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REVIEW ARTICLE

ENDODONTIC ROTARY SYSTEMS - A REVIEW

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ABSTRACT:
Over the past few decades, endodontic treatment modalities have shown tremendous advancements due to introduction of several new techniques and instruments. Understanding the fundamentals of file designs, along with the ease of operating them and combining them with pre- clinical trials, aids in choosing the ideal rotary Nickel Titanium file. Better apical cleaning, the essence of successful therapy, is now possible with the latest generation of rotary nickel–titanium instruments. In contrast to stainless steel files Nickel Titanium instruments have sufficient cleaning ability and can preserve the root canal anatomy. Thus appropriate handling of engine driven Nickel Titanium systems in combination with sufficient irrigation facilitates endodontic treatment.
Key Words: Generation, Nickel, Titanium.

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INTRODUCTION

Since the beginning of modern day endodontics, there have been numerous concepts, strategies, and techniques for preparing canals. Over the decades, a staggering array of files has emerged for negotiating and shaping them. In spite of the design of the file, the number of instruments required and the surprising multitude of techniques advocated, endodontic treatment has typically been approached with optimism for probable success. The following overview is a mechanical classification of each generation of file systems. Rather than identify the myriad of available cross-sections, files will be characterized as having either a passive or an active cutting action.

HYFLEX[3]

HyFlex™ Controlled Memory NiTi Files have been manufactured utilizing a unique process that controls the material's, making the files extremely flexible but without the shape memory of conventional memory NiTi Files. This gives the file the ability to follow the anatomy of the canal very closely, reducing the risk of ledging, transportation or perforation. Furthermore the files can be pre-bent, similar to the way of stainless steel. Particularly in root canals with abrupt curvatures this can help to avoid the creation of steps. HyFlex™ CM NiTi Files with Controlled Memory are up to 300 % more resistant to cyclical fatigue compared to conventional NiTi Files which substantially helps reducing the incidence of file separation.

GENERATIONS OF ROTARY SYSTEMS[1,2]

Table 1: 1st generation rotary instruments

Name of File	Year Of Introduction	Tip	Taper	Unique Features
Profile	1993	Non cutting	Fixed taper of 2%,4% and 6%	Negative rake angle Passive cutting blades
Quantec	1996	Non cutting tip	Constant taper	Semi active cutting blades
System GT	1998	Bullet nose tip	Constant rate of taper	Variable pitch reduce the screwing in effect
Hero 642	1999	Inactive tip	Constant taper	Triple helix geometry
Flex Master	2000	Non cutting	Constant taper	K type cutting blades provide high cutting efficiency, improved torsional resistance

Table 2: Second generation rotary files

Name Of File	Year Of Introduction	Tip	Taper	Unique Features
RaCe	1999	Non cutting safe tips	Varying taper	Reamer with alternate cutting edges
Protaper	2001	Modified guiding tip	Multiple taper	Multiple increasing /decreasing taper
K3	2001	Safe ended tip	Constant taper	Positive rake angle Crown down preparation
Hero shaper	2002	Inactive tip	Constant taper	Positive cutting angle Adapted pitch concept
Endosequence	2004	Non-cutting precision tip	Constant taper	Alternate contact point electropolish file Variable pitch
Bioracce	2011	Non-cutting safety tip	Constant taper	Electrochemical surface treatment Alternating cutting edge

Table 3: Third generation rotary files

Name of File	Year of Introduction	Tip	Taper	Unique Features
Twisted	2001	Safety tips	Constant taper	R-phase of NiTi alloy positive rake angle
Hyflex	2012	Safety tips	Constant taper	Controlled memory NiTi files
Wave one	2012	Modified tip	Variable taper	Reciprocating motion

Table 4: Fourth generation rotary files

Name of File	Year of Introduction	Tip	Taper	Unique Features
Self Adjusting File(SAF)	2010	Pointed cylinder	Adapts to canal	Compressible open tube design Up & down, back & froth motion

Table 5: Fifth generation rotary files

Name of File	Year of Introduction	Tip	Taper	Unique Features
Revo-S	2012	Inactive tip	Constant taper	It has 3 cutting edges, all located at 3 different radiuses, R1, R2 and R3
One Shape	2013	Safety tips	Constant taper	Variable cross section
ProTaper Next	2013	Modified tip	Variable taper	Unique Asymmetric Rotary M wire technology

ONE SHAPE SINGLE ROTARY FILE SYSTEM[4]

One Shape, the one and only Nickel Titanium instrument in continuous rotation for quality root canal preparations. One Shape allows for curved canal negotiation with an instrumental and easy dynamic. Its non-working (safety) tip ensures an effective apical progression avoiding obstructions which are often preceded by instrument separation. The instrument is with a variable cross-section. It has an original and innovative instrument design. A micro-mega innovation .i.e. the instrument presents with a variable cross-section along the blade. One Shape principle: 3 different cross-section zones are present. The first zone presents a variable 3-cutting-edge design. The second, prior to the transition, has a cross-section that progressively changes from 3 to 2 cutting edges. The last (coronal) is provided with 2 cutting edges.[5]

ProTaper NEXT[6]

The ProTaper Next files offer improved efficiency with fewer files when compared with the ProTaper Universal files. It has following features:

- Variable taper like ProTaper Universal files.
- Rectangular off-center cross-section design for greater strength.
- Unique Asymmetric Rotary (AR) Motion that further enhances ProTaper canal shaping efficiency.
- The patented design's axis of rotation differs from the center of mass. As a result, only two points of the rectangular cross section touch the canal wall at a time.
- PROTAPER NEXT's AR Motion allows you to achieve a fully tapered canal with fewer files. The result is the predictable ProTaper shape you expect — with greater procedural efficiency.
- Proven M-Wire Nickel Titanium alloy for increased flexibility and resistance to cyclic fatigue as compared to traditional NiTi.

REVO-S[7]

Revo-S, is a unique and innovative system which uses only 3 instruments. It is meant for initial endodontic treatment. It has asymmetrical cross section. Initiates a snake like movement inside the canal. It has 3 cutting edges, all located at 3 different radiuses, R1, R2 and R3. The smaller section allows more flexibility and offers a better ability to negotiate curves. The asymmetrical cross section increases the available volume for upward debris removal. Its protocol is follows:

Initial penetration[8]

- The first step consists of an initial penetration of the canal using a conventional stainless steel hand instrument (usually a K file No10 – MMC No10 L21 mm) which provides information about the canal anatomy complementary to that obtained by the pre-operative X-rays.
- The use of ENDOFLARE is recommended (The MICRO-MEG A +).
- The G-File safely enlarge the glide path in preparation for RCT with rotary instrumentation system (The MICRO-MEGA +).
- The instruments should be removed frequently from the canal and cleaned using a compress in order to eliminate the dentine debris.

Operative dynamics[9]

- Revo-S instruments should be used with a rotation speed ranging between 250 and 400 rpm.
- Use SC1 with slow and unique downward movement in a free progression and without pressure.
- Use SC2 with a progressive 3 wave movement (up and down movement).
- Use SU with a slow and unique downward movement in a free progression and without pressure. Then check apical patency and if

necessary, perform an upward circumferential filing movement.

Irrigation[10]

- The canal should be thoroughly irrigated using sodium hypochlorite between the use of each instrument. The use of a chelator is advised for instrument lubrication and dentine debris removal.

Apical finishing[11]

- The AS instruments should be used without apical pressure, after using the SU.
- If necessary and according to the root canal anatomy, use the AS30, AS35 and AS40 to enlarge the apical region.
- Their penetration depth corresponds to the working length. This length is shortened in thin root canals or with a marked curvature. They are then used in a step back motion (AS30 at WL, AS35 at WL -0.5 mm, AS40 at WL -1 mm if necessary).
- For a perfect apical finishing, use the sequence:
- AS30 only for an apical finishing at 30/100.
- AS30 then AS35 for an apical finishing at 35/100.
- AS30 then AS35 and finally AS40 for an apical finishing at 40/100.
- If an AS instrument fails to reach the working length, continue the preparation using the former instrument in order to work without any apical pressure.

SELF ADJUSTING FILE (SAF) [12-18]

The SAF (ReDent-Nova Israel) is a hollow file designed as a compressible, thin-walled pointed cylinder either 1.5 or 2.0 mm in diameter composed of 120- mm-thick nickel-titanium lattice .

Mode of operation

- The 1.5-mm file may easily be compressed to the extent of being inserted into any canal previously prepared or negotiated with a # 20 K-file. The 2.0-mm file will easily compress into a canal that was prepared with a #30 K-file.
- The file will then attempt to regain its original dimensions, thus applying a constant delicate pressure on the canal walls.
- When inserted into a root canal, it adapts itself to the canal's shape, both longitudinally and along the cross-section. In a round canal, it will attain a round cross-section, whereas in an oval or flat canal it will attain a flat or oval, providing a three dimensional adaptation.
- The surface of the lattice threads is lightly abrasive, which allows it to remove dentin with a back-and-forth grinding motion.
- The SAF is operated with transline (in and out) vibrating handpieces with 3,000 to 5,000 vibrations per minute and an amplitude of 0.4 mm. Such a handpiece may be the KaVo GENTLE power or equivalent combined with either a 3LDSY head (360_ free rotation; Kavo, Biberach Riss Germany) or MK-Dent head (360 degree free rotation; MK-Dent, Bargteheide, Germany) or RDT3 head (80 rpm when free and stops rotating when engaging the canal walls, recently developed by Re- Dent-Nova, Ra'anana,)
- The irrigation tube is connected to a continuous-flow source and has an on-off switch (white).
- The vibrating movement combined with intimate contact along the entire circumference and length of the canal removes a layer of dentin with a grinding motion.

Advantages and characteristics features of SAF [19-24]

- An Self-adjusting File that Adapts Itself to the Three Dimensional Anatomy of Root Canals
- Uniform Removal of Dentin and Remaining Wall Thickness
- Prevention of Canal Transportation
- High Durability
- Continuous Irrigation with Sodium Hypochlorite
- Removal of the Smear Layer in the Apical Part of the Canal

TWISTED FILES (TF)[25]

TF (Sybronendo) is a recently introduced Nickel Titanium engine-file manufactured with a twisting method. It was reported to have a higher fracture resistance than ground files. The manufacturer claimed that TF has a different surface texture (natural grain structure) that runs in the longitudinal direction and that the instrument is made of the **R-phase** of Nickel Titanium alloy (although no transition temperature data are presented). It was further claimed that these features serve to raise the flexibility and the fracture resistance of the instrument. There is also an absence of transverse-

running machining marks (as a result of electropolishing) that would result in slower crack initiation and propagation. To date, only very few reports of the fatigue behavior of this new twisted Nickel Titanium file are available.

Advantages of R phase technology used in the TF [26-27]

- Overcomes many of the limitations of ground file technology and opens up new opportunities for improved file design such as twisting.
- Optimize molecular phase structure and optimizes the resulting properties of nickel-titanium.
- Employs a crystalline structural modification that maximizes flexibility and resistance to breakage.

Research on TF has shown that files from new manufacturing methods that make TF results in a significantly higher average hardness than nickel titanium instruments from other manufacturing process.

CONCLUSION

Rotary instrumentation is an exciting and valuable advancement in canal preparation. The concept of shaping the root canal walls and maintaining the original canal curvature and shape has now become the prime motive of designing the new generation of Nickel Titanium rotary files. Understanding the fundamentals of file designs, along with the ease of operating them and combining them with pre-clinical trials, aids in choosing the ideal rotary Nickel Titanium file. Better apical cleaning, the essence of successful therapy, is now possible with the latest generation of rotary nickel–titanium instruments. In contrast to stainless steel files Nickel Titanium instruments have sufficient cleaning ability and can preserve the root canal anatomy. Thus appropriate handling of engine driven Nickel Titanium systems in combination with sufficient irrigation facilitates endodontic treatment. To minimize the risk of instrument fracture the use of Nickel Titanium rotary instruments with torque controlled motors not exceeding the recommended speed for the specific system should be used. However, each rotary system has its own advantages; so a hybrid concept should be utilized to gain optimum advantage of the newer generation rotary systems.

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