Mustansiriyah University
College of Dentistry
Endodontics lectures
Fifth year

NiTi Rotary File I

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When using the stainless steel files, occurrence of procedural errors cannot be avoided specially in case of curved canals. Deviation from the original shape, ledge formation, zipping, stripping and perforations are the common problems which are seen in such cases. But the super elasticity of Nickel Titanium (NiTi) alloy allows these instruments to flex more than the stainless steel instruments before exceeding their elastic limit, thereby allowing canal preparation with minimal procedural errors.

NiTi was developed by Buchler 40 years ago. NiTi is also known as the NiTinol (NiTi Navol Ordinance Laboratory in US). In endodontic commonly used NiTi alloys are called 55 NiTinol (55% weight Ni and 45% Ti) and 60 NiTinol (60% weight of Ni, 40% Ti).First use of NiTi in endodontic was reported in 1988, by Walia et al when a 15 No. NiTi file was made from orthodontic wire and it showed superior flexibility and resistance to torsional fracture. This suggested the use of NiTi files in curved canals

Properties of NiTi Alloys:

1-Shape memory.
2-Super elasticity.
3-Low modulus of elasticity.
4-Good resiliency.
5-Corrosion resistance.
6-Softer than stainless steel.

Super elasticity and shape memory of NiTi alloys is because of phase transformation in their crystal structures when cooled from the stronger, high temperature form (Austenite) to the weaker low temperature form (Martensite). This phase transformation is mainly responsible for the above mentioned qualities of NiTi alloys

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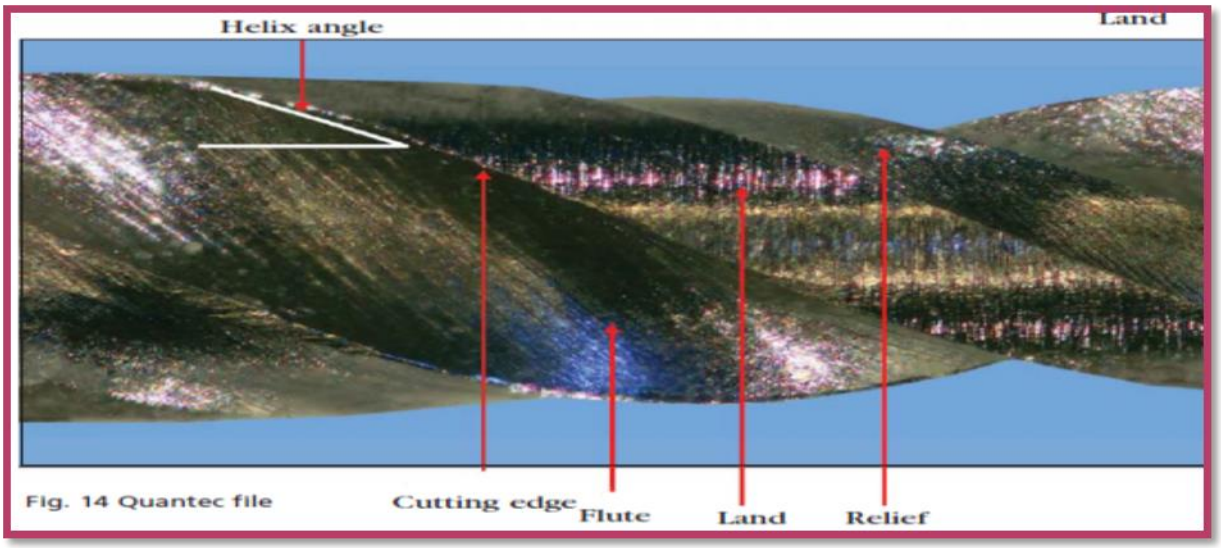
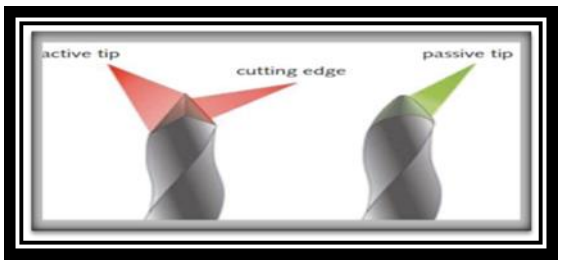


What are the components of a file?

- **Tip Design**

A rotary cutting instrument may have a design cutting or non-cutting tip. Cutting tips on rotary files make them too aggressive. An advantage of cutting tip is that it has the ability to enter narrow, somewhat calcified canals, but it also has disadvantage, if it accidentally go long (past the end of the tooth), upon retraction of the file, it will generally create an elliptical tear which is very difficult to repair and obturate and it also has the distinct possibility of transportation if the file is held at length for any period of time. Going long with a non-cutting tip will create a concentric circle at the end of the root. These are easily filled with a non-standardized cone.



- **helix angle**

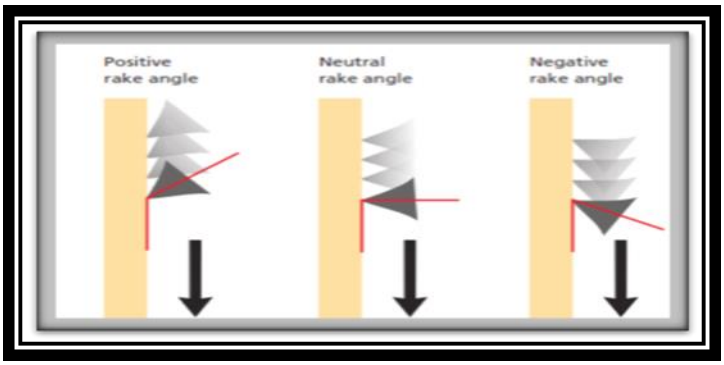
The angle that the cutting edge makes with the long axis of the file.

❖ Taper

Taper is described as the amount of file diameter increase per millimeter along the working surface from the tip toward the file handle

❖ Rake Angle

The rake angle is the angle formed by the cutting edge and a cross section taken perpendicular to the long axis of the instrument.



The cutting angle, on the other hand, is the angle formed by the cutting edge and a radius when the file is sectioned perpendicular to the cutting edge.

❖ Flute

The flute of the file is the groove in the working surface used to collect soft tissue and dentine chips removed from the wall of the canal.

❖ Pitch

Pitch is the distance between a point on the leading edge and the corresponding point on the adjacent leading edge

❖ Radial land

It's a flat area that is located directly behind the cutting edge of the instrument. The land touches the canal walls at the periphery of the file and reduces the tendency of the file to screw into the canal, reduces transportation of the canal, reduces the progression of micro cracks on its circumference, supports the cutting edge; and limits the depth of cut. Theoretically, the radial land improves irrigation flow apically and the movement of debris coronally.

❖ The core

The core is the cylindrical center part of the file having its circumference outlined and bordered by the depth of the flutes. The flexibility and resistance to torsion is partially determined by the core diameter

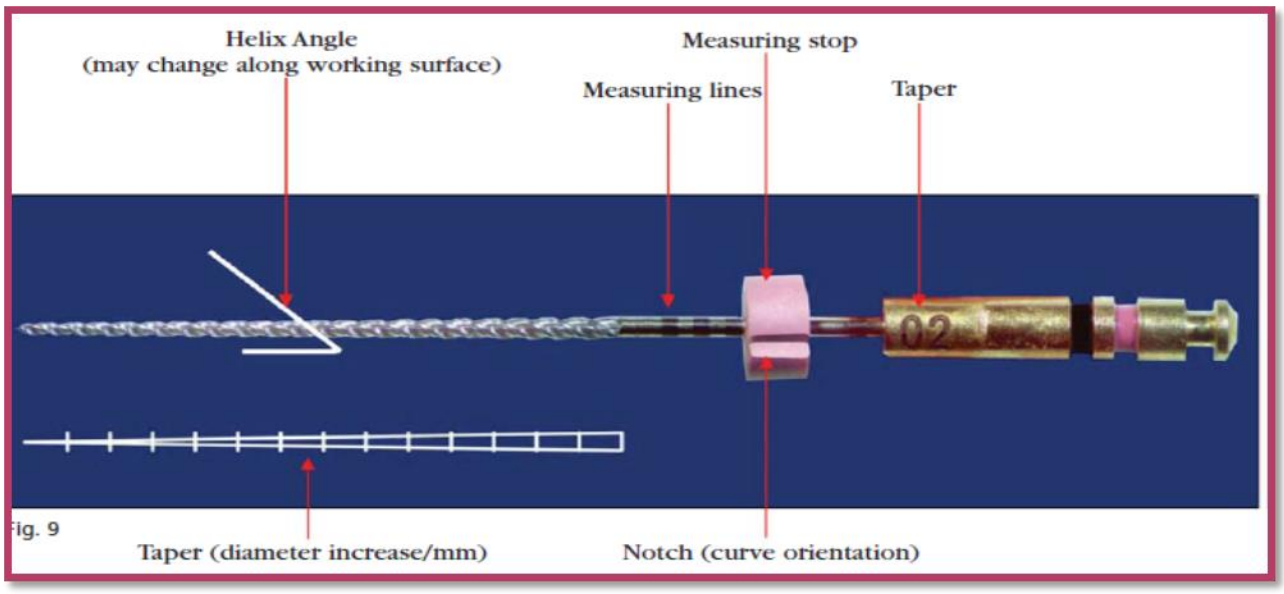


Fig. 9

Manufacturing of NiTi Files

Because of the presence of super elasticity and shape memory, the NiTi files cannot be manufactured by twisting as is done with K-Files. In fact, the NiTi files have to beg rounded for their manufacturing. Earlier there used to be NiTi hand files but latter automated use of NiTi files was developed to increase the efficiency of clinical treatment.

Traditionally, the shaping of the root canals was achieved by the use stainless steel hand file. However, techniques using stainless steel hand file have several drawbacks:

They require the use of numerous hand file & drills to adequately prepare the canals.

1. Hand instrumentation with stainless steel file is time consuming.
2. The stainless steel hand instrumentation techniques have an increased incidence of canal transportation

3. Finally, from a clinical stand point, the use of hand instrument in narrow canals can be very frustrating especially in teeth with different access

NiTi can have three different forms: martensite, stress-induced martensite (super elastic), and austenite. When the material is in its martensite form, it is relatively soft and can be easily deformed. Super elastic NiTi is highly elastic, while austenite NiTi is non-elastic and hard.

The NiTi alloy used to manufacture endodontic instruments is composed of approximately 56 percent (wt) nickel and 44 per cent (wt) titanium and is generically known as 55-Nitinol. The super elasticity of NiTi instruments is related to a stress-induced phase transformation in the crystalline structure of the material. The austensitic phase transforms into the martensitic phase on stressing, and in this form requires only light force for bending. After release of stresses, the metal returns to the austensitic phase and the file regains its original shape. The improved flexibility and unique properties of NiTi alloy provides an advantage when preparing curved canals and has made it possible to engineer instruments with greater tapers (4–12 percent), thereby allowing better control of root canal shape.