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Revolutionizing Pediatric Endodontics: A Review of Innovative Rotary Files

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ABSTRACT

Pediatric rotary files, designed for the endodontic treatment of primary and immature teeth, have gained attention for their efficiency and safety. This review examines the literature on various types of pediatric rotary files, highlighting their design features, biocompatibility, and clinical outcomes. Studies indicate a reduced treatment time and improved shaping ability compared to manual techniques. The review also discusses the importance of selecting appropriate files based on tooth anatomy and the age of the child. Overall, pediatric rotary files prove to be a promising tool in modern pediatric dentistry, providing effective and minimally invasive treatment options.

Introduction:

Various rotary file systems were used in Pediatric practice. However, the rotary file systems exclusive for Pediatric practice were first introduced in the year 2016 by Dr. Ganesh Jeevanandan.[1] The pediatric patients have a limited mouth opening. Hence the longer length of adult rotary files makes it difficult to use in Pediatric patients. Pediatric rotary files are designed with a shorter length. This provides ease of operation when working with pediatric patients.[2] Researchers had suggested that a rotary file with modified length, taper, and tip size would be more effective for pulpectomy in primary teeth. Various studies have shown that Ni-Ti instruments are efficient and effective for root canal preparation in permanent teeth. Barr ES et al. used Ni-Ti ProFile 0.04 taper rotary files for pulpectomy procedures and concluded that the use of Ni-Ti files resulted in uniform and predictable root canal fillings.[3] Although these les are frequently used for permanent teeth, a major concern in applying them for primary teeth is the possibility of lateral perforation on the inner surface of primary teeth. These lateral perforations can be due to the pre designed greater taper of the rotary files. Some of the commercially available Pediatric rotary files are Prime Pedo (India)[2], DXL-Pro Pedo (India, Kedo-S (India), Pro AF Baby Gold (India), Neolix (France), DencoKids files (China), and SaniKid rotary files (China).[1-6]

Novel Pediatric Rotary File Systems

Kedo-S File System: World's first files designed for root canal preparation in primary teeth developed by Dr. Ganesh Jeevanandan (Reeganz Dental Care Pvt. Ltd. India).[1]

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Kedo-SH Manual File: The Kedo-SH manual file system consists of six color-coded files with standard 16mm length and 12mm flutes. The white-coded K file is made up of stainless steel with 0.15 tip and 2% taper. This file is specifically designed to access the initial patency of the canal in primary molar teeth. The yellow-coded H file is made up of stainless steel with 0.20 tip and 2% taper. This file is specifically designed for removal of pulpal tissue from the canals in primary molar teeth. The red-coded file corresponds to the D1 rotary file, which is made up of nickel-titanium alloy with 0.25 tip and 4–8% taper. This file is used to prepare the mesiobuccal and mesiolingual in mandibular molars and mesiobuccal and distobuccal in maxillary molars. The blue-coded file corresponds to the E1 rotary file, which is made up of nickel-titanium alloy with 0.30 tip and 4–8% taper. This file is used to prepare the wider canals in primary teeth namely distal canal(s) in mandibular molars and palatal canal(s) in maxillary molars. The green-coded H file is made up of stainless steel with 0.35 tip and 2% taper. This file is specifically designed to remove the pupal tissue from the canals in maxillary and mandibular primary incisors. The black-coded file corresponds to the U1 rotary file, which is made up of nickel-titanium alloy with 0.40 tip and 4–8% taper. This file is specifically designed to prepare maxillary and mandibular anterior primary teeth. **(Fig 1)**

Figure 1: Kedo-SH Manual File System

Kedo-S Rotary File System: The Kedo-S system is available in six distinct generations, each iteration incorporating advancements to improve effectiveness and user convenience in endodontic procedures for children. **(Table 1)**[3,4]

First-Generation (Kedo-S Rotary File): The Kedo-S rotary file system consists of three files namely D1, E1 and U1. All the files are made up of nickel-titanium alloy with a triangular cross-section and a non-cutting tip. The files also have a negative rake angle with variably variable taper (VV). The Kedo-S files are 16 mm in length with 12 mm cutting blades (working area of the files). D1 of the Kedo-S rotary file system consists of 0.25 ISO tip diameter with a VV taper of 4–8%. This file is specifically designed for the narrower canals in primary teeth, namely mesiobuccal and mesiolingual in mandibular molars and mesiobuccal and distobuccal in maxillary molars. The E1 file consists of 0.30 ISO tip diameter with a VV taper of 4–8%. This file is specifically designed for the wider canals in primary teeth, namely distal canal(s) in mandibular molars and palatal canal(s) in maxillary molars. The U1 file consists of 0.40 ISO tip diameter with a VV taper of 4–8%. This file is specifically designed to prepare maxillary and mandibular anterior primary teeth. **(Fig 2)**[1,3,4]

Figure 2: Kedo-S Rotary File System

Second-Generation (Kedo- SG Rotary File): These files are crafted from heat-treated nickel-titanium (NiTi) using advanced M-Wire technology, which enhances their flexibility and durability. This innovative design not only increases the efficiency of the root canal procedure by reducing the time required but also significantly improves the quality of obturation by ensuring a more precise and thorough cleaning and shaping of the root canal system.[5,6]
Kedo-SG is almost similar to Kedo-S except for newer & improved characteristics which are:

- NiTi heat treatment done
- M wire technology
- Greater resistance to cyclic fatigue

Third-Generation (Kedo-SG Blue Rotary File): These files undergo a heat treatment process that imparts controlled memory, resulting in exceptional flexibility and up to 75% greater resistance to cyclic fatigue, attributed to the presence of titanium oxide. It is advised to operate them at speeds ranging from 250 to 300 RPM with a torque setting of 2.2 to 2.4 Ncm. Priyadarshini et al. found that utilizing Kedo SG blue files in lower primary molars resulted in reduced instrumentation times and enhanced quality of obturation. In a 2024 study by Jeepalyam S et al., the effectiveness of two pediatric rotary systems, Kedo-SG Blue and Prime Pedo files, was compared in primary mandibular molars. The study concluded that the Kedo-SG Blue™ rotary system outperformed the Prime-Pedo™ system by achieving shorter instrumentation and obturation times, along with a greater number of canals that were optimally filled.[4]
Kedo-SG Blue is the 3rd generation of Kedo file systems, similar to previous generations but with improved characteristics which included:

- Heat treated NiTi with controlled memory wiring
- Blue titanium oxide layer coating (prolongs usability of cutting, greater flexibility & increased resistance to cyclic fatigue)

Fourth Generation (Kedo- S Square Rotary File): This system simplifies the design by using only two files: the P1 file for molars and the A1 file for anterior teeth, a reduction from the three-file setup in previous generations. The files feature a variable cross-section, with the apical 5 mm having a triangular cross-section that makes three-point contact with the root canal, while the coronal 7 mm adopts a teardrop shape with two-point contact. The A1 file has a taper ranging from 6% to 8%, starting with a 6% taper in the first 5 mm, which then increases to 7% and 8%. This design minimizes the risk of over-preparation, allowing smoother flow and reducing the chance of obturating material extrusion. Additionally, these files are known for their low fracture rate. Mohamed RH et al. in a study revealed that Kedo-S Square files offer more conservative canal preparation, better taper control, and significantly reduced instrumentation time when compared to traditional K- and H-files, based on CBCT evaluation.[6,7]

Important characteristics of the file include:
Apical 5 mm: Triangular cross-section, three-point contact with canal wall, 4-5% taper, similar to Kedo S files.
Coronal 7 mm: Tear-drop cross-section, 2-point contact with canal wall, 6-8% taper, similar to H files.
Two files in this system are as follows: A1 – Replaces U1 file from previous generations. Tip diameter - 0.038 mm, cutting edge length 13 mm & 17 mm file length. Colour code – black. Green & black bands on handle for identification. P1-Replaces E1 & D1 files from previous generations. Tip diameter - 0.028 mm, cutting edge length 12 mm & 16 mm file length. Colour code-black. Green & black bands on handle for identification.

Fifth Generation (Kedo- S Plus Rotary File): Kedo S plus has recently launched an innovative file system that utilizes a uniform cross-section and dual-core material, enhanced through heat treatment and titanium oxide coating in the apical and middle regions. This design optimizes the accurate shaping of the apical region while mitigating the risk of iatrogenic lateral perforations. Impressively, one file is capable of preparing up to 14 molars. This system strikes an ideal balance between conservative canal preparation and comprehensive cleaning, making it versatile for a wide range of clinical scenarios. **(Fig 3)**[5,6]

Figure 3: Kedo-S Plus Rotary File

Sixth Generation (Kedo-Nano Plus): The latest generation file, Kedo-Nano Plus, is coated with nanoparticles along its length, making it highly flexible and capable of withstanding torsional forces in curved canals. As mentioned, we were able to clean the apical portion optimally, which is crucial due to the ramifications in this area, and were able to provide optimal obturation. This nano coating of the file was added to reduce the file fracture, which could have reduced the aggressive nature of the file in the coronal aspect, thereby leading to slightly reduced preparation in the coronal third of the canals. **(Fig 4)**

Figure 4: Kedo S Square, Kedo S Plus, Kedo Nano Plus

Table 1: Various Generation of Kedo-S Files

Features	Kedo-S	Kedo-SG	Kedo-SG Blue Rotary File	Kedo S Square	Kedo S Plus	Kedo Nano Plus
Length	File length - 16 mm	File length - 16 mm	File length - 16 mm	File length - 16 mm	File length - 16 mm	File length - 16 mm
	Flute length - 12 mm	Flute length - 12 mm	Flute length - 12 mm	Flute length - 12 mm	Flute length - 12 mm	Flute length - 12 mm

Metall-urgy	Nickel-Titanium alloy	Heat Treat-ed NiTi	Heat treated NiTi with Blue titanium oxide layer coating	CM wire technology	CM wire technology	CM wire technology
Cross-section	Dual Apical region: Triangular Coronal Section - Tear-shaped	Triangu-lar	Triangular	Dual Apical 5 mm - triangular Coronal 7 mm region – teardrop	Triangular	Triangular
Taper	4-8%	4-8%	4-8%	4-8%	4-8%	4-8%
RPM	150–300	150–300	250-300	250-300	250-300	250-300
Torque	2.2–2.4 Ncm	2.2-2.4 Ncm	2.2–2.4 Ncm	2.2–2.4 Ncm	2.2–2.4 Ncm	2.2–2.4 Ncm

DXL Pro Pedo Rotary File system: The DXL-Pro™ files are designed with features such as convex triangular cross sections, a guiding non-cutting tip, and controlled memory. This set includes three files with sizes #30, #20, and #25, each featuring a 4% taper. The #30 orifice enlarging file measures 16 mm in length, while the other two files are 18 mm long. These files undergo heat treatment, which, along with the controlled memory of both Prime Pedo™ and DXL-Pro™ rotary files, allows them to maintain proper alignment and preserve the natural architecture of primary molars. This design may enhance their resistance to fatigue and provide greater flexibility. Particularly in primary molars with curved root canals, improved fatigue resistance can reduce the risk of rotary file fracture.[2]

The files in this system are:
#30: 16 mm length, 8% taper, designed for orifice enlargement
#20: 16 mm length, 6% taper
#25: 16 mm length, 6% taper

Pro AF Baby Gold File: Pro AF Baby Gold file (Kids-e-dental Pvt. Ltd.in India) is a five-file system utilizing NiTi CM wire technology having constant taper of 4% or 6%. B1 file (#20–04%), B2 file (#25–04%), B3 file (#25–06%), B4 file (#30–04%), and B5 file (#40–04%). B1 and B2 files are used for preparing the narrow canals while the wide canals (distal/palatal) are prepared by B3 and B4. Specially designed with short length of 17 mm offers more safety and comfort. Advanced NiTi heat treated M wire provides better canal centricity. These files have high flexibility with minimal chances of separation. These files can also be used in adult patients with restricted mouth opening and third molar root canal preparation. In a study by Jain S et al., the canal transportation abilities of the Pro AF Baby Gold and Kedo-S files were compared using CBCT imaging. The findings revealed that the Pro AF Baby Gold file achieved significantly superior canal centricity in the apical region compared to the Kedo-S file.
A recent study by Misgar et al. demonstrated that pediatric rotary files, including Kedo-S and Pro AF files, outperformed manual NiTi K files in terms of smear layer evaluation. An *in vitro* study demonstrated that Pro AF files had significantly less instrumentation time in primary molars compared to K files. [8]

Pedoflex Rotary System: Pedo flex system (Orikam Health care, India) is a three-file system [#20 (yellow), #25 (red), and #30 (blue)] recommended for use at 350 RPM and 1.5 Ncm torque. Files are presented with a length of 16 mm with 4% taper and are super flexible. Cross section is triangular having sharp cutting edges and non-cutting tip, thereby preventing apical transportation. Additionally, the manufacturers claim that the flutes remain intact under stress, thereby increasing resistance to cyclic fatigue. Kesri R et al. in 2023 conducted a study to evaluate cutting efficiency of Pedoflex rotary, Kedo SH manual file, and manual K file systems used in root canal instrumentation while performing pulp therapy of deciduous teeth with a stereomicroscope and concluded that cutting efficacy of the Pedoflex rotary files was seen to be superior to that of Kedo SH and manual K files.[9]

NT Pedo Gold Pro files: The NT Pedo Gold Pro files are made from premium Nickel-Titanium (NiTi) alloy, providing both strength and flexibility. Featuring a progressive taper design, these files allow for precise and controlled root canal instrumentation, while the advanced flute design and tip geometry enhance safety during procedures. The process begins by preparing the access cavity and locating the canal orifice. Use a #8 or #10 K-File for initial exploration of the canal. Next, create a glide path with a #15 hand file to facilitate the insertion of rotary files. It's crucial to establish the working length using an apex Locator or radiograph for accuracy. Additionally, enhance the glide path with the 15/06 NT File, advancing it to the working length in an 'in and out' motion. Throughout the procedure, ensure to irrigate the canal to maintain cleanliness and recapitulate with the K-File between the use of two rotary files. For final preparation of the canal, choose the appropriate file based on the canal

width: use the 20/04 NT File for narrow canals and the 25/04 NT File for wider canals to achieve optimal shaping. It's essential to follow the recommended speed and torque settings, maintaining a speed of 300 RPM and a torque of 1.5-2.0 NCm for safe and efficient operation. Throughout the procedure, apply gentle and consistent filing pressure to avoid over-instrumentation. Additionally, regularly clean and irrigate the files to prevent debris accumulation and ensure their performance remains optimal.[10]

Dentmark P File: The Dentmark Pedo File for kids, identified by its blue color and heat treatment, demonstrates a remarkable fivefold increase in cyclic fatigue resistance compared to other files. Made from high-quality Nickel-Titanium material, these files come in standard lengths of 21 mm and 25 mm. Each package contains 4 pieces (P1: 25/04 17mm, P2: 30/04 17mm, P3: 40/04, 19mm, P4: 25/06, 17mm), available in assorted or single sizes, ensuring convenience for dental practitioners. With a torque range of 2.0 to 3.2 and a recommended rotary speed of 300 RPM, these files are designed to provide safe and effective instrumentation for pediatric dentistry.

Speedendo Pedo NiTi Rotary Files: These are specifically designed to simplify, enhance safety, and improve effectiveness in pediatric endodontics. Their innovative design and advanced material properties strike an ideal balance between flexibility, durability, and visibility, ensuring optimal outcomes for young patients. Featuring Blue CM-Wire Technology, the heat activation enhances flexibility and fracture resistance, promoting safe and efficient use. The blue coating also improves visibility, increasing contrast within the tooth structure for precise monitoring of the file's position and progress.

Begin by preparing the access cavity and exploring the canal using 8#, 10#, or 15# K-files. Use the open file 17/08 to prepare the upper third of the canal crown. Then, employ the 20#/04 (yellow), 25#/04 (red), 25#/26 (red), and 30#/04 (blue) files in a gentle brushing motion with irrigation. Move the instrument in a slow in-and-out pecking motion until you reach the working length. Remember to clean the cutting flutes after every few strokes, irrigate the canal, and recapitulate with a K-file. Keep the speed at 260 RPM and torque at 1 Ncm for optimal results.

Kids-e-File: Kids-e-files are advanced heat-treated rainbow rotary files specifically designed for effective and efficient root canal preparation in primary teeth. These innovative files feature a CM wire NiTi memory alloy, which enhances flexibility and resistance to cyclic fatigue. The triangular cross-section maintains central stiffness while offering high cutting efficiency, and the non-cutting safety tip further ensures safe usage. With a constant taper of 4 percent, these files help prevent dentinal cracks and over-preparation, allowing for smoother root canal debris removal. The unique rainbow surface treatment reduces the tendency for crack propagation, thereby improving resistance to cyclic fatigue. This design allows the files to easily navigate and prepare curved root canals while facilitating the transportation of debris up the canal, ultimately decreasing preparation time. Moreover, the inactive tip design minimizes the risk of perforations and zipping during preparation, making them a reliable choice for pediatric dentistry. The variable pitch design along the length of Kids-e-files enhances mechanical resistance and reduces the risk of tip fracture. The vibrant rainbow colors are not merely for aesthetic appeal; they result from a meticulous heat treatment process. This process involves three stages, beginning at the shank of the file. The base of the cutting file is heat-treated to achieve higher rigidity and improved control. As you move towards the tip, you'll notice a gradual color change, reflecting the different treatment levels. Each section undergoes treatment at progressively higher temperatures and durations, culminating in the tip, which experiences the highest level of heat treatment and maximum flexibility to prevent fracture.[5]

Prime Pedo™ Rotary File: The Prime Pedo™ files that are utilized feature-controlled memory, a triangular cross-section, and heat treatment. The Prime PedoTM file system includes the Starter file (8% taper, 16 mm), P1 file (#15, 6% taper, 18 mm), P2 file (#25, 6% taper, 18 mm), and endodontic file (2% taper, 18 mm). The length markings on the file are as follows: 12 mm up to the flutes, 13 mm stopper above the flutes, 14 mm marker ring present, and 15 mm above this mark, with a marker ring at 16 mm. As a result, a ruler or scale is not required to align the stopper for repeatedly setting the working length. The Prime PedoTM files have a gold treatment and controlled memory, which allows them to be centered in the curved canals of primary molars.

Nanavati K et al. conducted a study to evaluated the apically Extruded Debris during Pulpectomy Procedure in Primary Molar Teeth Using Two Different Rotary Systems (Prime Pedo and DXL Pro Pedo) and Hand Files. They concluded that the Prime Pedo™ and DXL-Pro Pedo™ pediatric rotary files extruded significantly lower number of debris apically during pulpectomy as compared to hand files.[11]

Sani Kid Rotary Files: Introduced in 2019 by Chengdu Sani Medical Equipment Co. Ltd., the Sani Kid system comprises three distinct files: 1S, 2S, and 3S. The 1S file, indicated in yellow, has a 04/20 configuration (4% taper, 20# size) and comes in lengths of 21 mm, 25 mm, 28 mm, and 31 mm. The 2S file, marked in red, features a 06/25 configuration (6% taper, 25# size) and is available in a 25 mm length. The 3S file, in green, has a 04/35 size (4% taper, 35# ring) and measures 28 mm. Each file is engineered with a short thread to enhance chip evacuation. They come in 17 mm and 19 mm lengths, with tapers of 4% and 6%, and are optimally

used at speeds of 150-300 rpm and torques of 2.0-2.5 N.cm.[12]

Denco Dental Kids Files (China): The Denco Kedo files, produced by Shenzhen Denco Medical Ltd. in China, are heat-activated blue NiTi files that come in four sizes: #25 (0.04 mm), #25 (0.06 mm), #30 (0.04 mm), and #40 (0.04 mm). They are available in lengths of 17 mm and 19 mm and are intended for use at a speed of 300 RPM with a torque of 2 Ncm. In a 2023 study led by Esra OZ et al., researchers assessed the effectiveness of different endodontic file systems in reducing Enterococcus faecalis in primary molars through microbiological testing. The study compared several pediatric rotary systems (EndoArt Pedo Kit Blue, EasyInSmile X-Baby, and Denco Kids), the ProTaper Next rotary system, and the WaveOne Gold reciprocating system. Findings revealed that both Denco Kids and EndoArt Pedo Kit Blue were more successful in lowering bacterial counts than EasyInSmile X-Baby. Moreover, there was no significant difference in bacterial reduction between ProTaper Next and the other file systems. Interestingly, in terms of single-file techniques, the Denco Kids rotary system significantly outperformed the WaveOne Gold in reducing bacterial levels.[13]

Endoart Pedo Blue Rotary Files Kit (Turkey): Designed specifically for pediatric endodontic treatments, this advanced rotary file system guarantees safe and efficient canal preparation in primary teeth. Constructed from heat-treated Blue Ni-Ti wire, it boasts superior flexibility, durability, and fracture resistance compared to standard Ni-Ti files. Its compact 16mm length makes it ideal for shorter root canals in children, ensuring easy handling and precision during procedures. The files feature a regular taper, which helps maintain the natural anatomy of the root canal while minimizing procedural errors. Enhanced sharpness facilitates smooth and efficient cutting with minimal resistance. With four times better cyclic fatigue resistance, this system guarantees greater longevity and safety. The laser-marked shank enhances easy identification, and each pack includes three assorted files for complete canal shaping. Material specifications include Nickel-Titanium wire, with a length of 16mm, intended for pediatric endodontics, a regular taper, and a high level of flexibility with an asymmetrical cross-section.[13]

Endogal Kids Rotary System: The Endogal Kids Rotary system, produced by Galician Endodontics Company in Lugo, Spain, includes four specialized files tailored for different canal sizes. The EK1 file (0.25 tip diameter, 4% taper) is intended for narrow canals, while the EK2 file (0.25 tip diameter, 6% taper) suits medium canals. The EK3 file (0.30 tip diameter, 4% taper) is designed for wide canals, and the EK4 file (0.40 tip diameter, 4% taper) is used for very wide canals in anterior teeth. Made from heat-treated NiTi alloy with a triangular cross-section, these files measure 17 mm in length, except for the EK4, which is 19 mm long. This system is compatible with both rotary and reciprocating motions, though reciprocating movement is preferable in pediatric cases as it reduces working time. Research comparing the Endogal and Reciproc Blue NiTi endodontic reciprocating systems has demonstrated comparable outcomes in canal preparation. However, the Reciproc Blue system was found to be more conservative in shaping the coronal third of the canal.[14]

Elephant Kidzo (India): Elephant rotary files are crafted from heat-treated alloy and come in smart sizes, designed for optimal performance in dental procedures. They are recommended to be used at a speed of 350 RPM with a torque of 2.5 n.cm. The KIDZO series includes sizes 25/4, 30/4, and 30/6, all available in a convenient 18 mm length. To ensure effectiveness in pulpectomy of deciduous teeth, users should utilize the files in sequence to achieve the full working length.[14]

Conclusion:

In conclusion, pediatric rotary files represent a significant advancement in endodontic treatment for children, offering improved efficiency, safety, and adaptability to dental anatomy. Their enhanced shaping abilities can lead to better clinical outcomes and increased patient comfort. Continued research and clinical evaluation are essential to ensure optimal use and to address any potential complications in diverse pediatric populations.

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