Endodontics

Dr. Bahaa Al-Tememi **Lecture 4**

Intracanal Instruments

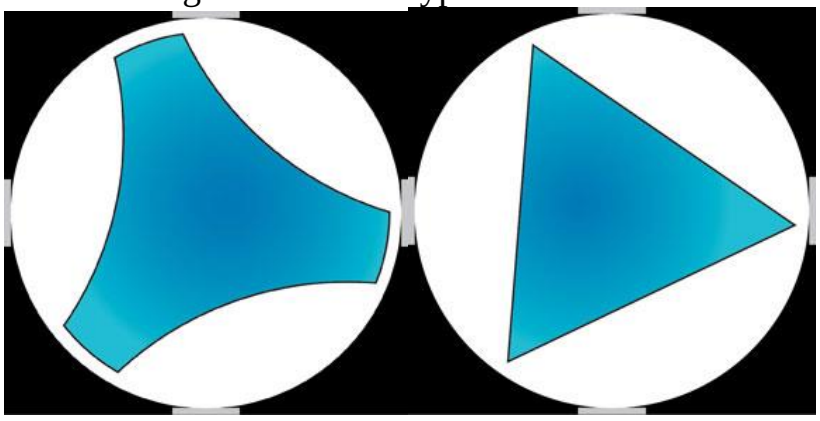
Rotary Nickel Titanium Instrumentation systems:

FIRST GENERATION

To appreciate the evolution of NiTi mechanical instruments, it is useful to know that, in general, first generation NiTi files have *passive* cutting radial lands and fixed tapers of 4% and 6% over the length of their active blades. This generation of technology required numerous files to achieve the preparation objectives. By the mid to late 1990s, GT files *(Dentsply Tulsa Dental Specialties)* became available that provided a fixed taper on a single file of 6%, 8%, 10%, and 12%. The single most important design feature of first generation NiTi rotary file was passive radial lands, which encouraged a file to stay centered in canal curvatures during work.

❖ Landed versus non-landed instruments

A cross section of the instrument reveals certain characteristics. A radial-landed instrument has a flattened aspect on the external aspect of the flute, whereas a non-landed instrument does not. While all files, if used improperly, can create challenges in maintaining a natural canal shape, a radial-landed instrument tends to stay more central in the canal space because of the flattened portions pressing against the lateral aspects of the canal walls. A non-landed instrument tends to cut the tooth more efficiently, but distortion of the canal is a much greater problem, especially for the less experienced clinician. This distortion of a canal shape tends to lead to iatrogenic mishaps such as straightening of canals, apical transportations and perforations. Proper attention to details must be maintained regardless of the type of instrument used.



Landed Non landed

SECOND GENERATION

The second generation of NiTi rotary files came to market in 2001. The critical distinction of this generation of instruments is they have active cutting edges and require fewer instruments to fully prepare a canal. To discourage taper lock and the resultant screw effect associated with both passive and active fixed tapered NiTi cutting instruments, EndoSequence *(Brassler USA)* and BioRaCe *(FKG Dentaire)* provide file lines with alternating contact points. Although this feature is intended to mitigate taper lock, these file lines still have a fixed tapered design over their active portions.

The clinical breakthrough occurred when ProTaper *(Dentsply Tulsa Dental Specialties)* came to market utilizing multiple increasing or decreasing percentage tapers on a single file. This revolutionary, progressively tapered design limits each file's cutting action to a specific region of the canal and affords a shorter sequence of files to safely achieve the preparation objectives.

ProTaper Universal system:

The ProTaper System is made up of 8 instruments that are divided into 2 groups: 3 Shapers with the marking SX, S1 and S2 and 5 Finishers (F1 - F5). The difference in design of this system is the varying tapers along the instruments' long axes. The three shaping files have tapers that increase coronally, and the reverse pattern is seen in the five finishing files. The Shapers are instruments for eliminating coronal interferences and to create a smooth pathway for the Finishing instruments while the Finishers are for the finalizing of the shape created by the Shapers and for giving a definitive taper and diameter to the canal.

Protaper rotary files (left) and hand files (right).

The characteristics of these instruments can be summarized as follows:

– the ProTaper SX have a total length of 19 mm with a blade length of 16 mm. The diameter at the tip is 0.19 mm. The taper at D1 is .035 increasing at D9 to .19. After which decreases to .02 from D10 up to D14 and it has no taper at D15 and D16

– the ProTaper S1, identified with a purple ring on its handle, is available in lengths of 21 and 25 mm, with a tip diameter of 0.17 mm and a blade of 16 mm. The taper of the S1 is .02 at D1, .04 at D4, .08 at D8 and .11 at D15.

– the ProTaper S2, identified with a white ring on its handle, is available in lengths of 21 and 25 mm with a diameter at the tip of 0.20 mm and a blade of 16 mm. The taper of S2 is .04 at D1, .06 from D5 up to D9, and .115 at D15.

– The Finisher 1 (F1) is identified with a yellow ring on its handle; D0 = 20/100. The taper of the F1 is .07 at D1- D3 which then reduces to .055 at D5-D15
– The Finisher 2 (F2) − red ring − D0 = 25/100. The taper of the F2 is .08 at D1-D3 which then decreases to .06 at D5 and then to .055 at D6-D15.
– The Finisher 3 (F3) − blue ring − D0 = 30/100. The taper of F3 is .09 at D1-D3 which then decreases to .07 at D4-D5 and then to .05 at D6-D15.
– The Finisher 4 (F4) – two black rings − D0 = 40/100 and apical taper is 6%.
– The Finisher 5 (F5) − two yellow rings − D0 = 50/100 and apical taper is 5%.

Recently, an enhanced version of protaper universal was launched to the market called **ProTaper Gold.** ProTaper Gold rotary files has the exact geometries as ProTaper Universal, but has been metallurgically enhanced through heat treatment technology. Pro taper *Gold offers increased flexibility and a 50% increase in cyclic fatigue resistance, which provides enhanced safety.* This is especially important in the finishing files, when navigating challenging curves in the apical region.

THIRD GENERATION

Improvements in NiTi metallurgy became the hallmark of what may be identified as the 3rd generation of mechanical shaping files. In 2007, manufacturers began to focus on utilizing heating and cooling methods to reduce cyclic fatigue and improve safety when rotary NiTi instruments work in more curved canals. This 3rd generation of NiTi instruments significantly reduces cyclic fatigue and, hence, broken files. Examples of brand lines that offer heat treatment technology are Twisted File *(SybronEndo)* and Hyflex *(Coltene Whaledent).*

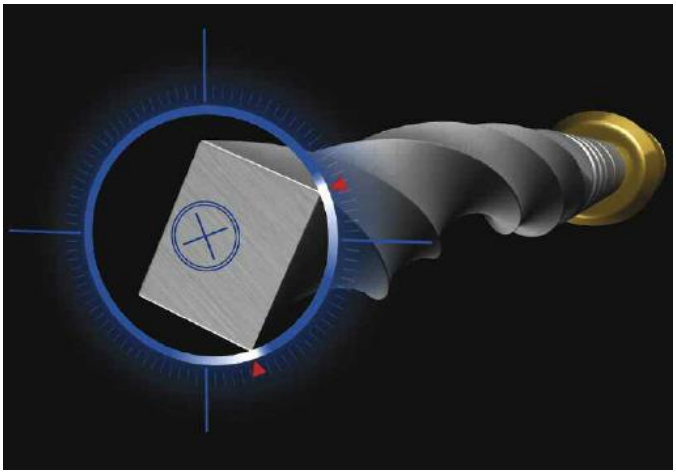
FOURTH GENERATION

Another advancement in canal preparation procedures utilizes reciprocation, which may be defined as any repetitive up-and-down or back-and-forth motion. Innovation in reciprocation technology led to a 4th generation of instruments for shaping canals. This

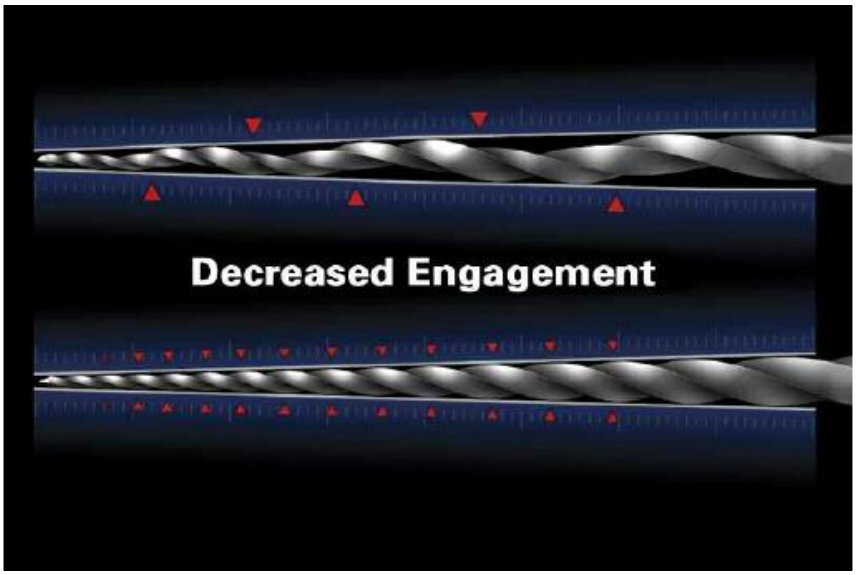
generation of instruments and related technology has largely fulfilled the long hoped-for single-file technique. By far the most popular single-file concept is termed WaveOne and Wave one gold *(Dentsply Tulsa Dental Specialties and Maillefer)* and Reciproc *(VDW)*. WaveOne represents a convergence of the best design features from the 2nd and 3rd generation of files, coupled with a reciprocating motor that drives any given file in *unequal* bidirectional angles. The CCW engaging angle is 5 times the CW disengaging angle and is designed to be less than the elastic limit of the file. Strategically, after 3 CCW and CW cutting cycles, the file will have rotated 360º, or one circle. This novel reciprocating movement allows a file to more readily progress, efficiently cut, and effectively auger debris out of the canal.

FIFTH GENERATION

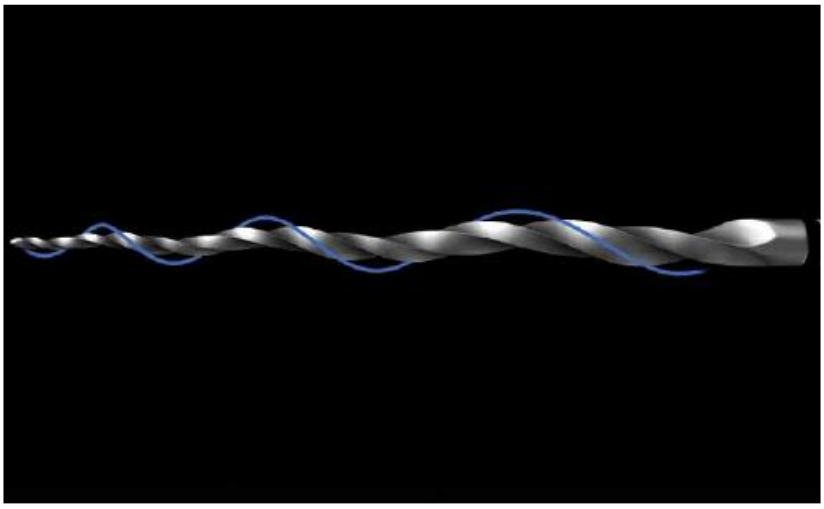
The 5th generation of shaping files has been designed such that the center of mass and/or the center of rotation are offset. In rotation, files that have an offset design produce a mechanical wave of motion that travels along the active length of the file. Like the progressively percentage tapered design of any given ProTaper file, this offset design serves to further minimize the engagement between the file and dentin. In addition, an offset design enhances augering debris out of a canal and improves flexibility along the active portion of the file. Commercial examples of file brands that offer variations of this technology are Revo-S, One Shape *(Micro Mega)* and ProTaper Next *(Dentsply Tulsa Dental Specialties/Dentsply Maillefer)*. Today, the safest, most efficient, and simplest file systems utilize the most proven design features from the past, coupled with the most recent technological advancements currently available.



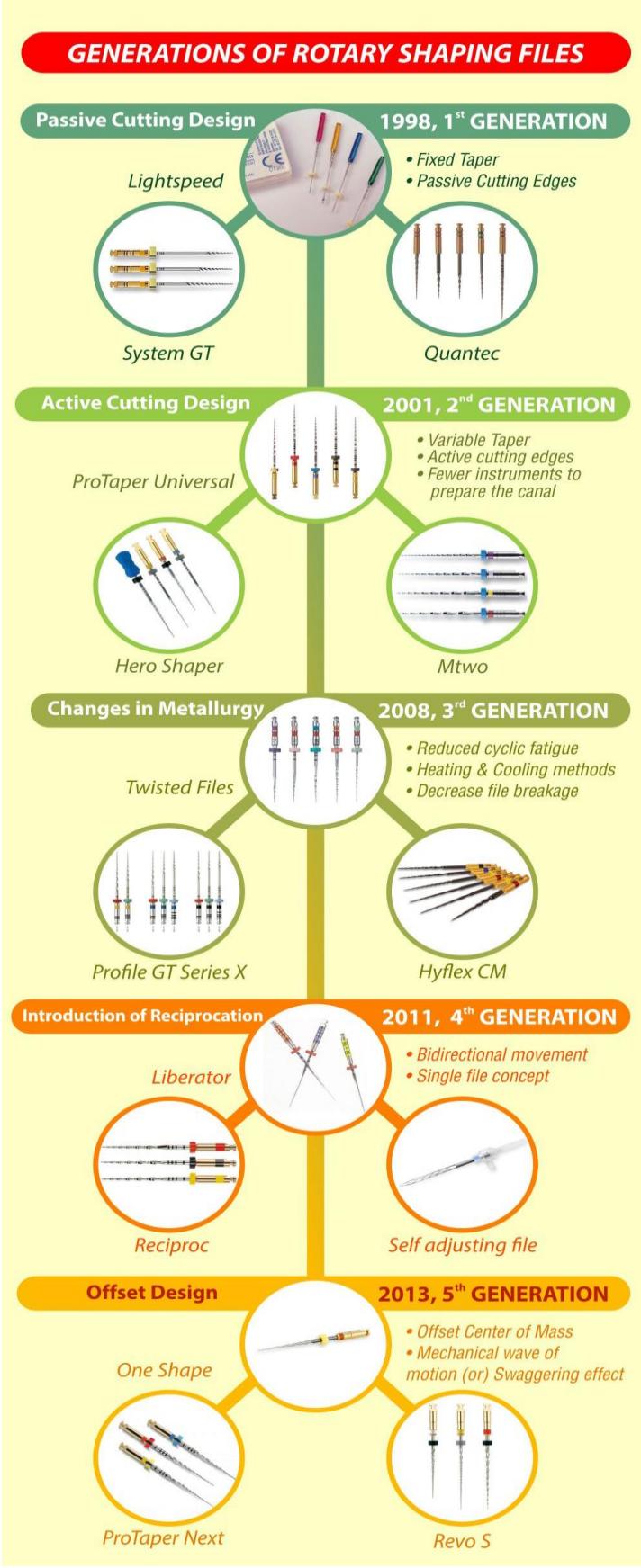
A cross-section of a ProTaper Next file. Note an offset mass desirably reduces file engagement, provides greater space for debris, and improves flexibility.



A PTN file has a progressively tapered and offset design. These features minimize engagement, maximize debris removal, and improve flexibility. By contrast, the bottom image shows a fixed tapered file with a centered mass and axis of rotation.

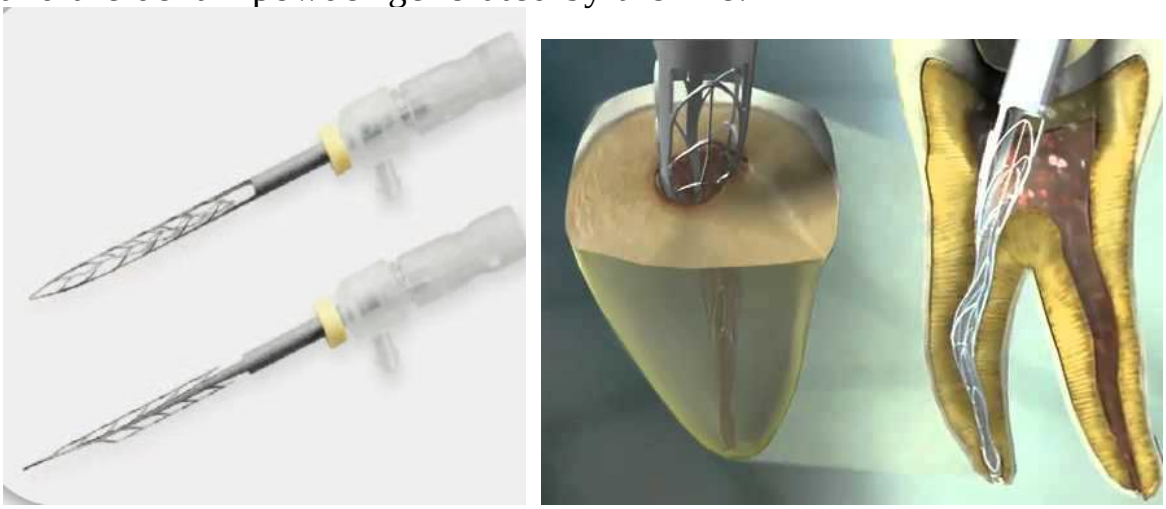


Similar to a sinusoidal wave, a rotating PTN file produces a mechanical wave of motion, or swaggering effect, along its active portion.


GENERATIONS OF ROTARY SHAPING FILES
Passive Cutting Design
1998, 1st GENERATION
• Fixed Taper
• Passive Cutting Edges
Lightspeed
System GT
Quantec
Active Cutting Design
2001, 2nd GENERATION
• Variable Taper
• Active cutting edges
• Fewer instruments to prepare the canal
ProTaper Universal
Hero Shaper
Mtwo
Changes in Metallurgy
2008, 3rd GENERATION
• Reduced cyclic fatigue
• Heating & Cooling methods
• Decrease file breakage
Twisted Files
Profile GT Series X
Hyflex CM
Introduction of Reciprocation
2011, 4th GENERATION
• Bidirectional movement
• Single file concept
Liberator
Reciproc
Self adjusting file
Offset Design
2013, 5th GENERATION
• Offset Center of Mass
• Mechanical wave of motion (or) Swaggering effect
One Shape
ProTaper Next
Revo S

Group IV: Engine-Driven Three-Dimensionally Adjusting Files (Self-adjusting file)

The self-adjusting file (SAF) represents a new approach in file design and mode of operation. The file is a hollow device, designed as a cylinder of thin-walled, delicate NiTi lattice with a lightly abrasive surface. An initial glidepath is established with a #20 K-file to allow the insertion of the SAF file. The file is proposed to be compressed from its 1.5 mm diameter into dimensions equivalent to those of a #25 K-file. The handpiece generates in-and-out vibrations with 5000 vibrations per minute and 0.4 mm amplitude. The compressed file will adapt itself to the root canal walls, applying a uniform cutting action gradually removing a uniform dentin layer from the canal walls. There is a continuous flow of irrigant which removes the tissue debris and the dentin powder generated by the file.



The self adjusting file(SAF).

Group V: Engine-Driven Reciprocating Instruments:

Endo-eze reciprocating files

The Giromatic handpiece, a rotary instrument in use since 1969, delivers 3000 quarter-turn reciprocating movements per minute. Rasps and barbed broaches are most often used in Giromatic handpieces, but K-type and H-type instruments also can be used. The endo-eze file system (Ultradent) is a recently introduced addition for Giromatic handpieces. The set has four instruments that are designed to clean the middle third of the canal. The sizes and tapers are 0.10 #0.025 taper, 0.13 #0.035 taper, 0.13 #0.045 taper and 0.13 #0.06 taper. The use of stainless steel hand instruments is suggested for the apical third of the canal.

Group VI: Sonic and Ultrasonic Instruments

Another mechanically driven instrument motion is vibratory (ultrasonic or sonic) motion. The intent is to create instrument motion and activity with sonic or ultrasonic frequencies. A variety of tips and configurations are available for conservatively removing dentin during apical root-end preparations and for searching for and negotiating small canals.

Two types of units, ultrasonic and sonic, are marketed. Ultrasonic devices, which operate at 25 to 30 kHz, include the magnetostrictive Cavi-Endo (Dentsply Caulk, Milford, DE), and the piezoelectric ENAC (Osada, Tokyo).

Sonic devices, which operate at 2 to 3 kHz, include the Sonic Air MM 1500 (MicroMega), the Megasonic 1400 (Megasonic Corp, House Springs, MO), and the Endostar (Syntex Dental Products, Valley Forge, PA).

Ultrasonic device holders can fit regular types of instrument blanks (e.g., K-files), whereas sonic devices use special inserts known as Rispi-Sonic, Shaper-Sonic, Trio-Sonic, or Heli-Sonic files.

Uses of Sonic and Ultrasonic Instruments:

- ***Access enhancement:*** Use of round or tapered ultrasonically activated diamond coated tips has shown to produce smoother shapes of access cavity.

Diamond coated ultrasonic tips

-Orifice location: Ultrasonic instruments are very useful in removal of the chamber calcifications and locating the canal orifices.

-Irrigation: Studies have shown the use of endosonics have resulted in cleaner canals. Acoustic streaming forces with in the irrigant together with the oscillation of the instrument are useful for dislodging the debris out of the canal.

-Sealer placement: One of the methods of sealer placement is by using an ultrasonic file which runs without fluid coolant.

-Gutta-percha obturation: Moreno first suggested the technique of plasticizing gutta-percha in the canal with an ultrasonic instrument. The gutta-percha gets plasticized by the friction being generated. Final vertical compaction is done with hand or finger pluggers.

-MTA placement: Low powered ultrasonics can be used to vibrate the material into position with no voids.

-Endodontic retreatment

In re-treatment cases, ultrasonic instruments can be used for removal of posts, gutta percha or silver points from root canals.