Submitted: 28 December, 2022 Accepted: 27 March, 2023 Published: 03 September, 2021 DOI:10.22514/jocpd.2023.067

CASE REPORT

Journal of Clinical Pediatric Dentistry

Adaptive instrumentation of root canals in primary teeth using XP-endo shaper: a case series

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Abstract

Dental caries is indeed the biggest cause of tooth loss, particularly in the primary dentition. In primary teeth with carious pulp involvements, endodontic intervention in the form of pulpotomy (removal of only the coronal pulp) or pulpectomy (removal of coronal and radicular pulp) is advocated. Pulpectomy can be laborious and time-consuming, especially when using traditional hand endodontic files to shape root canals. In paediatric dentistry, motorised nickel-titanium (Ni-Ti) rotary instrumentation has proved significant in enhancing the quality of pulpectomy. In primary dentition, however, these files may leave more than half of the root canals unaltered by instrumentation, just as they do in permanent dentition. The XP-endo® Shaper is a revolutionary heat-dependent endodontic file that uses an asymmetrical rotating motion to address the maximum area of the root canal space, resulting in anatomic root canal instrumentation. The case series describes the use of this novel XP-endo® Shaper file for anatomic root canal instrumentation in primary molars with irreversible pulpitis. The purpose is to demonstrate the efficacy and advantages of this cutting-edge endodontic treatment method. This case series can be an informative resource for other endodontic specialists by providing a practical illustration of how adaptable instrumentation can be utilised to successfully treat a patient. In conclusion, The use of the XP-endo Shaper® for pulpectomy demonstrated faster and instrumentation that was confined with the original shape of the canals, although further research is required to fully utilise these findings.

Keywords

Anatomic instrumentation; Primary teeth; Pulpectomy; Rotary files; XP-endo® shaper

1. Introduction

In the primary dentition, the main concern is the carious loss of molars and subsequent lack of space for permanent successors. Regardless of the complex morphology of root canals, pulpectomy is the treatment of choice for carious primary molars with irreversible pulpitis extending into the root canals [1, 2]. The primary goal of root canal treatment (RCT) during pulpectomy is to mechanically shape the entire root canal space, create a path to the apex for chemical cleaning with a preferred root canal irrigant, remove bacterially infected hard and soft tissues, and create space for subsequent obturation, all within a short period of time [3, 4].

Traditionally, hand files were used to perform pulpectomy in primary teeth, which had known drawbacks. In pediatric dentistry, the time taken for root canal instrumentation during pulpectomy has significantly reduced with the introduction of rotational Ni-Ti files, resulting in increased patient compliance throughout treatment [5, 6]. Rotary tools made of nickel-titanium (Ni-Ti) are rapid, safe, and precisely aligned, with a low chance of mistakes throughout the process. Moreover, they have a decent taper, which helps to improve obturation quality [7]. Several rotary files have been introduced and clinically tested for use in pediatric endodontics. These endodontic files have a spinning blade and flutes on a solid central metal core, and they may successfully accomplish the aims of root canal shaping when canals are straightforward, straight, and thin with a round cross-section. However, these files might not be sufficient if the root canal is large or has an irregular shape, leaving behind diseased tissue by leaving the majority of the root canal area unmodified. The root canals of primary molars frequently have an oval shape at the apex and an ovoid or ribbon shape in the coronal region, presenting a significant challenge for effective root canal cleaning, shaping and disinfection when rotary devices are employed for shaping [8].

FKG Dentaire (La Chaux-de-Fonds, Switzerland) launched the snake-shaped XP-endo® Shaper instrument, a new rotary file that is designed to adapt to the shape of the root canal system, expanding or contracting as it progresses through the working length. It is a heat-sensitive rotary file that instruments the root canals in an asymmetrical motion, allowing it to access canal abnormalities or the majority of the root

canal space [9]. It also has a booster tip that confers a unique geometry, with six cutting edges at the tip. With an initial diameter of #15 and taper of 0.01, the XP-endo Shaper® expands once inside the canal, achieving a size of #30 and a taper of 0.04 [9]. The XP-endo Shaper® is a single file system, used at high speed, manufactured by highly flexible MaxWire® alloy, all of which result in an ideal preparation of the root canals with minimal time for instrumentation. Also, the turbulence generated within the root canal not only helps in auguring the debris occlusally but also leads to irrigation agitation resulting in better root canal disinfection [10]. The root canal instrumentation time was very less (around 1–2 minutes) using XP-endo Shaper® in the current cases. The case reports below describe the use of this heat-dependent anatomic instrumentation method in primary molars. To the best of the authors' knowledge, there is currently no information on the use of anatomic endodontic instrumentation in primary dentition. Given the limited number of studies and absence of case reports on the use of adaptive instrumentation in pulpectomy procedures, there is an urgent need for further research in this area [8, 9, 11].

2. Case reports

2.1 Case 1

A seven-year-old boy was referred to the Department of Oral Health and Advanced Dentistry with a chief complaint of sharp, localized pain in his lower right back region that had been present during the night for the past five days. The patient had no significant medical history. Previous dental investigation revealed that the gums around the affected tooth were inflamed and persistant discomfort. Clinical examination of the primary right mandibular first (84) and second (85) molars revealed dental caries, but tenderness on vertical percussion was only observed with respect to tooth 85. An intraoral periapical radiograph of the affected teeth showed radiolucency involving enamel and dentin with respect to tooth 84, and caries involving enamel, dentin, and pulp with respect to tooth 85 (Fig. 1a).

Based on clinical examination and radiographic interpretation a diagnosis of proximal dental caries with respect to 84, and symptomatic irreversible pulpitis with respect to 85 was drawn. Restorative procedure for tooth 84 and pulpectomy procedure for tooth 85 was planned for the patient.

The treatment was initiated by administering an inferior alveolar nerve block using 2% lignocaine with 1:80,000 adrenaline (Lignox, Indoco Remedies Ltd. Mumbai, India). For tooth 85, an ideal endodontic access cavity was prepared with a #4 round bur, followed by flooding the coronal space with 3% sodium hypochlorite (Prime Dental Products Pvt. Ltd., Mumbai, India) facilitating initial fixture of the coronal pulp in chamber and it's easy removal by a spoon excavator (Hu-Friedy LLC, Frankfurt, Germany), and finally identifying all canals present by Ash Endodontic Probe (DG16; Dentsply Sirona, Sydney, Australia). The apical patiency for all the canals present (mesiobuccal, mesiolingual, and distal) were gained with a #10 K-file (Mani Inc, Tochigi, Japan). The working length was established by using an electronic apex locator (Propex pixi; Dentsply Maillefer, Ballaigues, Switzerland), was confirmed by a radiograph and kept 1 mm short of the apex. The glide path was established using #15K file (Dentsply Maillefer) for further instrumentation with XP-endo® Shaper file till the estimated working length.

After flooding the root canals with 2 mL of warm 1% NaOCl, the XP-endo® Shaper file (21 mm) was first inserted passively until it encountered resistance. The file was subsequently reintroduced after the tip was coronally retracted, the endomotor (Xsmart; Dentsply Maillefer) was turned on, and the speed and torque were set at 800 rpm and 1 Ncm, respectively. 4–5 times, the file was moved lightly in a vertical direction towards the working-length (WL). Once the WL was reached, the file was retracted and cleaned, the apical patency was checked with a #15 K-file, the canal was flooded once more with 1 mL of warm NaOCl, and the file was used again for an additional 10 strokes to the WL to perceive the instrumentation complete. This was done in accordance with the manufacturer's instructions and was followed by irrigating the canal with 2 mL of warm NaOCl. The final regimen of irrigation with 17% ethylenediaminetetraacetic acid (EDTA) and normal saline was carried out. The prepared root canal space was filled with Metapex (Meta Biomed Co. Ltd. Chungbuk, Korea). Metapex is a popular obturating material in pulpectomy treatments because to its superior radiopacity, biocompatibility, and antibacterial qualities, which aid in minimising bacterial leakage and eventual re-infection of the tooth. Furthermore, it does not discolour teeth, making it an excellent alternative for pediatric patients. For tooth 84 a disto-occlusal cavity was prepared and restored using glass ionomer cement (Type IX; GC Fuji, Tokyo, Japan).

The immediate postoperative radiograph revealed optimal filling with metapex in relation to tooth 85 and restoration with respect to tooth 84 (Fig. 1b). This radiograph also demonstrates that the file led to careful preparation that avoided over-enlargement and preserved the root canal space's anatomical structure. The coronal seal of the endodontically treated tooth was done with glass ionomer cement (GC Fuji II, Tokyo, Japan). Finally, D4 and E5 size stainless steel crowns (3M ESPE, St, Paul, MN, USA) were cemented using type I glass ionomer cement (Fig. 1c) for tooth 84 (Hall's technique) and 85 respectively. The patient reported no discomfort at the six-month follow-up appointment, and the endodontically treated tooth (85) showed no indication of mobility.

2.2 Case 2

Another four-year old girl child was referred to the department, with a complaint of dull and night pain in her lower left back region for the past 4 days with additional mention of sensitivity on consumption of hot or cold beverages. The accompanying parent gave a history that the child was under analgesic medication for the three days and presented a non-contributory past medical history. On clinical examination, deep caries was seen with respect to primary left mandibular second molar (75) with no evidence of swelling or sinus. The tooth exhibited a positive response to the vertical percussion test. The intra-oral peri-apical radiograph revealed deep carious radiolucency involving enamel, dentine, and pulp

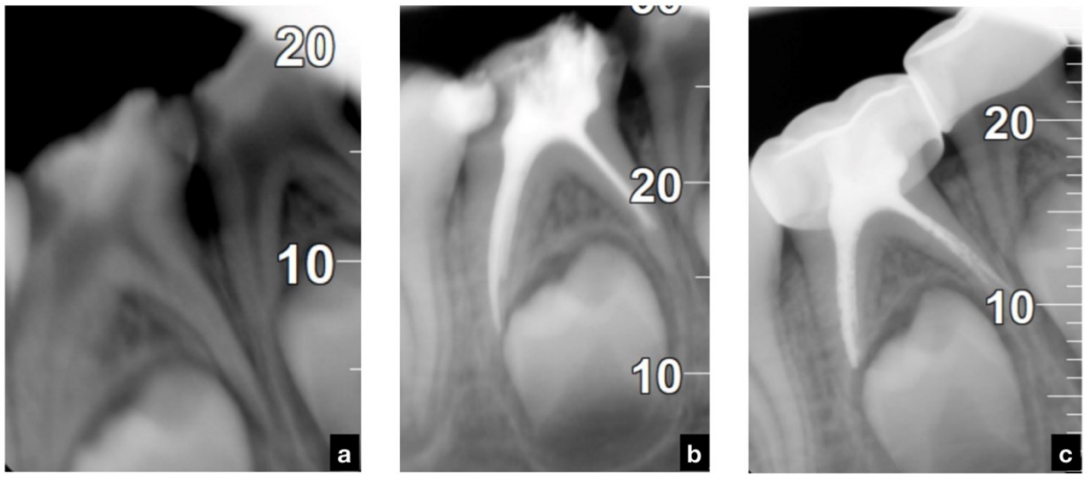

FIGURE 1. First RCT performed and primary tooth restoration. (a) Preoperative radiograph wherein the extent of caries is seen (84 disto-proximal involving enamel and dentine and 85 involving enamel, dentine, and pulp); (b) Post treatment radiograph (84 with disto-proximal GIC restoration and 85 with obturation after root canal instrumentation); (c) Placement of crowns on 84 and 85.

with respect to tooth 85 (Fig. 2a). Based on clinical and radiographic interpretation a diagnosis of dental caries with symptomatic irreversible pulpitis was made and pulpectomy procedure and final restorations were planned and executed in a similar way as described in Case 1 (Fig. 2b,c). The post-obturation radiographs illustrate the successfully shaped and obturated wider canals.

2.3 Case 3

Another four-and-half year girl child was referred to the department complaining of sharp night pain in the upper left back region since a couple of days, with no contributory past medical history or drugs. Clinical examination revealed deep carious lesion with primary left maxillary first molar (64) and positive of pain on vertical percussion. The pre-operative radiograph exhibited deep carious lesion involving enamel, dentine, and pulp (Fig. 3a). Based on clinical and radiographic interpretation a diagnosis of dental caries with symptomatic irreversible pulpitis was made and pulpectomy procedure and final restorations were was planned and executed in a similar way as described in Case 1 (Fig. 3b,c). The post-obturation radiographs illustrate the successfully shaped and obturated wider canals with respect to the mesio-buccal and palatal without a round tapered preparation and maintaining the anatomy of the canals.

3. Discussion

In the recent era of treating infected primary molars, there has been a paradigm shift. As a result, the therapy for infected primary teeth has shifted from extractions to pulpectomies, conserving arch length and assisting the permanent successors in their position [12]. The goal of RCT is to remove infected tissue and seal the entire root canal space in three dimensions with a biocompatible substance. Appropriate root canal shape facilitates the irrigant's ability to reach the apical third, which is necessary for root canal disinfection [13].

When it comes to endodontic treatment of primary teeth, the time taken to complete root canal instrumentation and disinfect the entire root canal space before obturation is crucial. Traditionally, endodontic therapy for primary teeth was done using hand files (H and K), with the major problem being that the treatment was not well tolerated by younger patients. Failure to respect root canal geometry, causing root canal transportation owing to stiffness, post-operative discomfort, inflammation, and delayed healing due to debris extrusion during instrumentation are examples of iatrogenic accidents induced by instrumentation [14]. The introduction of Ni-Ti rotary instrumentation in pediatric dentistry ushered in the modern era of pediatric endodontics. Its use lowered instrumentation time and eliminated the drawbacks of hand file instrumentation, resulting in a consistent, funnel-shaped obturation [14, 15].

When used for instrumentation in oval and flat-oval canals, rotary files have been observed to be unsuccessful, leaving roughly 40–60 percent of the root canals intact. The rotary/reciprocating Ni-Ti files force a circular shape on the root canals without respecting their real cross-sectional shape, producing unequal removal of radicular dentin when utilized in irregularly shaped root canals [16]. The root canal morphology of primary teeth is characterized by wide ovoid and ribbon-shaped canals that are difficult to instrument and disinfect [17].

The XP-endo® Shaper file introduces a new heat-dependent, snake-like MaxWire® alloy technology in root canal instrumentation (Fig. 4) [8]. It uses an asymmetrical rotary motion, which results in a semicircular shape as it expands at 35 °C or higher. The file is soft in its martensitic phase, which is reached at room temperature. However, when placed in the canal at body temperature, it returns to the memorized shape (austenitic phase). The advantageous MaxWire® alloy offers high flexibility and fatigue resistance, and the ability to progress within the canals with ease and agility, expanding or contracting according to the canal morphology, thus respecting the root canal anatomy, and addressing most of the root canal area [8].

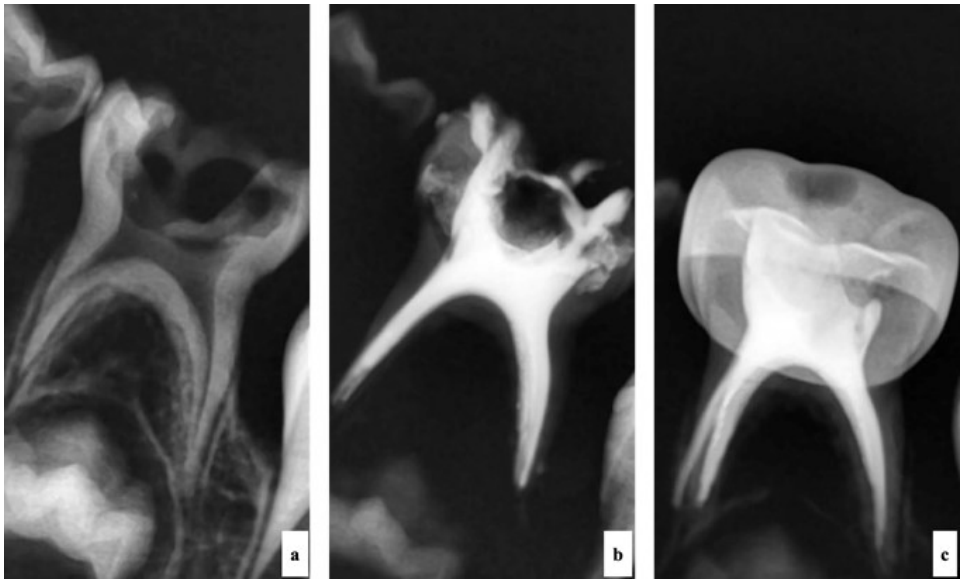

FIGURE 2. Second RCT performed and primary tooth restoration. (a) Preoperative radiograph of tooth 75 wherein caries is seen involving enamel and dentine, and pulp; (b) Post obturation radiograph after root canal instrumentation; (c) Placement of crowns on 75.

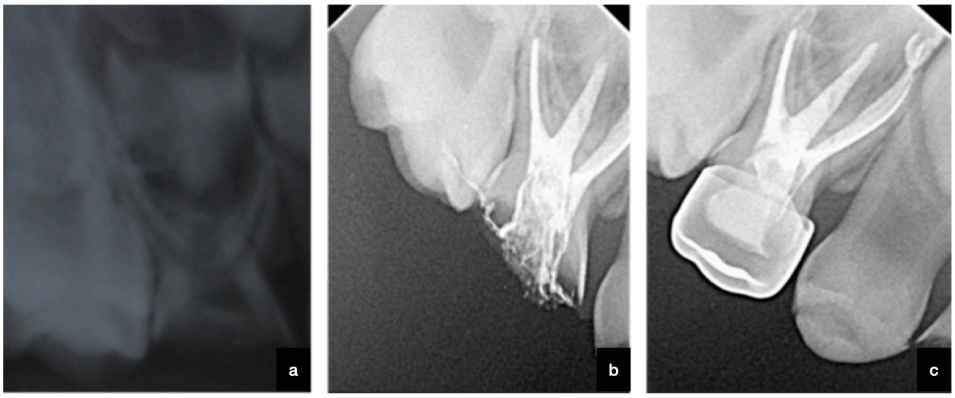

FIGURE 3. Third RCT performed and primary tooth restoration. (a) Preoperative radiograph of tooth 64 wherein caries is seen involving enamel and dentine, and pulp; (b) Post obturation radiograph after root canal instrumentation; (c) Placement of crowns on 64.

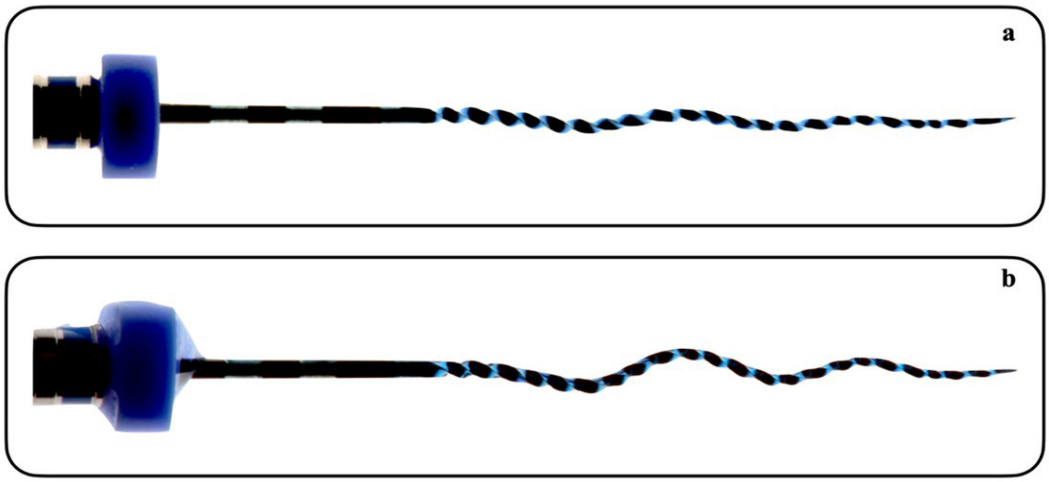

FIGURE 4. Temperature-dependent shape transition of the XP-endo Shaper adopted from Pawar *et al.* [8], 2021. (a) XP-endo Shaper file at room temperature (20 °C); (b) the same file at body temperature (35 °C). The extremely flexible file will push itself into canal recesses not reachable by rotary Ni-Ti files.

The "snake" shape MaxWire® technology results in minimal stress generation to the dentine walls, reducing the risk of micro-cracks formation in the radicular dentine due to support from the spring action against the walls. The micro-debris resultant by instrumentation are efficiently removed, due to the turbulence generated by the instrument rotating at high speed and the available space compared to instruments with a larger core diameter. These properties are remarkably advantageous as the primary teeth are thin, curved, and have softer and less dense root dentine with undetectable root resorptions [2].

For root canal instrumentation, XP-endo Shaper files have shown effectiveness, especially when dealing with oval-shaped canals. Even in intricate canal layouts, these files' distinctive shape enables effective shaping and cleaning of the canal walls. The capacity of XP-endo Shaper files to maintain the canal form and ability to create a more centered canal preparation, which can reduce the risk of root canal transportation and ensure more effective cleaning and disinfection is one of its main benefits [17]. This shape can increase the effectiveness of following cleaning and obturation operations [18]. In comparison to conventional Ni-Ti files, the files have better flexibility and fracture resistance, which lowers the chance of an instrument separating during usage [19–21]. Moreover, it has been demonstrated that using XP-endo Shaper files can speed up the cleaning process and use less irrigant, both of which can lessen the patient's postoperative pain [10, 22].

The innovative shape of the XP-endo Shaper file allows for efficient and conservative removal of dentin, reducing the risk of iatrogenic errors such as transportation or over-instrumentation while maintaining the original shape of the root canal. This, in turn, can result in less post-operative discomfort and inflammation, as well as faster healing timeframes. This is especially critical in pulpectomy procedures, when the goal is to remove as much pulp as practicable while causing little or no damage to the surrounding tissues as possible. This instrumentation approach was used because it has various benefits over other pulpectomy procedures, such as better treatment results, a lower risk of complications, and increased patient comfort.

Under the constraints of this case series with three treated teeth, the results indicate that the patient and operator could be decreased and a consistent preparation with high quality obturation could be accomplished.

4. Conclusions

Taking into account the limitations of the findings from the current case series, it can be said that using rotary files in pediatric dentistry leads to faster, more uniform instrumentation, and high obturation quality. Being a single file system, the XP-endo Shaper® may prove to be an efficient and quicker alternative for root canal instrumentation in primary teeth. In comparison to conventional endodontic techniques, the use of XP-endo Shaper files during pulpectomy procedures has a number of benefits. XP-endo Shaper files are a possible addition to the endodontic toolbox since they improve the efficacy and efficiency of canal preparation while reducing the risk of procedural issues. Further research is necessary to maximize the utilization of these data in pediatric endodontic practice.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

AUTHOR CONTRIBUTIONS

BT and AMP—designed the research study. BT—performed the research. FP, DAW and RR—analyzed the data. RR, AMP and LT—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Informed consent was sought from the parents or legal guardians of each patient included in our case series to guarantee ethical compliance and patient confidentiality. Furthermore, because they do not contain experimental therapies, case reports normally do not need ethical approval; yet ethical issues including patient privacy and confidentiality were considered for each patient. Author B.T., a pediatric dentist who has been practicing pediatric dentistry for more than a decade, carried out all the treatments.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest. Luca Testarelli is serving as one of the Editorial Board members of this journal. We declare that Luca Testarelli had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to JD.

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How to cite this article: Bhagyashree Thakur, Ajinkya M. Pawar, Dian Agustin Wahjuningrum, Rodolfo Reda, Francesco Pagnoni, Luca Testarelli. Adaptive instrumentation of root canals in primary teeth using XP-endo shaper: a case series. Journal of Clinical Pediatric Dentistry. 2023; 47(5): 170-175. doi: 10.22514/jocpd.2023.067.