

Current Developments in Rotary Root Canal Instrument System : A Review

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Abstract

Success in modern day endodontics is based on various principles comprising of diagnosis and treatment planning, knowledge of anatomy and morphology, thorough debridement of the root canal system, mechanical preparation of root canal along with chemical disinfection and three-dimensional obturation, followed by the coronal restoration. In order to facilitate the obturation of root canal system, adequate shaping of root canal is necessary.

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Introduction

Endodontic instruments play a significant role in the success of endodontic treatment starting from the preparation of the access cavity to the final obturation of the root canal space. A continuously tapering funnel shape with the smallest diameter at the end point and the largest at the orifice has been deemed to be the most appropriate canal shape for filling with gutta-percha and sealer.

Since the introduction of the first rotating nickel-titanium (NiTi) files for the preparation of the root canal systems in endodontics, the domain of endodontics has changed. Their increased flexibility, shape and memory, potentially allows shaping of narrow-curved canals without causing aberrations. These files also show superior resistance to torsional fracture due to higher ductility. The variety of rotary instruments for endodontic treatment is staggering. There has been a constant quest for quicker, safer and effective instruments for the treatment protocol.¹

Different Rotary Root Canal Systems

1) Reciproc (VDW)

Introduced in 2008. A system specifically used as reciprocatory .

i. Taper

It is available in .05, .06 and .08 taper .

ii. Cross-Section

S- Shaped cross section.

iii. Length

Available in 21 , 25 and 31 mm

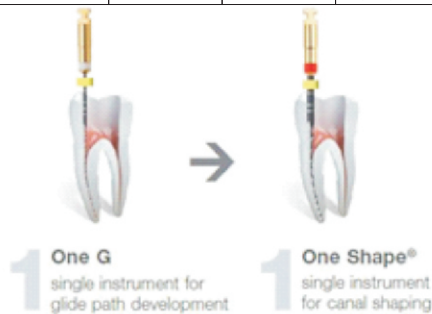
iv. Special Feature

- M – wire technology
- Designed to use as a single instrument.¹

2) One Shape (Micro Mega)

Introduced in 2012. Completing canal shaping with only single file in continuous motion.

No. of File	Tip	#ISO	Length
1	.25	6%	21, 25, 29mm



Taper

The files have a taper .6%

Cross Section

It is seen in three different cross-section zones.

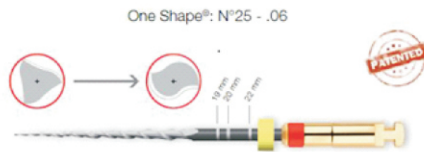
- First zone (apical) presents a variable 3-cutting-edge design.
- Second (middle) prior to the transition , has a cross – section that progressively changes from 3 to 2 cutting edges.
- Last (coronal) is provided with 2 cutting edges

Tip

Non cutting tip , that provides an effective apical progression

Length

It is available in 21 , 25 , 29 mm

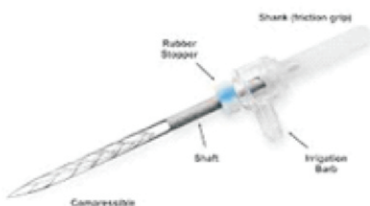


Special Features

The variable pitch of One Shape reduces instrument screwing effects. Anti Breakage Control (IABC) is a safety bonus : the instrument will unwind to avoid separation.²

3) Self Adjusting File

SAF system was introduced in 2010



The SAF is a hollow file designed as an elastically compressible , thin – walled pointed cylinder , composed of a thin nickel – titanium lattice. The SAF is used as a single instrument to achieve complete 3 D root canal shaping and cleaning.

No. of Instruments File	Tip	Taper	Length
2	SAF-1.5mm	.20	.40
	SAF-2mm	.35	.60

Tip

The SAF 1.5 mm is designed for canals with initial apical size of ISO 20-40. The SAF 2 mm is designed for use in wider canals , with initial

apical size of ISO 35-60 , commonly found in retreatments , upper incisors , canines & younger patients.

Length

SAF is available in three sizes :21mm , 25mm & 31mm with diameters : 1.5 and 2 mm.



Special Feature

File portion of the SAF consists of a metal lattice hollow cylinder and is constructed from medical grade nickel-titanium alloy. The file's cylindrical lattice structure permits compression when inserted into the root canal followed by gradual radial expansion. File is surface treated by sandblasting , enabling it to dentin from the canal's interior surface. It has self abrasive surface. It is extremely flexible and compressible. It does not impose its shape on the canal but rather complies with the canal's original shape.³

4) Wave One (Dentsply)

Introduced in 2011 and is a single use

No. of File	Tip Sizes	Taper	Length
	.21	6%	
	.25	8%	
	.40	8%	

Taper

File has taper of 6% & 8%

Cross-Section

WaveOne files have a reverse helix and 2 distinct cross-sections along the length of their active portions. From D1 – D8 , the WaveOne files have a modified convex triangular cross-sections , whereas from D9 - D16 , these files have a convex triangular cross-section. The design of the 2 WaveOne cross-sections is further enhanced by a changing pitch and helical angle along their active portions.

Tip

Non-cutting modified guiding tips , enabling these files to safely progress through virtually any secured canal . Together , these design features enhance safety and efficiency

when shaping canals that have a confirmed , smooth , and reproducible glide path. Tip has the centering ability.

Length

- They are available in 21 , 25 and 31 mm.
- Manufactured by M- Wire technology.
- Variable pitch flutes along the length of the instrument considerably improves safety.⁴

5) V-Taper (SS White Dental)

- Introduced in 2012
- V-Glide Path 2 File System
- Safe-end prevents ledging , transportation and perforation
- Reduced shaft diameter increases flexibility required for curved canal negotiation.
- Variable taper design preserves vital dentin in coronal third.
- Variable pitch design reduces screw-in effect.
- V-Glide Path 2 NiTi files are engineered with the same rate of taper as
- V-Taper 2 NiTi rotary files , making transition from glide path development to shaping seamless.Used together , the V File system offers ability to develop safe and predictable canal patency and follow with both , deep apical shaping and conservative coronal shaping.
- V-Taper 2 Rotary NiTi File System
- Deep apical shape creates better access for irrigation and cleaning ,and 3D obturation.
- Variable taper design creates conservative coronal shape , preserves dentin.
- zA1-2 files per case , lowest cost for shaping per root canal procedure.
- Strongest tested file system

Hand Files					
Description	Size	Order #	Order #	Order #	Package Size
SS White Stainless Steel K-File	10(O2)	21203	21208	21208	6 PACK

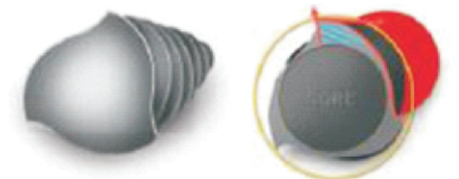
Rotary Files					
Description	Size	Order #	Order #	Order #	Package Size
V-Glide Path™ 2 NiTi Rotary Files	13(V03)	21317	21318	21318	6 PACK
V-Glide Path™ 2 NiTi Rotary Files	17(V04)	21301	21309	21309	6 PACK

Tip

- Non-cutting tip - safeguards against protection.
- Variable pitch - variable helical angle and variable flute pitch
- Variable taper - preserve dentin through the peri-cervical area.
- Reduced shaft - allows file to remain flexible, even in the most curved canals & also allow debris to move up and out the.
- canal while instrumenting.⁵



- Strong & Flexible through Parabolic Core Design



6) Neoniti (Orikam)

- Introduced in 2012
- Neoniti C1 file has a high cutting efficiency
- No screwing effect and good flexibility even towards the handle ,
- allowing good tactile perception during the circumferential brushing action.
- Repositioning of the canal orifices can be achieved easily and quickly.
- Neoniti A1 file has no screwing effect , can achieve an easy and safe access to the apex even in the case of curved canals , and has a rounded gothic tip , achieving a satisfying shape of the apex.
- According to the results , it appears that the neoniti A1 file can be used for a single-instrument technique in continuous rotation after the use of the orifice opener.⁶

7) TF-Adaptive (Kerr Dental)

Introduced in 2013, It has proposed to maximize the advantages of reciprocation while minimizing its disadvantages.

File System & File Technique

2 sets of three file system.

- 1 for small calcifying canals.
- 1 for standard & largers canals.

No. of instruments within each sequence can also vary & adapt to canal anatomy with the last instrument of the sequence used only when the greater apical enlargement is needed d/t larger original canal dimensions and / or enhanced final irrigation techniques.

SMALL (SM)	SM1: #20/ .04	SM2: #25/ .06	SM3: #35/ .04
MEDIUM/ LARGE (ML)	ML1: #25/ .08	ML2: #35/ .06	ML3: #50/ .04

Sequence are also different in their shaping concepts .The medium / large canal sequence is a “true” crown-down technique while the small canal sequence employs a smaller , more flexible instrument (0.4 taper 20 tip size) to pre enlarge the canal & create a glide path which decreases instrument stress for next larger file in sequence , allowing better maintenance of original canal trajectory.

It is an interrupted motion with the following CW-CCW angles : 600 – 0 degree. This interrupted motion is not only as effective as continuous rotation in lateral cutting, thus allowing optional brushing/circumferential filing for better debris removal.

Adaptive Motion Technology



Rotary: 600° clockwise and 0° counterclockwise file motion when no load is applied. Reciprocation: 370° clockwise and up to 50° counterclockwise file motion when load is applied.

Advantages

- Not also it minimizes iatrogenic errors by

reducing the tendency of

- "Screwing in " that is commonly seen with NiTi instruments of great taper.
- * While negotiating the canal , d/t increases instrumentation stress & metal fatigue , motion of TF adaptive instrument changes into a reciprocation mode , with specifically designed CW & CCW angles which vary from 600 – 0 degree upto 370-50 degree.
- It is quite interesting that the clinician will hardly perceive the differences in changing motion d/t very sophisticated algorithm which permits a smooth transition b/w changing angles.
- TF instruments have been found to be the most flexible NiTi instruments available , being significantly more flexible than Protaper & M2 , which are instrument with design & mass very similar to waveOne and reciproc.⁷

8) ProtaperNext (Dentsply)

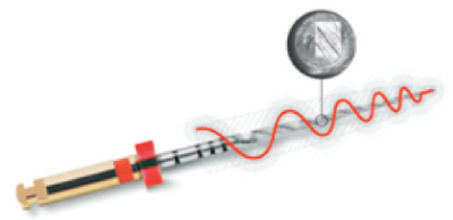
Introduced in 2013.The ProTaperNEXT(PTN)system provides shaping advantages through the convergence of a variable tapered design on a given file(ProTaper Universal) , innovative M-Wire technology , and a unique offset mass of rotation (as developed by Dr. Michael J. Scianamblo and the Dentsply)

There are 5 PTN files available ,in different lengths , for shaping canals ,namely X1 , X2 , X3 , X4 , and X5.In sequence , these files have yellow , red , blue , double black , and double yellow identification rings on their handles , corresponding to sizes 17/04 , 25/06 , 30/07 , 40/06 , and 50/06,respectively.

Advantages

• Progressively Percentage Tapered Design On A Single File:

The original ProTaper Universal NiTi rotary file system utilizes both an increasing and decreasing percentage tapered design on a single file. This design feature serves to minimize the contact b/w a file and dentin ,which Decreases dangerous taper lock and the screw effect ,while increasing efficiency. Taking advantage of this mechanical design, ProTaper NEXT also utilizes progressive tapers on a single file.



• M-Wire Technology :

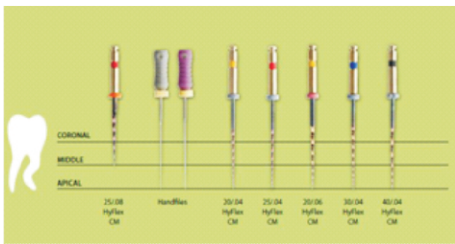
Compared to traditional NiTi , research has shown that M-wire technology improves the resistance to cyclic fatigue by almost 400% when comparing files of the same tip diameter , taper and cross-section. The good news is M-wire improves the resistance to cyclic fatigue , decreases the potential for broken instruments, and increases flexibility incorporating M-wire into the mechanical design of ProTaper NEXT represents a strategic improvement to the ProTaper brand of files.⁸

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9) Hyflex File (Coltene)

- Controlled memory niti files

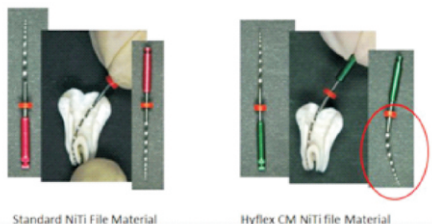


Single Length Technique

Single length technique, in which all files are used except the short orifice opener up to the working length, allows accurate and anatomically accurate preparation using Hyflex CM files.

Benefits

- 300% more resistance to separation
- Hyflex NiTi files with controlled memory are upto 300% more resistant to cyclical fatigue compared to other NiTi files which substantially helps reducing the incidence of file separation.
- No rebound + Extreme flexibility = Superior canal tracking
- Hyflex NiTi files have been manufactured utilizing a unique process that controls the material's memory, making the files extremely flexible but without the shape memory of other NiTi files. This gives the file ability to follow the anatomy of the canal very closely, reducing the risk of ledging, transportation or perforation.



- Regains shape after sterilization = Multi-use
- The shape and strength of files with straightened spirals can be restored during autoclaving and reused. Files not returning to original shape should be discarded.

Regeneration by thermal treatment



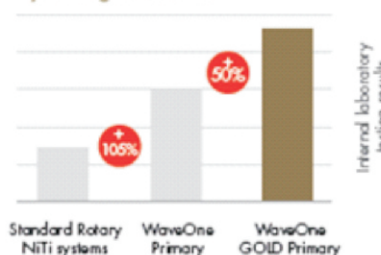
- Use any technique: Hyflex files can be used

with crown-down, step-back or recommended single length technique.⁹

10) Wave One Gold (Dentsply)

- Introduced in 2014.
- REINFORCES PATIENT SAFETY
- Primary WaveOne GOLD file is 50% more resistant to cyclic fatigue than WaveOne Primary file.
- Reduced screwing effect compared to standard rotary systems.

Cyclic fatigue resistance



Covers A Wider Range Of Canal Morphologies

- Enhanced file flexibility.
- Extended size range: small, primary, medium, large.

Shortens The Shaping Time

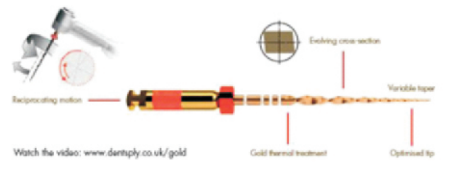
Takes the cutting efficiency to a higher level.

A single file per treatment translates into faster shaping time and thus more time for irrigation.

Ready To Use + Single Use

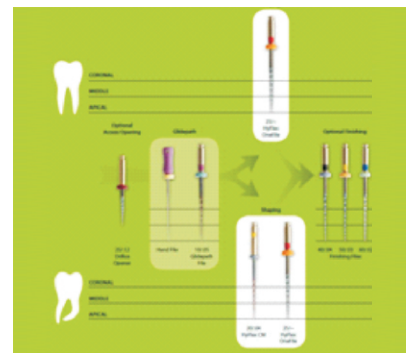
- Simplicity.
- Increased safety margin, by always using files with maximum fatigue resistance potential.
- Maximised cutting efficiency.

WaveOne GOLD brings a metallurgically advanced single-file technique with optimized tip diameters, tapers, and the cross-section to produce a file that really improves safety, efficiency and flexibility when preparing canal.¹⁰



11) Hyflex-EDM (Electrical Discharge Machining) (Coltene)

- Introduced in 2015
- The new Hyflex EDM files constitute the 5th generation root canal files.
- Hyflex EDM files have completely new properties d/t their innovative manufacturing process using electric discharge machining.
- Workpieces are machined in the EDM manufacturing process by generating a potential between workpiece and the tool.
- The spark generated in this process causes the surface of the material to melt and evaporate.
- This creates the unique surface of the new NiTi files and makes the Hyflex EDM files stronger and more fracture resistant.



- All Hflex EDM NiTi files can be used at 400 rpm and at a torque of to 2.5 Ncm (25 mNm) except the Glidepath files which can be used with 300 rpm and at a torque of upto 1.8 Ncm (1.8 mNm).
- Upto 700% higher fracture resistance.
- Specially hardened surface.
- Less filing required for treatment success.

Reduced Number of Files

Depending on the clinical situations, use of Hyflex EDM files reduces the number of files to 2-3 pieces particularly in straight and larger canals.¹⁰

Conclusion

It should be kept in mind that the clinical outcome of endodontic treatment is significantly affected by preoperative diagnoses but not by the specific choice of an instrumentation system (Peters et al. 2004). The results of the present study suggest that all systems evaluated ex vivo respected the original root canal curvature, were safe to use, and saved time with respect to the manual technique.

References

- Residual dentine thickness Anil K Tomer, Anjali Miglani, PriyaliChauhan, Nidhi Malik and Anushree Gupta. International Journal of Applied Dental Sciences 2016; 2(4): 96-99.
- Rationale for the use of low-torque endodontic motors in root canal instrumentation Gambarini G. Rationale for the use of low torque endodontic G. Gambarini motors in root canal instrumentation. Endod Dent Traumatol Department of Periodontics-Endodontics, Dental 2000; 16:95-100. C Munksgaard, 2000.
- Incidence of Dental Crack Formation during various Endodontic Procedures Himanshu Dixit1, Manoj Nair2, Nitin Shah3, Varsha Pandit
- Evaluation of Apical Debris Removal Using Various Sizes and Tapers of ProFile GT Files Lynn J. Albrecht, DDS, J. Craig Baumgartner, DDS, PhD, and J. Gordon Marshall, DMDVOL. 30, NO. 6, JUNE 2004.
- Effect of a Combination of Torsional and Cyclic Fatigue Preloading on the Fracture Behavior of K3 and K3XF Instruments YaShen, DDS, PhD, Abdullah Mahmoud Riyahi, BDS, Les Campbell, DDS, MSc, Huimin Zhou, PhD, Tianfeng Du, DDS, PhD, Jijun Wang, DDS, PhD, Wei Qian, DDS, PhD, and Markus Haapasalo, DDS, PhD JOE — Volume 41, Number 4, April 2015.
- Single Versus Multiple Endodontic File Use. Authored by John West, DDS, MSD Volume 35 No.12 Page 62 2016.
- Rotary endodontics or reciprocating endodontics: which is new and which is true? Gourav K Sahu, Shivani Consul, KJ Nandakishore et al (2016).
- Obturation quality after four years of storage using the non-instrumentation technique peter portmann, stefanimwinkelried and adrianlussi.
- Comparative Evaluation of the Effect of Manufacturing Process on Distortion of Rotary ProFile and Twisted File: An In Vitro SEM Study Swati Sharma, Rajendra Kumar Tewari, PankajKharade, and PankajKharade 2015 Autumn; 9(4): 216-220.
- Hyflex CM and EDM Files: Revolutionizing the Art and Science of Endodontics harpreetsingh and poojakapoor Volume 5 Issue 7 - 2016