
Life on Social Media

Endodontic File Systems – Parameters that Influence File Characteristics

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1. Characteristics of the endodontic file
2. Other influencing variables
3. Clinical perfomance

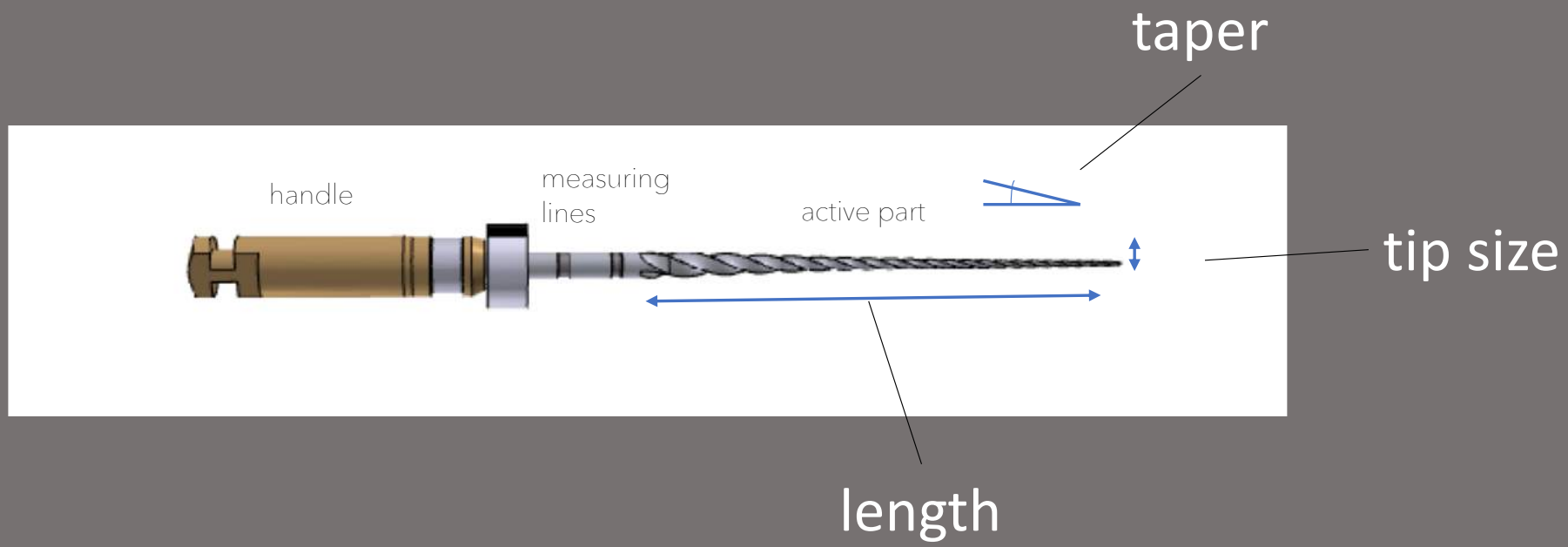
1 **Characteristics of the endodontic file**

- **Standard indications: size, length & taper**
- **Characterization of cross-section**
- **Flute, pitch & helix angle**
- **Material and heat treatments**

2 Other influencing variables

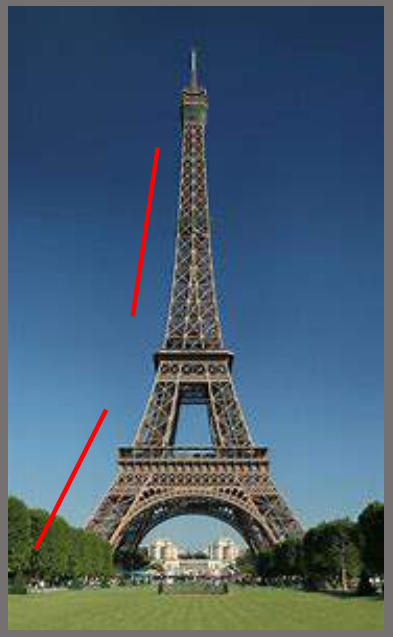
3 Clinical performance

The standard indications: length, tip size & taper – What's missing?



Taper: Cairo, Paris or London?

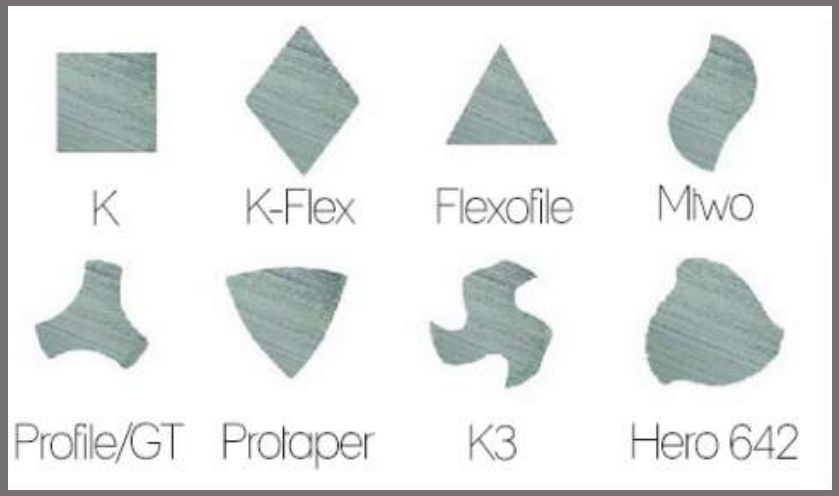
Pyramid: Constant taper
ISO standard



Eiffel tower: Progressive taper

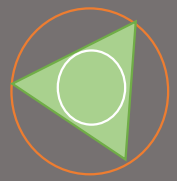
Lipstick building: Regressive taper

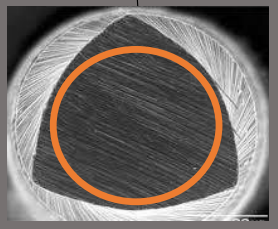
There is a lot of information hiding in the cross-section…



- Cross-section area & core area
- Variability of cross-section along the working length
- Size & shape of flutes
- Off-centering
- Number of cutting edges
- Angle of cutting edge (rake angle)

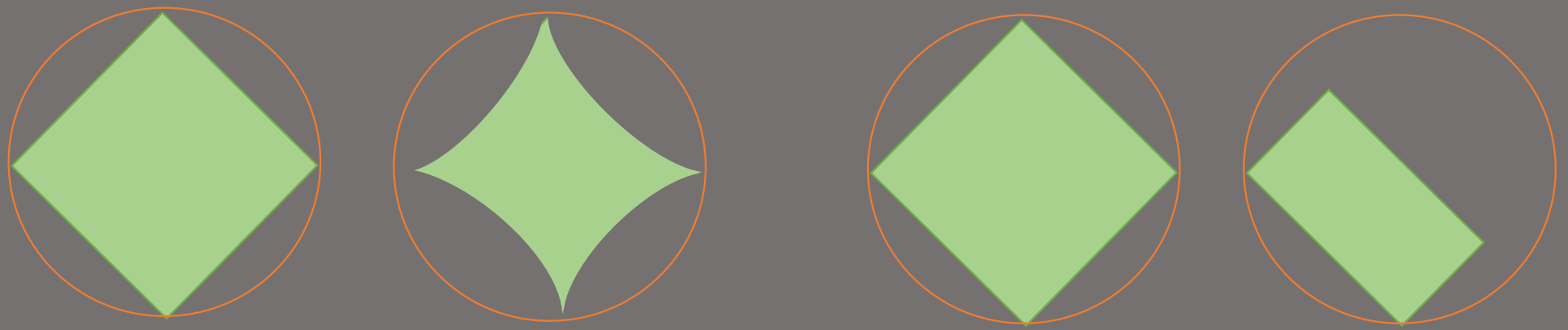
How strong is my core?





- Cross-sectional area and core cross-sectional area will be different depending on the shape of the cross-section
- Ideally the cross-sectional core area increases toward the tip

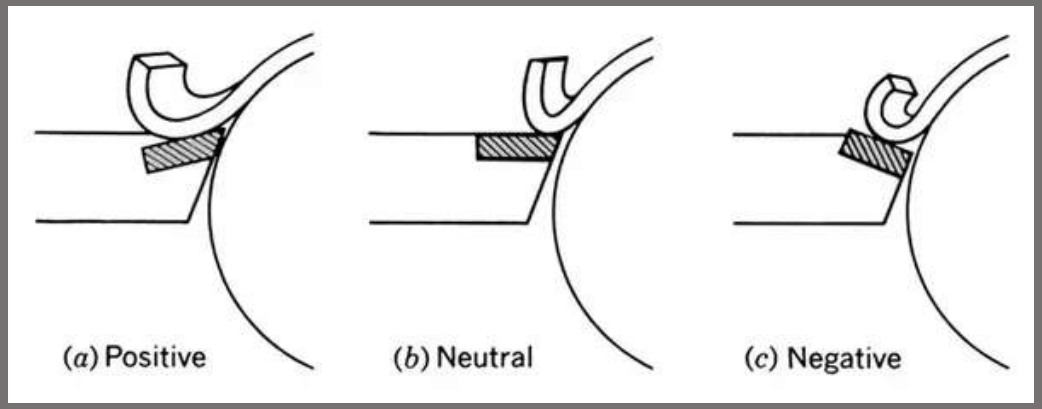
Space for debris to reduce ‘filling’ the flutes



- Depth of the flutes
- Shape Cross-section (Triangle has more space for debris removal than square)

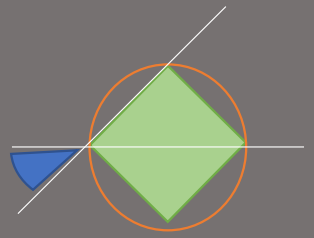
- Move the center of the cross-section out of the center of the rotational axis
- Leading cutting edge creates chips

How can I see how well it will cut?

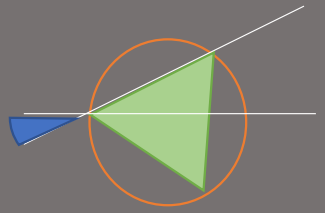


Negative and positive rake angle/cutting angle

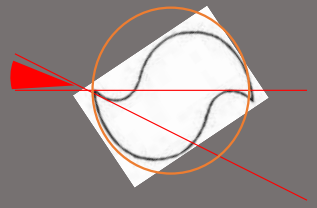
Multiple cutting edges will reduce the force you can apply on one edge



-45° cutting angle – scraping action
More efficient with filing motion

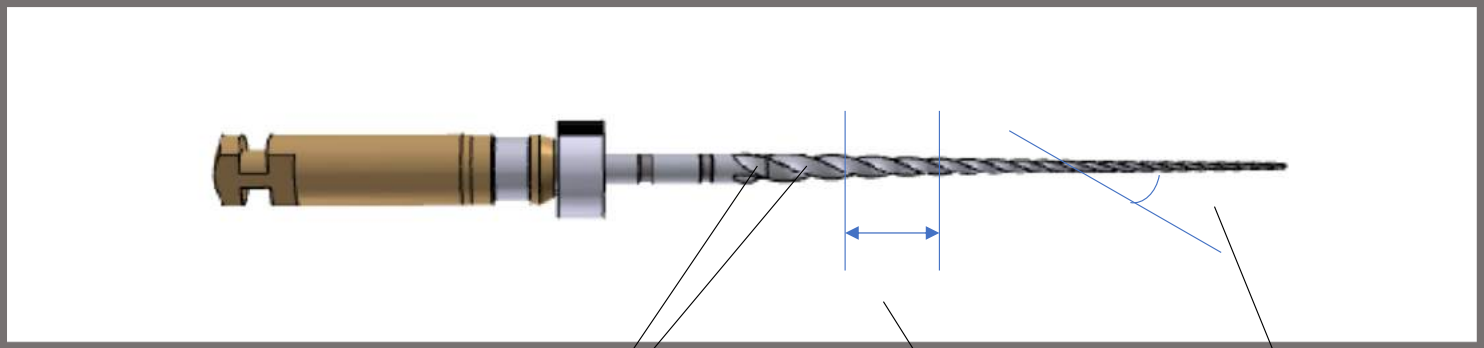


-30° cutting angle



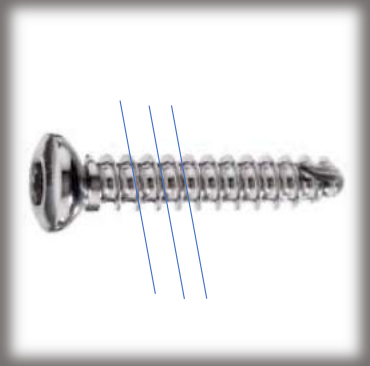
+20° cutting angle – cutting action
More efficient with rotating motion

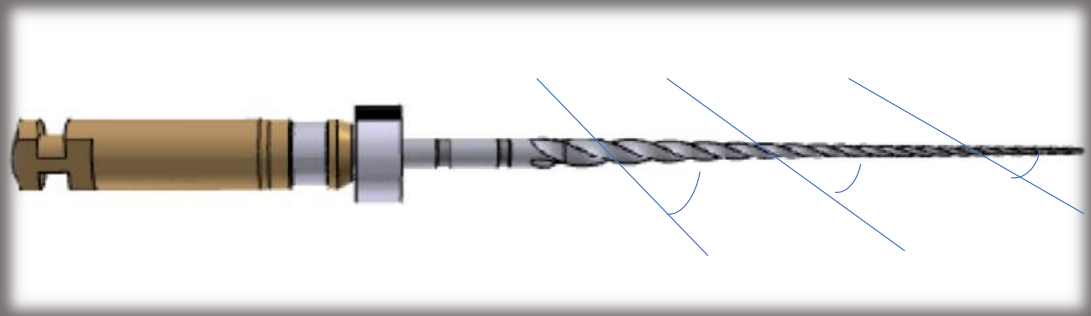
Flute, pitch & helix angle have a big impact



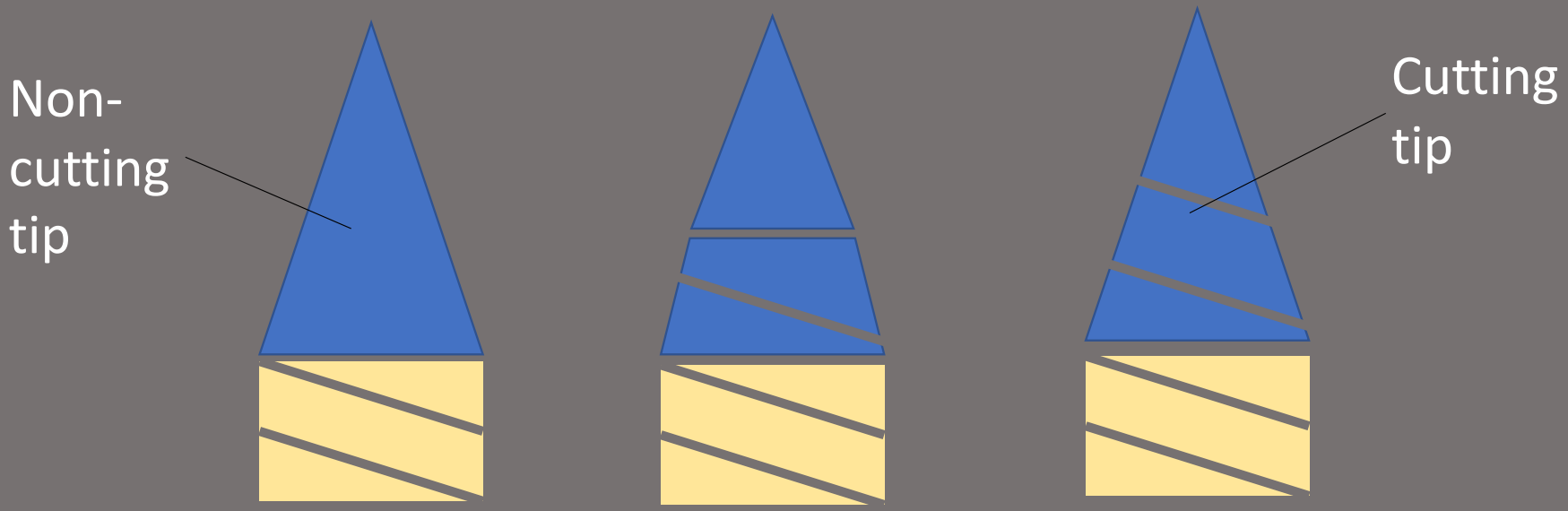
- Flute: Groove between cutting edges
- Pitch: Distance between the same points on the cross-section
- Helix angle: Angle between the cutting edge and the axis of rotation

Helix angle should be variable to avoid screwing



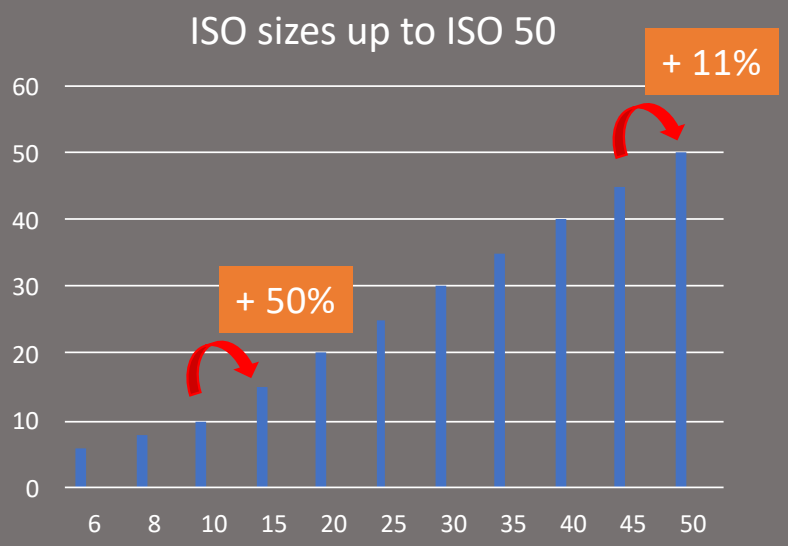


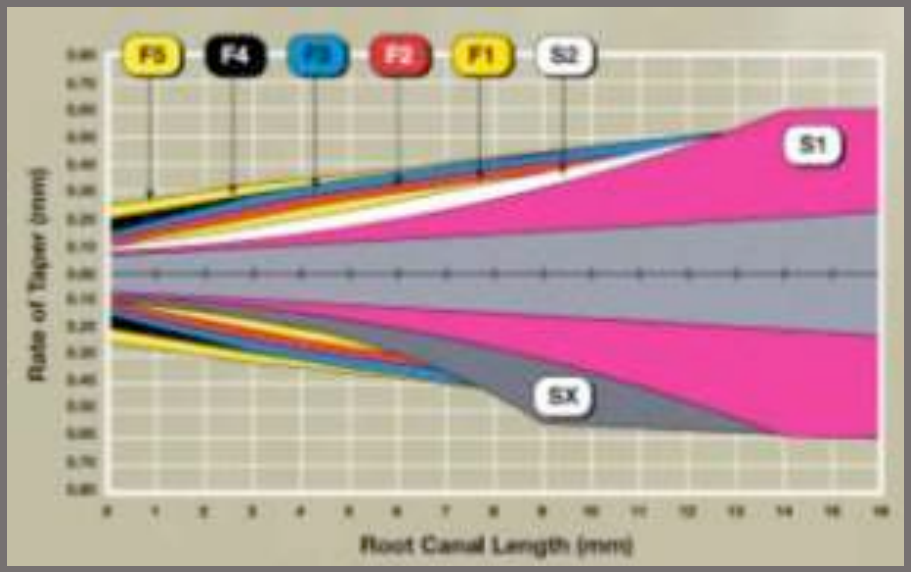
The tip will guide the file and enlarge the canal



- Non-cutting, partially cutting or cutting, depending on proximity of flute to the tip and cutting angle of leading edge

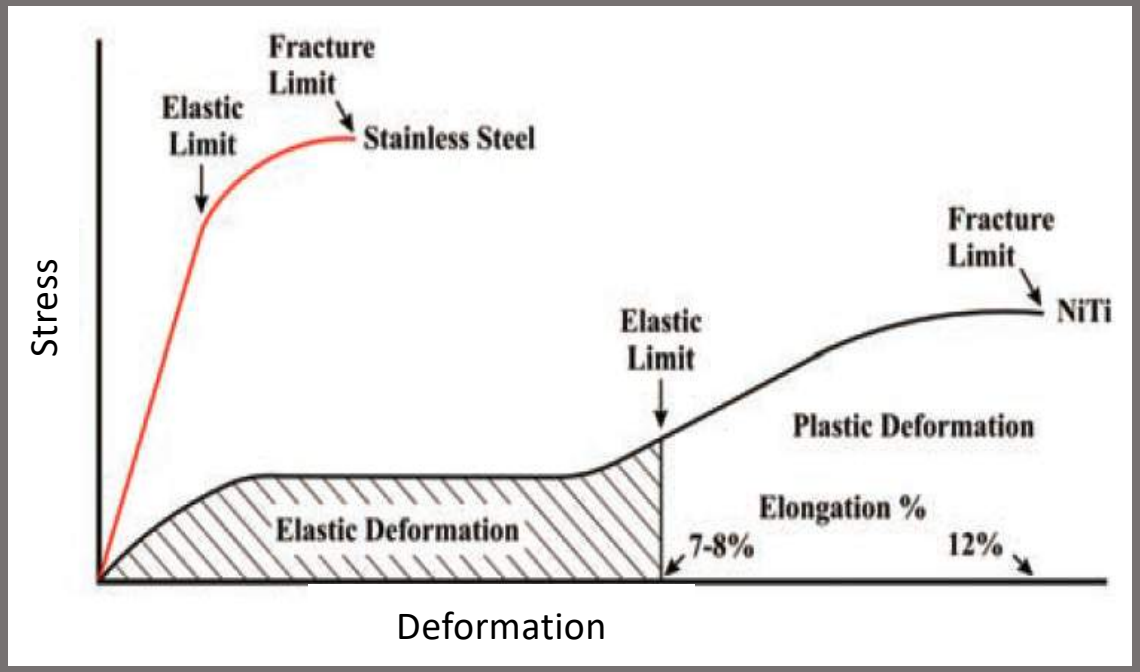
File System – additional factor: work volume

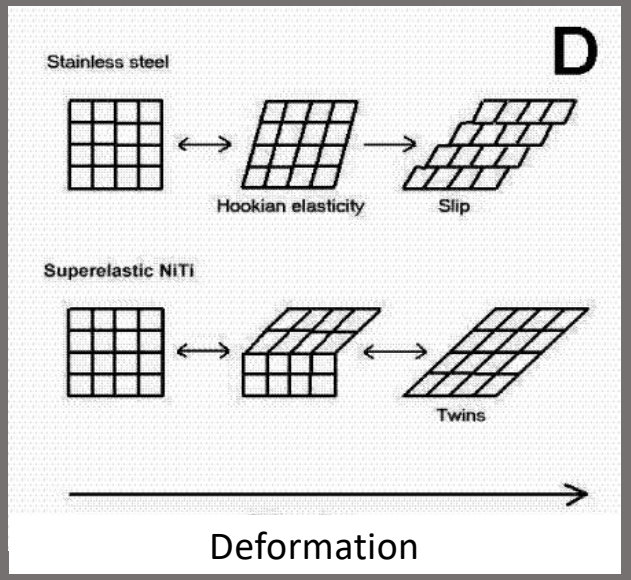




Hard and cutting or soft and blunt?

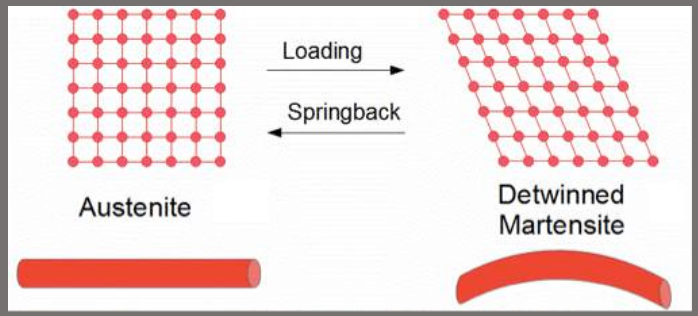
If all canals were straight, stainless steel files would have better results than nickel-titanium



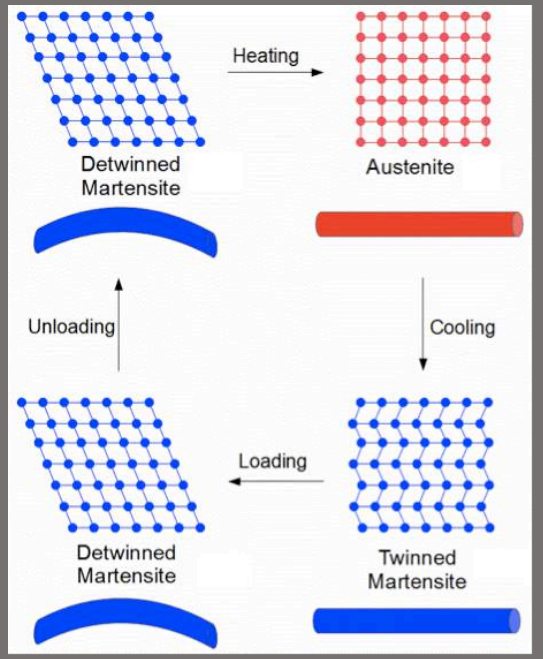


The two main phases of Nickel Titanium

Superelastic material Af < RT



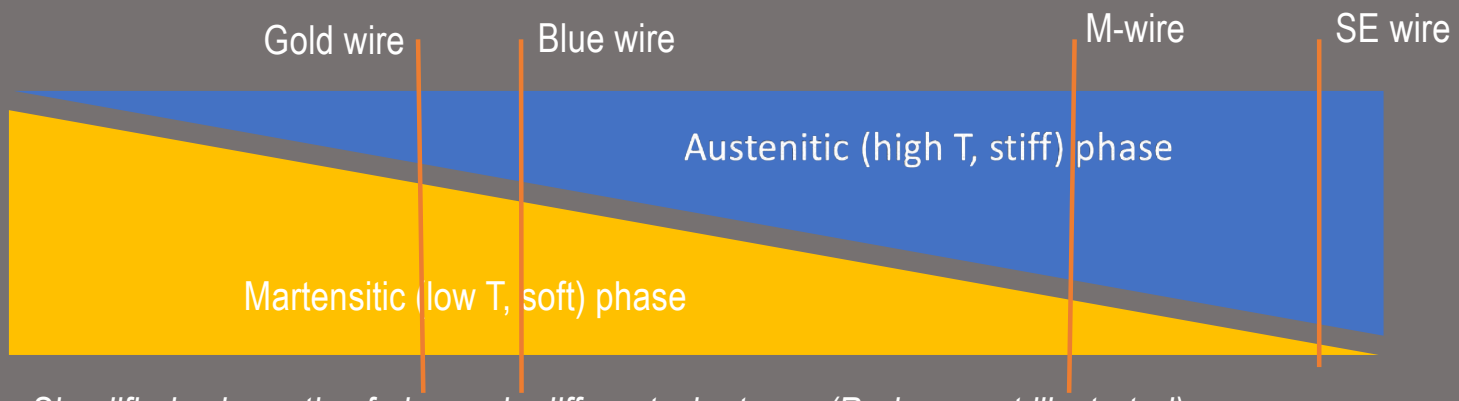
Austenitic material: stiff and elastic, will return to shape after bending



Shape memory material Af > RT

Martensitic material: soft and bends easily, will keep shape until heated

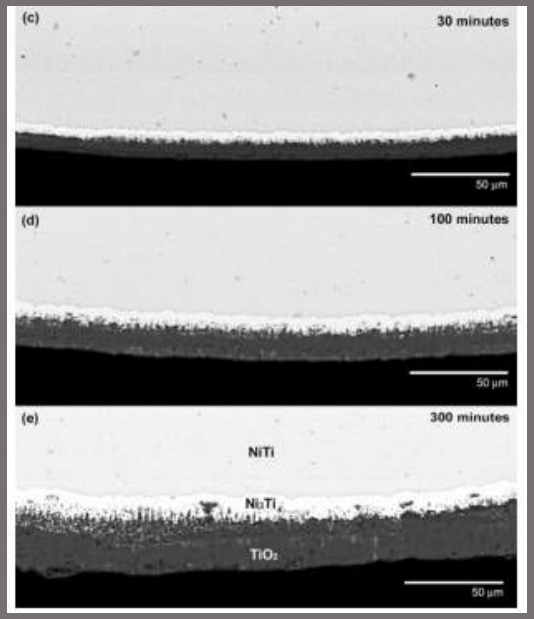
The transition temperature can be modified to get the desired properties

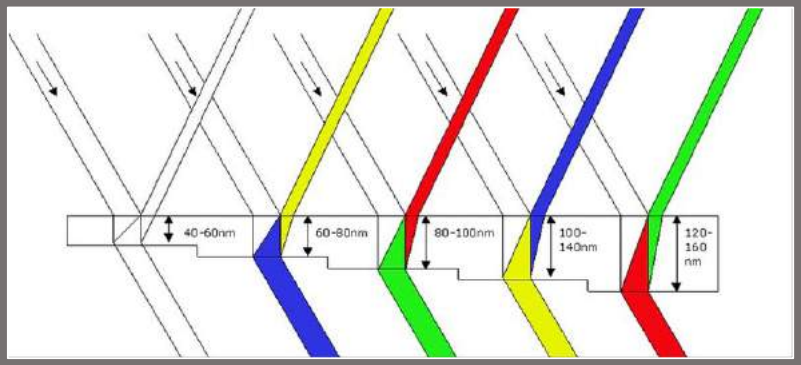


Simplified schematic of phases in different wire types (R-phase not illustrated)

Nickel Titanium properties are influenced by heat treatment, mechanical history and chemical composition

The colour of the wire is a consequence of the titanium oxide thickness





The wavelengths of light that is reflected from the surface depend on the thickness of the titanium oxide layer.

1 Characteristics of the endodontic file

2 **Other Influencing Variables**

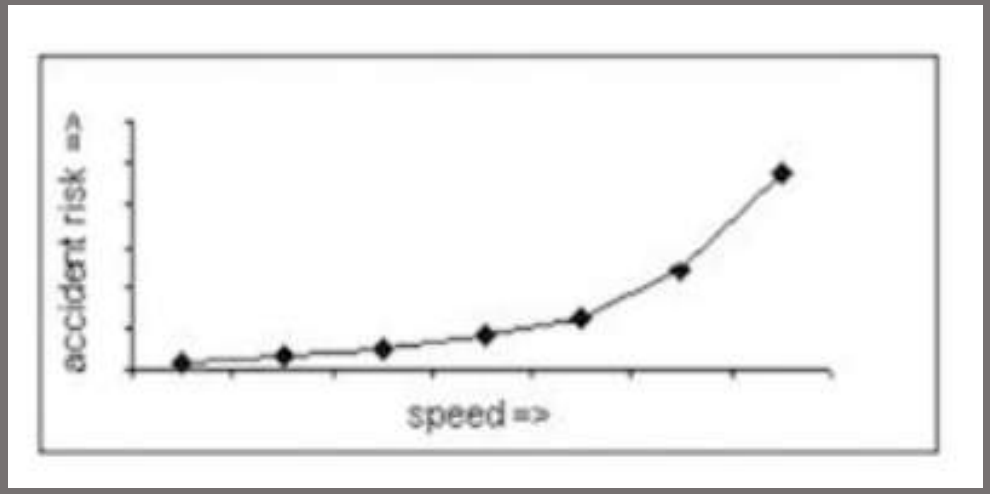
- **Motion: Sense & speed of rotation**
- **Torque limiting motor**
- **Canal anatomy**
- **Speed and depth of insertion**

3 Clinical Performance

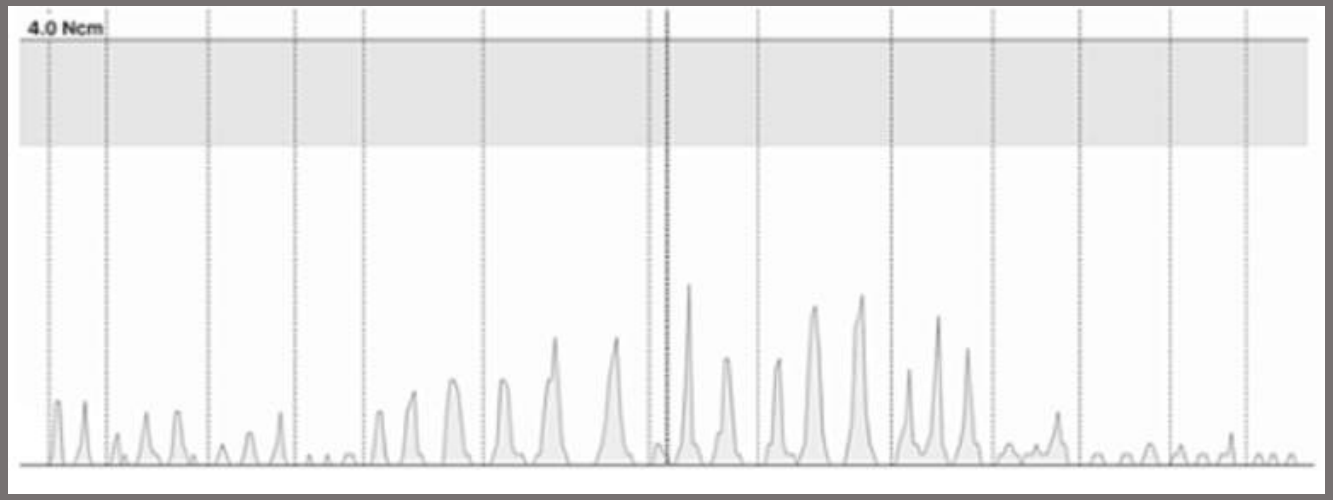
Motion: Sense & Speed of rotation

- Continous rotation or reciprocating

- Increasing speed leads to higher cutting efficiency but also increases risk of fatigue breakage



Torque limiting motor



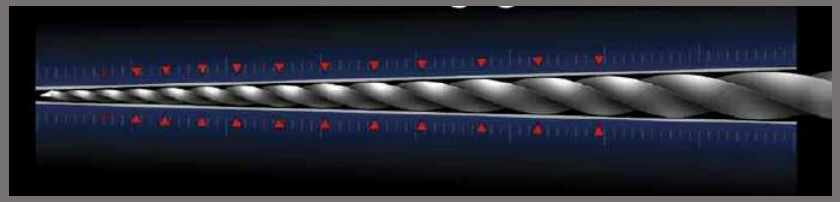
- If the torque goes over a defined value the motor gives a sound/stops/auto reverses
- Torque limit should not have any influence on the act of shaping

Canal anatomy

CANAL AND ROOT MORPHOLOGY	☐ Slight or no curvature (<10°) ☐ Closed apex (<1 mm in diameter)	☐ Moderate curvature (10-30°) ☐ Crown axis differs moderatel from root axis. Apical opening 1-1.5 mm in diameter	☐ Extreme curvature (>30°) or S-shaped curve ☐ Mandibular premolar or anterior with 2 roots ☐ Maxillary premolar with 3 roots ☐ Canal divides in the middle or apical third ☐ Very long tooth (>25 mm) ☐ Open apex (>1.5 mm in diameter)
RADIOGRAPHIC APPEARANCE OF CANAL(S)	☐ Canal(s) visible and not reduced in size	☐ Canal(s) and chamber visible but reduced in size ☐ Pulp stones	☐ Indistinct canal path ☐ Canal(s) not visible

AAE Endodontic Case Difficulty Assessment Form and Guidelines

Avoid engaging to much of the file at the same time & limit applied force



The area of engagement can be limited by limiting depth of insertion

Depending on the taper shape the area of engagement may already be predefined

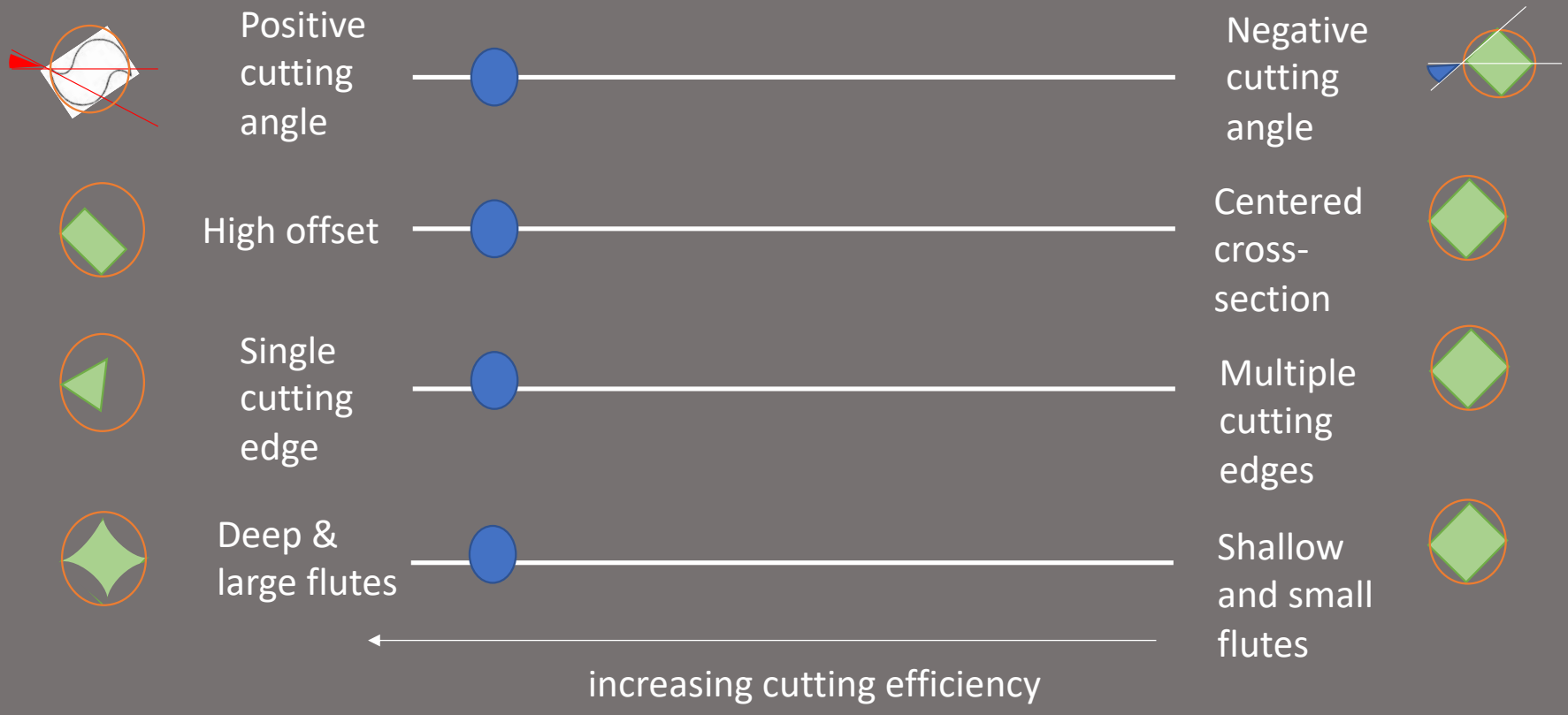
1 Characteristics of the endodontic file

2 Other Influencing Variables

3 Clinical Performance

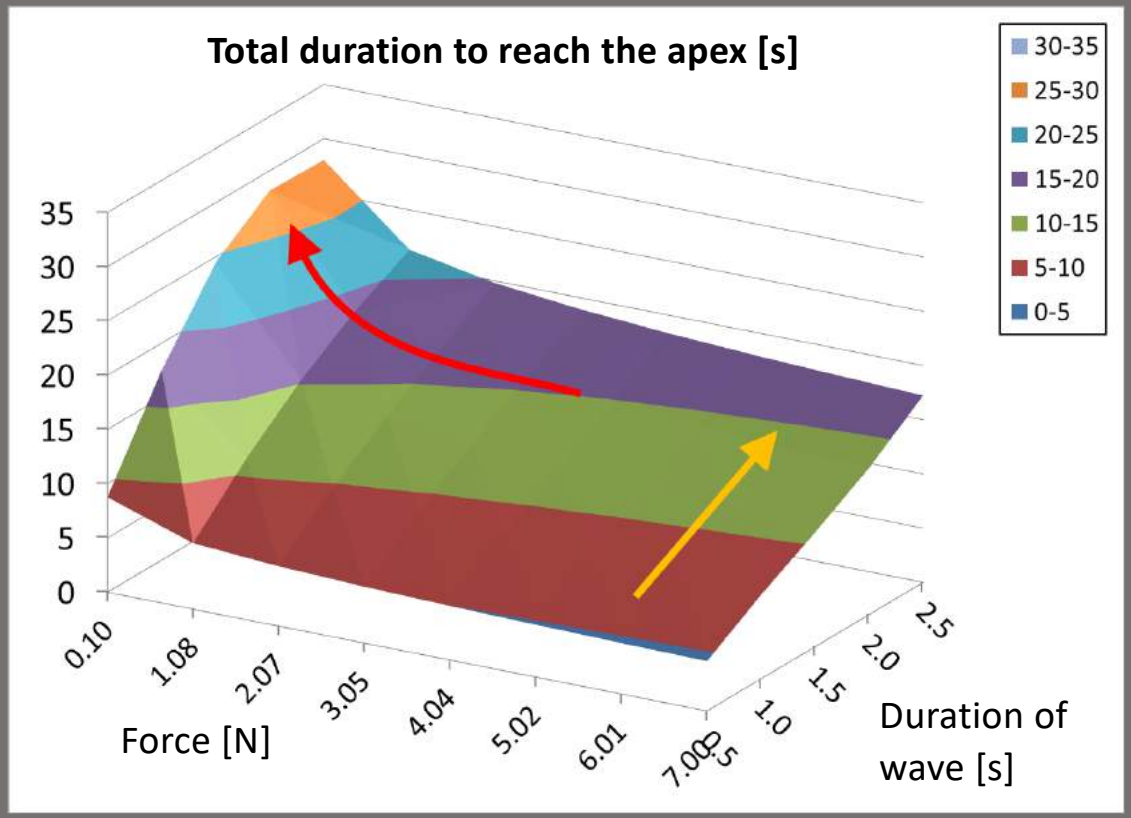
- **Cutting efficiency**
- **Flexibility and torsional strength**
- **Fatigue resistance**
- **Screwing effect**
- **Final shape**

The geometrical factors influencing cutting efficiency



Understanding cutting efficiency

- Positive cutting angle & single cutting edge -> best cutting action
- High offset & large, deep flutes -> best evacuation of debris
- Minimize file engagement and clean the flutes regularly
- Increasing speed of rotation of the file increases efficiency (but also risk of breakage)
- Insertion depth should be small and force applied should be limited



Flexibility & torsional strength

Small cross-sectional core area

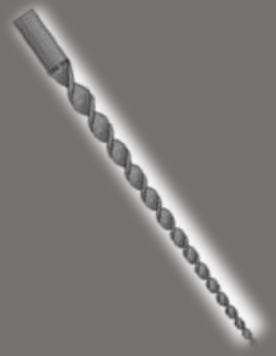
High offset

High pitch/low helix angle

Large cross-sectional core area

Centered cross-section

Low pitch/high helix angle



increasing flexibility

increasing torsional strength

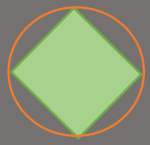
Fatigue resistance

Straight canal

High canal curvature

Small cross-sectional area / file size

Large cross-sectional area / file size



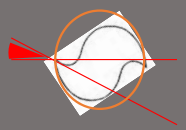
Heat Treated material

Non-Heat Treated material

increasing number of cycles to failure

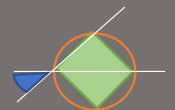
increasing risk of fatigue breakage

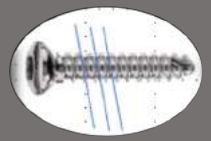
Screwing effect makes you feel less in control



Positive cutting angle

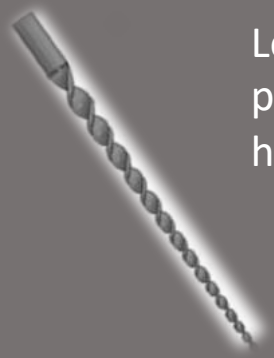
Negative cutting angle





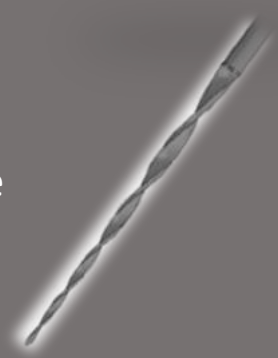
Constant Helix angle

Variable Helix angle



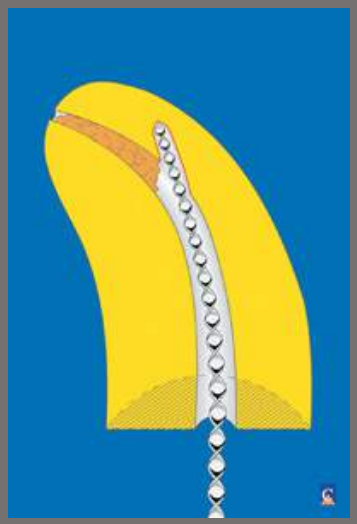
Low pitch/high helix angle

High pitch/low helix angle



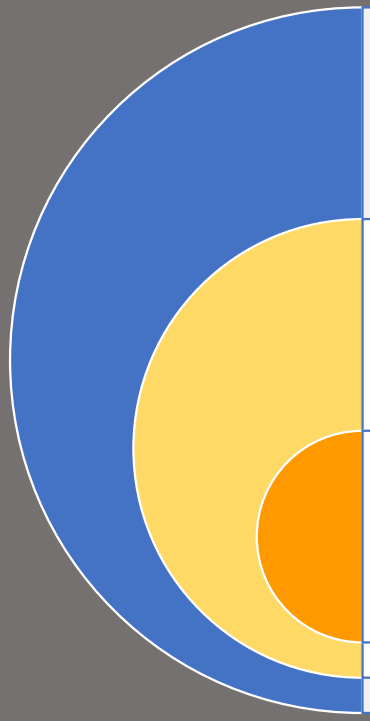
Stronger screwing effect

Final shape



Transportation, ledges and perforation may occur if files are too stiff

The Clinical Outcome is a Result of Many Variables…



Clinical Performance	• Observable Performance • Outcome
Other influencing variables	• Canal dimensions & state • Clinicians Implementation
Characteristics of the endodontic file	• Geometrical variables • Material

Questions?