Endodontics

Lec.3

Intracanal Instruments

INSTRUMENT FABRICATION

Two techniques for manufacturing endodontic instruments have been developed:

- **Ground-Twisted**

This technique consists first of grinding, then twisting. Raw wire is ground into tapered geometric blanks; (square, triangular, and rhomboid). The blanks are then twisted counterclockwise to produce helical cutting edges**.** These are K-type files and reamers. K-type files have more twists per millimeter of length than the corresponding size of K-type reamer. Both have a pyramidal tip (75 ± 15 degrees) that is produced by grinding after twisting.

- **Machined**

This technique involves machining (grinding) the instrument directly on a lathe; an example is the Hedstrom-type file. All nickel titanium instruments are machined. Some manufacturers produce K-type files using the machined (lathe-grinding) process. This change from the grinding and twisting manufacturing process results in different physical and working properties from the original K-type file. For instance, the machined file has less rotational resistance to breakage than a ground-twisted file of the same size.

STANDARDIZATION:

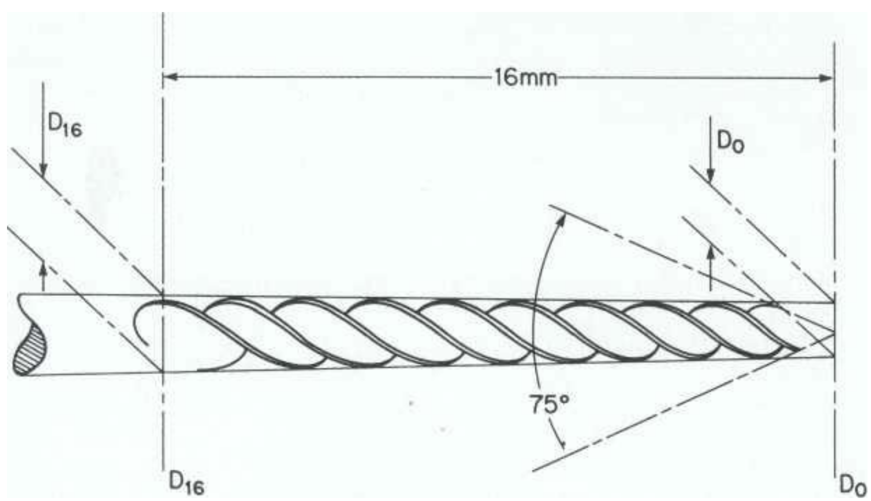
- **Lengths**

The full extent of the shaft, up to the handle, comes in three lengths: standard, 25 mm; long, 31 mm; and short, 21 mm. The long instruments are often necessary when treating canines over 25 mm long. Shorter instruments are helpful in second and third molars or in the patient who cannot open widely. Other special lengths are available, such as the popular 19 mm instrument.

- **Sizing**

In 1959, a new line of standardized instruments and filing material was introduced to the profession. This numbering system, last revised in 2002, using numbers from 6 to 140, was not just arbitrary but was based on the diameter of the instruments in hundredths of a millimeter at the beginning of the tip of the blades, a point called D0, and extending up the blades to the most coronal part of the cutting edge at D16; 16 mm in length. File tip diameters increase in 0.05 mm increments up to the size 60 file (0.60 mm at the tip), and then by 0.10 mm increments up to size 140. The file diameter increases at a rate of 0.02 mm per running millimeter of length. So the final cutting part of the instrument (known as D16) is 0.32 mm wider than the first part of the tip.

At the present time, instruments with a taper greater than the ISO 0.02 mm/mm have become popular: 0.04, 0.06, and 0.08. This means that for every millimeter gain in the length of the cutting blade, the width (taper) of the instrument increases in size by 0.04, 0.06 and 0.08 of a millimeter rather than the ISO standard of 0.02 mm/mm. These new instruments allow for greater coronal flaring than the 0.02 instruments.



Classification of intracanal instruments

They are divided into six groups:

Group I: Manually-operated instruments, such as barbed broaches, reamers and K-type and H-type instruments.

Group II: Low-speed instruments with a latch-type attachment. Typical instruments in this group are Gates-Glidden (GG) burs and Peeso reamers. They are typically used in the coronal part of the canal and never used in a canal curvature.

Group III: Engine-driven nickel-titanium rotary instruments. They consist of a rotating blade that can safely be operated in, and adapt itself to, curved root canals. Most engine- driven instruments available today belong to this group.

Group IV: Engine-driven instruments that adapt themselves three-dimensionally to the shape of the root canal. Like other nickel-titanium instruments, they adapt to the shape of the root canal longitudinally but additionally they adapt also to the cross-section of the root canal. There is currently only one instrument in this group: the self-adjusting file (SAF).

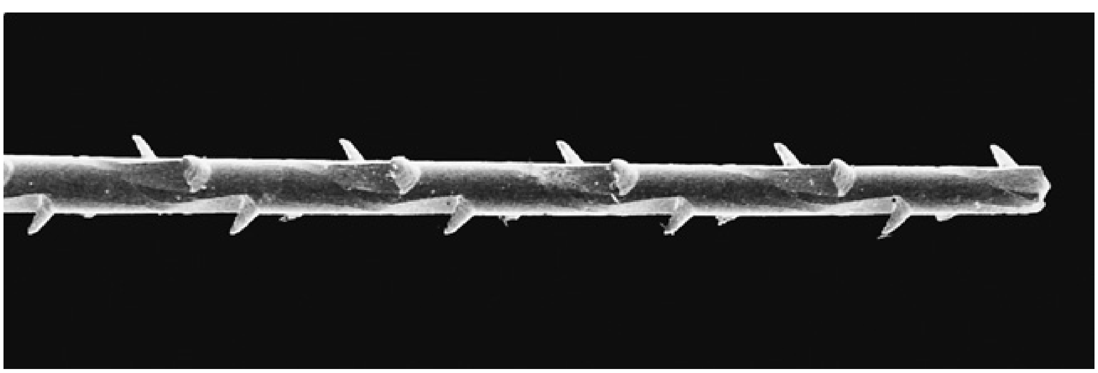
Group V: Engine-driven reciprocating instruments.

Group VI: Ultrasonic instruments.

<u>Group I: Manually-operated instruments</u>

- **<u>Barbed Broaches</u>**

Barbed broaches are produced in a variety of sizes and color codes. They were the earliest endodontic instruments used to extirpate the pulp. They are manufactured by hacking a round, tapered wire with a blade to form sharp, projecting barbs that cut or snag tissue. A barbed broach does not cut or machine dentin; this instrument is mostly used to engage and remove soft tissue from the canal. It is an excellent tool for removing cotton or paper points that have accidentally become lodged in the root canal.



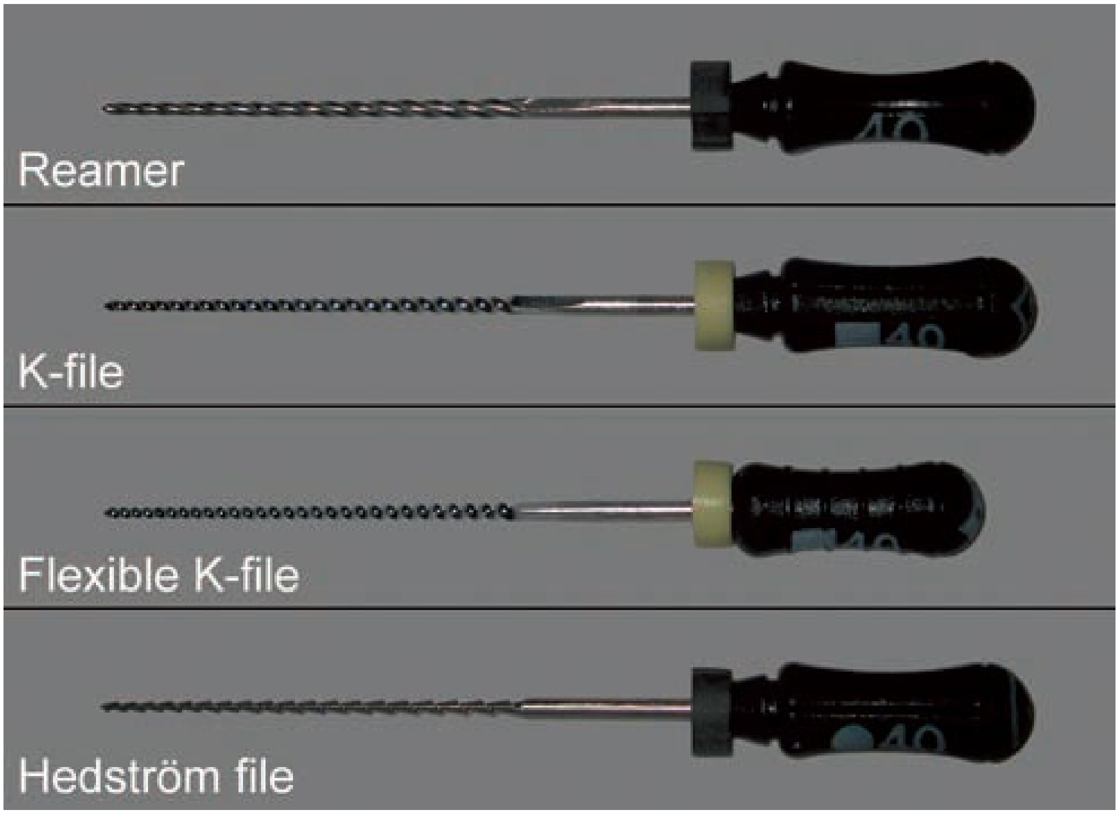
- **Reamers**

Reamers made from stainless steel wire that may be square or triangular in cross-section. A tapered wire is twisted to create sharp cutting flutes that are present every 0.5 –1mm along the working part of the instrument. When these instruments are used in rotation, the flutes cut into the dentin and remove it from the canal walls. The use of hand, stainless steel ISO-sized reamers has declined in popularity because of their lack of flexibility (especially in larger sizes), their inability to prepare canals with anything other than a round cross section, and their lack of cutting efficiency when compared with other instruments.

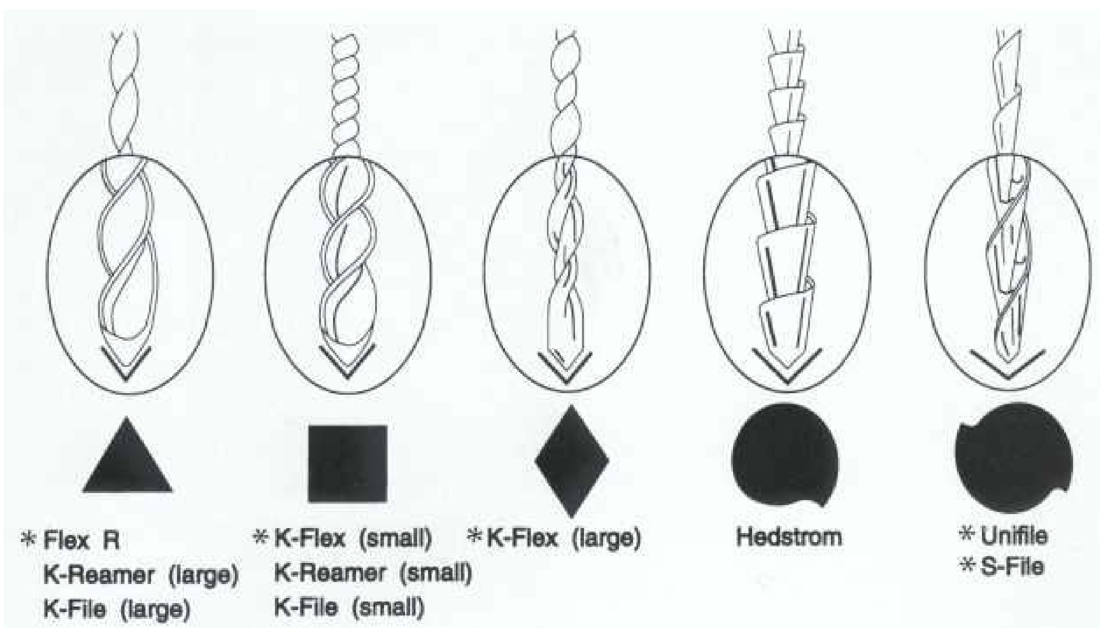
- **Files**

Files come in a number of configurations within the standard of a 2% taper. There are three main types: K-files, K-Flex and Hedström files. K-files are manufactured in a similar manner to reamers except that the cutting spirals produced by twisting are much tighter. The cross-section can be triangular or square in shape. K-Flex files are essentially similar to K-files except that the cross-sectional design is such that the instrument is able to flex more than the conventional K-file. The cross-section of the K-Flex is rhombus or diamond shaped. The cutting edges of the high flutes are formed by the two acute angles of the rhombus and present increased sharpness and cutting efficiency. The alternating low flutes formed by the obtuse angles of the rhombus and act as an auger, providing more area for increased debris removal. The decreased contact by the instrument with the canal walls provides a space reservoir that, with proper irrigation, further reduces the danger of compacting dentinal filings in the canal.

Hedström files are manufactured by grinding a tapered blank that has a round cross section. Machining produces a spirally tapered series of cones with cutting edges at the base of each cone. The instrument is designed for a filing motion and cuts only when being withdrawn from the root canal. If used in rotation it may break relatively easily because of the small core diameter. The use of Hedström files is mainly for flaringH root canals, especially oval shaped canals. They can also be used for removal of fractured instruments and gutta-percha in retreatment cases. Hedström files in larger sizes are more rigid and may cause ledges or strip perforations within curved root canals and should therefore be used with great caution.



Various stainless steel hand files (size 40).



Longitudinal and cross-sectional shapes of various hand-operated instruments. Note that small sizes of K-reamers,K-files, and K-Flex have a different shape than the larger sizes.

Traditional instruments modifications

1- Nickel titanium file.

Files made from nickel titanium showed greater elastic flexibility and resistance to torsional fracture than stainless steel. This file has a non-cutting tip and it tends to maintain the curvature of the root canal.

2- **Golden mediums**

These instruments are a series of intermediate size instruments. They correspond in size to halfway between standard ISO sizes and correspond to 12,17,22,27,32 and 37 in number.

3- Canal Master U

This hand instrument is used to prepare the apical third of the canal. It has a non-cutting pilot tip, 1 mm length cutting blade and a narrow parallel sided shaft. It is used to allow for better cutting with more space for debris accumulation and further removal. It reduces the possibility of ledge or transportation.

Group II: Low-Speed Rotary Instruments

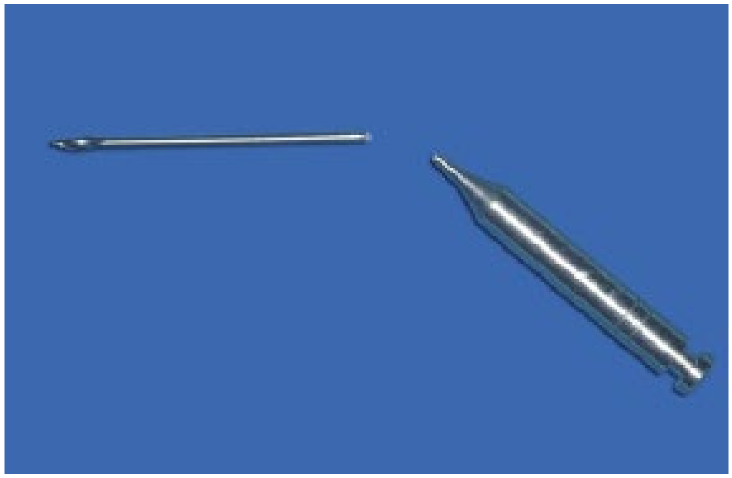
Many types of rotary instruments are used during endodontic procedures. In addition to conventional burs, burs with extended shanks for low-speed contra angle handpieces are useful for providing good visibility during deep preparation of the pulp chamber. This is particularly important when using an operating microscope when performing such procedures after access to the pulp chamber has been achieved. Straight-line access to the initial point of curvature can be accomplished using rotary instruments such as Gates-Glidden burs and Peeso instruments.

1. **Gates-Glidden drills**

The Gates-Glidden drills are steel instruments for the contra angled handpiece characterized by a long shank and an elliptical extremity which is flame shaped with a “guiding” non-cutting tip. The Gates-Glidden drills are available in six sizes and marked with circular notches on the part that attaches to the contra angled handpiece; the Gates # 1 has one notch, the # 2 has two notches and so on. The calibration of the Gates Burs is measured at the widest part of their eliptical portion; the # 1 has a maximum diameter of 0.50 mm, which increases 0.20 mm for each successive size, until # 6 which has a maximum diameter of 1.50 mm. The length of the cutting part increases progressively with the caliber, although always remaining less than 50% than that of the Largo drills (Peeso Reamers). The Gates drills are available in a short version with an overall length of 28 mm, with a shank length plus active part of 15 mm, and a long version with an overall length of 32 mm, with a shank length plus active part of 19 mm. The Gates-Glidden drills are designed with the weakest point at the start of the shank, so that they are easier to remove in case they fracture inside the root canal; it is very important to remember that the Gates # 1 and # 2 are very fragile and can fracture at the level of the tip, especially if the recommended rotational speed of 800 rpm is exceeded and if they are subjected to bending stress. The blades of the Gates-Glidden drills do not have angles but flat cutting planes to reduce the aggressiveness and the tendency to screw in. The Gates drills must be used passively on withdrawal from the canal with a brush like circumferential movement and their use must always be preceded by preflaring of the canal using hand instruments. An active use of the Gates Glidden drills is not recommended because they can lead to the formation of ledges and dangerous structural weakening that in the curved and thin canals can cause stripping. Used correctly, the Gates drills in fact represent an important aid for the endodontist, especially for eliminating coronal interferences and in the preparation of the coronal one third of the canal.

A **B**

A.1-6 Gates-Glidden drills. **B.** G-G no.3 (x25).



fracture of Gates-Glidden drills always occurs at the base of the shaft.

2. **Peeso Drills**

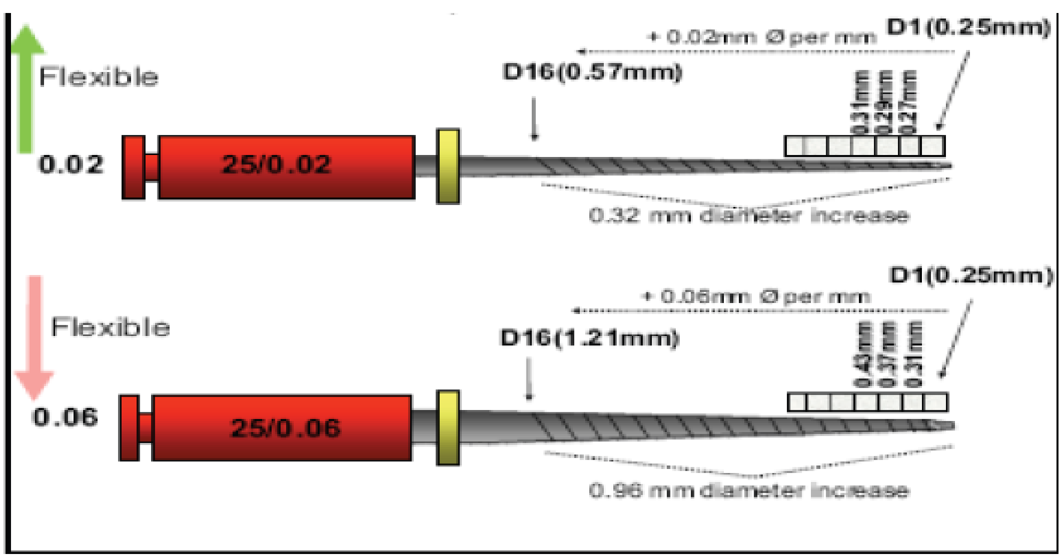
The Largo drills or Peeso Reamers are steel instruments for the contra angled handpiece similar to the Gates-Glidden drills, from which they differ in that the blades are spread over a wider surface and the shape that is cylindrical. The design of the blade (radial lands type) and the non cutting tip is in fact identical to that of the Gates drills. The # 1 Largo Bur has a maximum diameter of 0.70 mm that increases by 0.20 mm for each successive size until finally reaching Largo # 6 that has a maximum diameter of 1.70 mm. Due to the extension of the active part, the Largo drills have a very aggressive cutting action and can easily cause root stripping if not used carefully. Their initial use as suggested by some authors for opening the canal orifice is particularly dangerous, even if the instrument has a so called “non working tip”. Trying to open a canal orifice with the smallest of these instuments is the same as introducing a rotary instrument with a caliber 70 into a canal into which a .08 file enters with difficulty! On the contrary, the Largo drills are very useful in the preparation of the dowel space (post space) in canals already enlarged or in retreatments to speed up the removal of the obturation material.

The Largo drills or Peeso Reamers.

<u>Group III: Nickel Titanium Rotary Instruments for Canal Preparation</u>

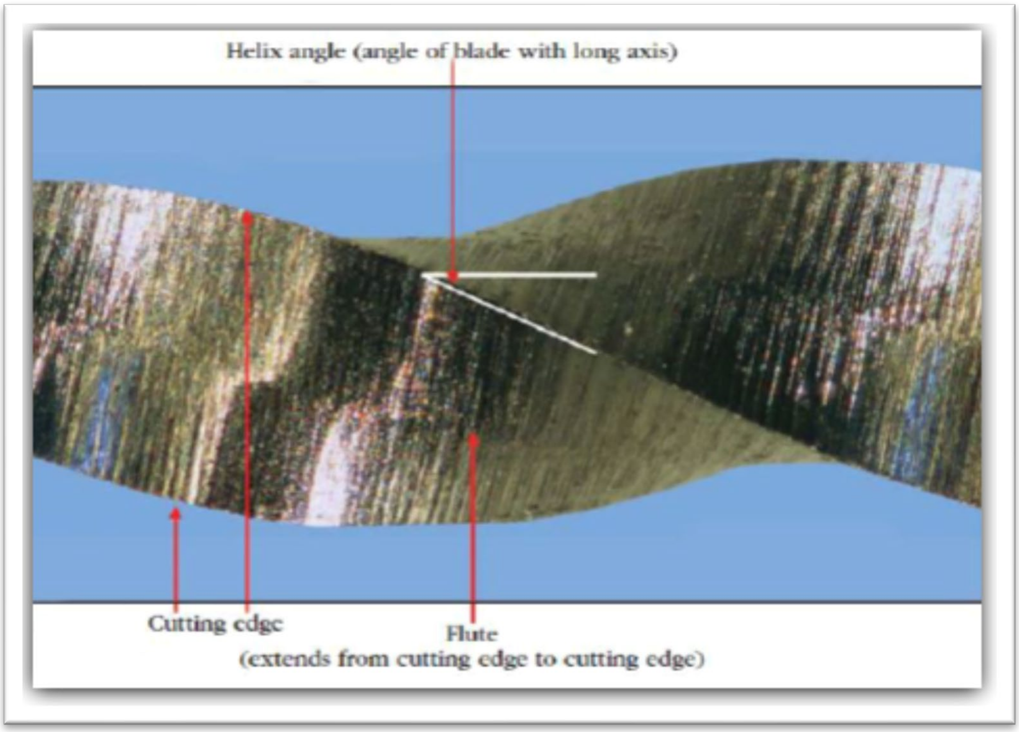
- ***<u>Components of a file:</u>***

1- The taper. It is expressed as the amount the file diameter increases each millimeter along its working surface from the tip toward the file handle. For example, a size #25 file with#.02 taper would have a 0.27 mm diameter 1 mm from the tip, a 0.29 mm diameter 2 mm from the tip, and a 0.31 mm diameter 3 mm from the tip. Some manufacturers express the taper in terms of percentage (e.g., a #.02 taper is a 2% taper).



Tapering of endodontic instruments

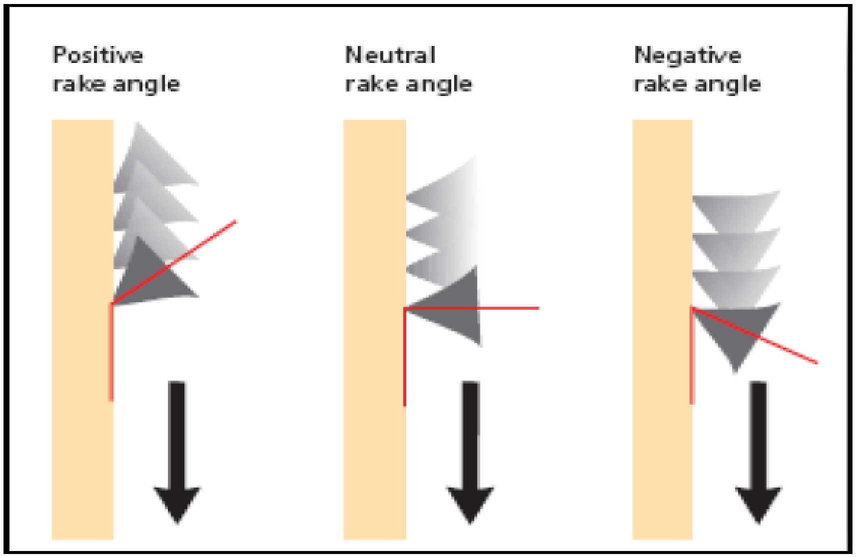
2- The flute of the file. It is the groove in the working surface used to collect soft tissue and dentin chips removed from the wall of the canal. The effectiveness of the flute depends on its depth, width, configuration, and surface finish.



3- Helix angle. It is the angle the cutting edge forms with the long axis of the file. It gathers debris collected in the flute from the canal.

4- Rake Angle

The rake angle can be seen as the angle between the leading edge of a cutting tool and the surface being cut. A rake angle can be negative, neutral or positive. If the angle formed by the leading edge and the surface to be cut (its tangent) is obtuse, the rake angle is said to be positive or cutting. If the angle formed by the leading edge and the surface to be cut is acute, the rake angle is said to be negative or scraping. In general, conventional endodontic instruments have a slightly negative rake angle and most Ni-Ti rotary files have a slightly negative or neutral rake angle. Positive rake angles will cut more efficiently than neutral or negative rake angles which scrape the inside of the root canal. This is because the instrument produces a real cutting action and there is a “smoothing” of the dentin wall. Many practitioners believe the ideal rake angle is, in fact, slightly positive but not overly positive. An overly positive rake angle will result in digging and gouging of the dentin. This can lead to separation.



5- The pitch of the file. is the distance between a point on the leading edge and the corresponding point on the adjacent leading edge. The smaller the pitch or the shorter the distance between corresponding points, the more spirals the file has and the greater the helix angle.