

REVIEW ARTICLE

Rotary Endodontics in Pediatric Dentistry: Literature Review

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ABSTRACT

Pulpectomy is indicated in primary teeth with carious pulp exposures in which coronal and radicular pulp exhibits clinical signs of hyperemia or evidence of pulp necrosis with or without caries involvement. In primary teeth, it can be challenging and time-consuming, especially during canal preparation, which is considered one of the most important steps in root canal therapy. The development of NiTi rotary files has helped pediatric dentists also. With the availability of rapidly coming versions of these files, it may be difficult to pick appropriate file systems and techniques most suitable for an individual case. Practitioners must always bear in mind that all file systems have benefits and weaknesses.

Keywords: Endodontics, Primary teeth, Pulpectomy, Rotary.

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INTRODUCTION

Maintenance of primary teeth until physiological exfoliation contributes to proper mastication, phonation, aesthetics and prevents the development of deleterious habits in children. Therefore, primary teeth with pulpitis or necrosis should be considered for endodontic treatment.^[1] Pulpectomies of primary teeth with severe pulpal involvement should be considered as the treatment of choice.^[2]

Clinical success is achieved when there is painlessness, no sign of inflammation, infection or mobility. Radiographic success is achieved when the lesions are resolved within six months, and no pathologic root resorption is observed.

The development of nickel-titanium alloys has allowed the use of rotary instruments in endodontic treatment. When compared to the permanent dentition, the rotary instrumentation is faster in deciduous teeth, due to the smaller root canal length. The rotary technique of instrumentation is known to minimize the debris extrusion and also facilitates obturation. It also favors a patient's cooperation by shortening the treatment time for shaping the canals that is one of the greatest challenges in pediatric endodontics. Some systems that have been used for pediatric endodontics are ProFile, ProTaper, Hero 642, Mtwo, K3, FlexMaster and Wave One.^[3]

ROTARY SYSTEMS IN PAEDIATRIC DENTISTRY

The application of rotary instrumentation in Paediatric Endodontics dates back to 1993. The use of NiTi rotary files in primary teeth root canals was first described by Barr et al. in 2000. Since then various NiTi rotary systems with a modified technique have found its use in Paediatric Dentistry.^[4]

Ni-Ti files have an elastic memory because of which they do not need pre-curvature; they can prepare the root canal in high speed as they are motor activated. The elastic memory of the Ni-Ti file reduces the probability of root canal deformation, and the radial land of the Ni-Ti file keeps it in the centre of the root canal via wall support and inactive tips. It has been seen that shaping procedures can be more easily and predictably completed, but a good demonstration of an

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effective cleansing of the entire root canal system using Ni-Ti rotary instruments has not been shown.^[5]

Design of Rotary Instruments

Taper

The taper usually is expressed as the amount the file diameter increases each millimeter along its working surface from the tip towards the filehandle. It is particularly important concerning "system concepts".^[6] These files have the constant apical tip size, but their taper varies from 0.04–0.12. The idea behind variable or graduating tapers is that each successive file is only engaging a minimal aspect of the canal wall.^[7]

Design of Tip

The cutting instrument can have a cutting or non-cutting tip. Rotary files with cutting tips are more aggressive than non-cutting tips. A non-cutting tip will create a concentric circle at the end of the root that can be obturated easily.^[7]

Rake Angle

Rake angles affect the cutting efficiency of the instrument, and it is the angle formed by the cutting edge to the long axis of the instrument. The cutting efficiency of the positive rake angle is better than neutral rake angles, which just scraps the canal. If the angle formed by the leading edge and the surface to be cut acute, the rake angle is said to be negative or scraping.^[7]

Radial Land

A radial land is a surface that projects axially from the central axis, between flutes, as far as the cutting edge, this surface is called the land.^[8]

Helical Angle

The helical angle is the angle that the cutting edge makes with the long axis of the file. As a rotary file works in a canal, the dentinal debris needs to be removed quickly and effectively.^[9]

Pitch

It is the number of spirals or threads/unit. Screws have a constant pitch and constant helical angles so that the instrument can be pulled down/sucked down into the canal. This feature is highly significant in rotary instrumentation while using files with a constant taper.^[10]

THE PROTAPER SYSTEM

These instruments were designed by Dr. Cliff Ruddle, Dr. John West, and Dr. Pierre Machtou. ProTaperNiTi instruments (DentsplyMaillefer, Ballaigues, Switzerland) represent a new generation of instruments for shaping root canals. The ProTaper system is based on a unique concept and comprises just six instruments, three shaping files and three finishing files [Table 1].^[11,12]

Technique of using ProTaper in Primary Teeth

The pulpectomy starts with the access and removal of coronal tissue. The abrupt cervical constriction in primary molars, with a shelf of dentin overlying the canal orifice, which results in an acutely curved root canal orifice, should be removed to facilitate straight-line access and to reduce the risk of

instrument separation. Then approximate working length is measured. After the approximation of working length and before instrumentation, the pulp chamber is copiously irrigated with 2.5% sodium hypochlorite.

Then a number 10 k file is first used to explore the canals. Now the ProTaper SX file is inserted into the canal to about 3 mm beyond the root canal orifice with a slight brushing motion to remove any remaining overlying dentin and to improve straight-line access. The S2 file is then inserted into the canal while rotating and taken to the working length. The S2 file has a tip size of 20 and an apical taper of 4%, which approximates the root canal size of primary molars. If a point of resistance is encountered, no attempt is made to go beyond the resistance point to avoid risk of instrument separation. Pulp tissue is commonly wrapped around the S2 file when it was withdrawn.

Irrigation with 2.5% sodium hypochlorite and normal saline is done copiously during filing. Lateral perforation is avoided by using only SX and S2 files during preparation. The S1 file is not used, because it is too small to efficiently prepare the root canals of primary molars, and the F series is not used either, because the increased taper (7%~9 %) and tip size might result in excessive apical dentin removal. For teeth undergoing physiological root resorption the greater taper (8%~5.5%) F2 file might be a better choice than S2.^[13]

Advantages

Reduces friction, increases the cutting efficiency, lowers the risk of instrument separation, replaces Gates-Glidden drills, selective removal of dentin.^[13]

Disadvantages

Cannot be used twice in same root and unexpected lateral perforation.^[14]

THE K3 ROTARY SYSTEM

The K3 rotary nickel-titanium file system (SybronEndo, Orange, California) was introduced initially in North America in January 2002. The K3 system was designed by Dr. John McSpadden (Lookout Mountain, Georgia).^[15] The availability of K3 canal shaping files concerning various parameters is given in Table 2.

Table 1: Design specifications

No. of instruments/set	Tip sizes	Size increments	r.p.m. (recommended)	Lengths
6 (3 shaping files; SX, S1, S2; 3 finishing files; F1,F2,F3)	19-30	Vary along the working part of an individual instrument	150 to 300 minimal axial force, low to medium torque to fracture, varying working torque	19,21,25 mm

Table 2: The availability of K3 canal shaping files with regard to taper, tip size, and length

Taper	Tip size	17 mm	21 mm	25 mm	30 mm
02	#15 - #40		YES	YES	YES
04	#15 - #60		YES	YES	YES
06	#15 - #60		YES	YES	YES
08	#25	YES	YES	YES	
10	#25	YES	YES	YES	
12	#25	YES	YES	YES	

Technique of using K3 Rotary System in Primary Teeth

The pulpectomy procedure is begun with standard access and removal of coronal tissue. The working length is established by placing the first adjusting file to radiographic working length; the instrumentation is started with the 0.06 taper file. The canals are cleansed and shaped with 3 progressively larger tapered files, using the “crown down” technique; each instrument is changed according to the manufacturer’s recommendation. After use of each file, the root canals are irrigated with 1 mL of 1% NaOCl. This system is used with at 350 rpm and slow torque.^[16]

Advantages

Excellent cutting characteristics, increased flexibility, canal tracking, prevents screwing in effect, minimum wear of root canal walls, less time, less canal transportation, resist torsional and cyclic fatigue, reduces patient’s fatigue and tactile control.^[2,16-18]

Disadvantages

High cost, use at a particular speed (300 – 350rpm), handling should be gentle and should never be forced.^[19]

THE FLEXMASTER SYSTEM

Another new generation files are FlexMaster (FM) nickel-titanium (NiTi) files [Table 3]. They have been used in Europe successfully for some time. The cutting blades of FM instruments have no radial lands to provide efficient and effective removal of dentine. The overall manufacturing quality is high, with minimal metal flash and rollover.^[20]

Technique of using FlexMaster in Primary Teeth

The pulpectomy procedure begins with standard access and removal of coronal tissue using the crown down preparation technique. The root canal orifices were enlarged with the orifice shaper “Introfile” until the middle third of the root canal. At first 25/0.04 taper is used until the resistance is felt followed by 25/0.02 taper till the working length.^[5]

Another technique of application of the Flex-Master system for the preparation of primary root canals during pulpectomy is instrumentation with 25-mm-long FlexMaster Ni-Ti rotary files using a modified crown down technique with 35/0.06, 35/0.04, 30/0.06 and 40/0.02 tapers. Shaping is completed with a gentle advance and withdrawal motion. Instruments are removed when resistance is felt and changed for the next instrument.^[21]

Advantages

Superior radiographic findings, less chair time, occasional instrument fracture, safe, less canal transportation and fewer

canal aberrations, prepare curved canals rapidly, and with minimal transportation.^[21,22]

THE HERO SHAPERS

The Hero instruments (Micro-Mega, Besancon, France) are an example of a second-generation rotary system. Three essential rules must be followed when using the HERO 642 (Micro-Mega, Besancon on, France)–the first rotary NiTi instrument designed without radial lands:^[23]

- The difficulty of the case, including consideration of the canal curvature, and degree of dentine mineralization determine the most suitable sequence
- The correct levels of penetration for each taper must be respected
- Circumferential shaping of the canal is achieved using a brushing motion.

The technique of using HERO Shaper in Primary Teeth

The canal orifice must be located and an access cavity prepared by removing all coronal interferences. The canal orifice must be opened and preferably enlarged. A pre-operative radiograph is used to estimate the working length. The first penetration with a #10 K-file coupled to an electronic apex locator will confirm the first evaluation. The working length can be re-evaluated once the coronal two-thirds has been prepared. Preparation is performed with 21 mm nickel-titanium instruments with 2 and 4% tapers using the crown down technique.

The rotation speed must be kept constant and not exceed 600 r.p.m. The waves should not exceed the penetration levels of the files, i.e., 0.06 at 2/3 WL and 0.04 at WL. However, if the canal is large or its curve is moderate, it can allow a 0.06 instrument to penetrate to the apex. It may not be necessary to use the 0.04 instruments in that scenario.^[14,24]

Advantages

The requirement of limited numbers of files are required, simpler, short operating time, remove interferences, facilitate treatment more efficiently, uniform dentine removal and symmetrical canal shapes.^[25]

Disadvantages

Risk of breakage must be taken into consideration; no pressure should be applied on the head of the handpiece, use at constant rotational speed and high cost.^[14,24]

THE MTWO NiTi ROTARY SYSTEM

A new generation of NiTi rotary instruments recently introduced in the European market is the Mtwo endodontic instruments (VDW, Munich, Germany). After this basic

Table 3: Available FlexMaster instruments in different lengths and ISO sizes

Taper (%)	Marking	ISO Size	Length (mm)
2	One ring	15-70	21, 25, 31
4	Two rings	15-40	21, 25, 31
6	Three rings	15-40	21, 25

sequence, which gives the canal a #25/.06 shape, three different approaches to root canal preparation are permitted by this system. The first sequence allows clinicians to achieve enlarged apical diameters using the size 30/0.05 taper, 35/0.04 taper or 40/0.04 taper; the second leads to a .07 taper maintaining a size #25 apical preparation; the third implies the use of the Mtwo apical files.^[26]

Technique of using Mtwo Rotary System in Primary Teeth

The procedure of pulpectomy begins with access preparation and removal of coronal tissue. A Pre-treatment radiograph is taken to determine the working length. The Root canal preparation is done with 21 mm long MtwoNiTi rotary files driven with constant torque at a maximum speed of 280rpm. Four rotary instruments are used 10/0.04, 15/0.05, 20/0.06 and 25/0.06 to full working length.^[27,28]

Advantages

Increased instrument stability, efficient dentine removal, excellent lateral cutting ability, automatic upwards transport of debris, no screw-in effect, short working time, efficient preparation and no unnecessary loss of tooth substance.²⁹

Disadvantages

High deformation rate, instrument fractures, and high cost.^[29]

THE WAVE ONE RECIPROCATING SYSTEM

New Wave One NiTi file system from DENTSPLY Maillefer is a SINGLE file system, SINGLE-file system, to shape the root canal completely from the beginning till the end. Mostly, the technique requires only one hand file, followed by one single Wave One file to shape the canal thoroughly.

The Wave One single-file reciprocating system consists of three files. Lengths available are 21, 25 and 31mm:

The Wave One Small file:

- They are used for the instrumentation of fine canals.
- The tip size is ISO 21, with a continuous 6% taper.

The Wave One Primary file:

- Used for the instrumentation of the majority of the canals.
- The tip size is ISO 25 with 8% apical taper that reduces towards the coronal end.

The Wave One Large file:

- Used for the instrumentation of large canals.
- The tip size is ISO 40 with 8% apical taper that reduces towards the coronal end.^[30]

Technique of using Wave One in Primary Teeth^[30]

- Straight-line access,
- Wave One files selection;
- Single-file shaping;
- Copious irrigation with 5% NaOCl and EDTA before, during, and after instrumentation.

Wave One file selection and Clinical Procedure^[31]

A good pre-operative IOPA radiograph will give an estimation of a number of canals, canal size, canal length, and degree of

its curvature. Only the first-hand file into the canal will aid in the selection of the Wave One file as follows:

- Use Wave One Small file in the canals where 10 K-file is very resistant to movement
- Use Wave One Primary file in the canals where 10 K-file moves to whole canal length easily or passively.
- Use Wave One Large file in the canals where a 20 K-file or larger goes to the whole length.

Single-file Shaping

- Insert hand file into 2/3rd of the canal length and provide watch-winding motion.
- In motion insertion of Wave One file to 2/3rd of the canal length.
- Copious irrigation.
- Insert hand file to a full length of the canal, confirm with an apex locator and reconfirm with a radiograph.
- Insert Wave One file to a full length of the canal.
- Confirm the diameter of apical foramen with hand file of the same size as Wave One file (snug fit implies complete preparation)
- If Wave One file is loose at the apical end, consider the next size of Wave One file

Guidelines for use^[31]

- Use Wave One files with a progressive up and down movement 3-4 times with minimal force application.
- Removal of a file is recommended on a regular basis followed by cleaning the file and irrigating the canal.
- Confirm the patency of the canal if the file does not progress and consider using a smaller Wave One file.
- Glide path management is minimal with Wave One shaping files, but it can also be secured firstly with path files.
- Complete hand preparation of an apical portion of the non-reproducible glide path in severely curved canals should be considered.
- If used short of a length, the brushing action of Wave One files can help to relocate the canal orifice and to expand coronal shape.
- Copious and constant irrigation with NaOCl and later EDTA, to avoid instrumentation in a dry canal.
- Activation of irrigating solutions to enhance their effectiveness in short preparation time, ideally use EndoActivator (DENTSPLY Maillefer).

Advantages

One instrument per tooth, low cost, less instrument separation, decreased global shaping time, eliminates of procedural errors using a single instrument and possibility of prior contamination.^[30]

Kedo –S Rotary System

Kedo-S (Reeganz Dental Care); Kids Endodontic Shaper is the world's first rotary file exclusively for shaping primary teeth. It is invented by Dr.Ganesh Jeevanandan and came into existence in Nov 2016.

It is a three files system 16mm in length - D1, E1, U1. D1 is specifically designed for molars with narrower canals. E1 is designed for molars with wider canals, and U1 is devised for incisors. They are made functional at a speed of ≤ 250 rpm.

This system claims to provide a safe procedure and simple technique to complete the shaping of primary root canals in the shortest time available. However, studies are yet to be conducted to confirm its efficacy.^[32]

SUMMARY AND CONCLUSION

The research in the field of rotary endodontic instruments is an ongoing process. With every passing day, newer systems with better efficiencies are being introduced. NiTi rotary system in Paediatric Dentistry is like a double-edged sword with great advantages and disadvantages. There is a reduction in tactile sensitivity during apical preparation if compared with manual preparation, so to control working length, previous training of the operator in rotary instrumentation is important. The high cost of and need for training to learn the technique are other limitations Ni-Ti rotary systems.

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