may further reduce procedural errors.
The integration of advanced imaging, digital technologies and improved irrigation strategies may also enhance the predictability of paediatric endodontic treatment.

**Conclusion**

Root canal instrumentation is a critical component of pulpectomy in primary teeth and must be performed with consideration of their unique anatomical and physiological characteristics.
Conventional hand instruments continue to have an important role because of their tactile feedback and ability to negotiate complex canals. However, NiTi rotary and reciprocating systems provide important advantages, particularly reduced instrumentation time, improved shaping efficiency and more predictable canal preparation.
Current evidence indicates that rotary instrumentation does not consistently demonstrate superior cleaning compared with hand instrumentation, although it generally provides greater time efficiency and may reduce unnecessary dentine removal. [13-17] Therefore, rotary instrumentation should not be viewed as a replacement for hand instrumentation but as a complementary approach.
The ideal instrumentation protocol should be conservative, anatomy-driven and patient-centred, combining appropriate hand instrumentation, rotary or reciprocating systems and effective irrigation to achieve adequate disinfection while preserving the integrity of the primary tooth and the developing permanent successor.

**References**


1. American Academy of Pediatric Dentistry. Pulp therapy for primary and immature permanent teeth. Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry, 2025, 487–96.
2. Fuks AB, Guelmann M, Kupietzky A. Current developments in pulp therapy for primary teeth. Endod Topics,2010:23:50–72.
3. Haapasalo M, Endal U, Zandi H, Coil JM. Eradication of endodontic infection by instrumentation and irrigation solutions. Endod Topics,2005:10(1):77–102.
4. Ahmed HMA. Anatomical challenges and current developments in root canal preparation of primary molars. Int Endod J,2013:46:1011–22.
5. Cleghorn BM, Boorberg NB, Christie WH. Root canal systems in primary teeth. Endod Topics,2010:23:6–33.
6. Ahmed HM. Pulpectomy procedures in primary molars. Eur J Gen Dent,2014:3:3–10.
7. Nazari Moghaddam K, Mehran M, Farajian Zadeh H. Root canal cleaning efficacy of rotary and hand files instrumentation in primary molars. Iran Endod J,2009:4:53–7.
8. Barr ES, Kleier DJ, Barr NV. Use of nickel titanium rotary files for root canal preparation in primary teeth. Pediatr Dent,2000:22:77–8.
9. Ozen B, Akgun OM. Ni-Ti rotary vs hand files. J Int Dent Med Res,2013:6:6–8.
10. Silva LA, Leonardo MR, Nelson-Filho P, Tanomaru JM. Comparison of rotary and manual instrumentation techniques on cleaning capacity and instrumentation time in deciduous molars. J Dent Child (Chic),2004:71:45–7.
11. Kummer TR, Calvo MC, Cordeiro MM, Vieira RS, Rocha MJ. Ex *vivo* study of manual and rotary instrumentation techniques in human primary teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2008, 105–92.
12. Seraj B, Ramezani G, Ghadimi S, Mosharrafian SH, Motahhary P, Safari M, *et al*. In *vitro* comparison of instrumentation time and cleaning capacity. Minerva Stomatol,2013:62:17–22.
13. Katge F, Patil D, Poojari M, Pimpale J, Shitoot A, Rusawat B, *et al*. Comparison of instrumentation time and cleaning efficacy in primary teeth. J Indian Soc Pedod Prev Dent,2014:32:311–6.
14. Kuo CI, Wang YL, Chang HH, Huang GF, Lin CP, Guo MK, *et al*. Application of Ni-Ti rotary files for pulpectomy in primary molars. J Dent Sci,2006:1:10–5.
15. George S, Anandaraj S, Issac JS, John SA, Harris A. Rotary endodontics in primary teeth – a review. Saudi Dent J,2016:28:12–17.
16. Vieyra JP, Enriquez FJ. Rotary vs hand instrumentation efficiency. Dentistry,2014:4:214.
17. Crespo S, Cortes O, Garcia C, Perez L. Rotary vs manual instrumentation. J Clin Pediatr Dent,2008:32:295–8.
18. Thakkar TK, *et al*. Advances in rotary endodontics in pediatric dentistry. EC Dent Sci,2019:18(6):1320–30.
19. Kaushik H, Singhal R, Kakram A. Rotary file systems for pediatric patients: a review. Int J Health Sci Res,2023:13:212–6.
20. George S, Anandaraj S, Issac JS, *et al*. Rotary endodontics in primary teeth. Saudi Dent J,2016:28:12–7.