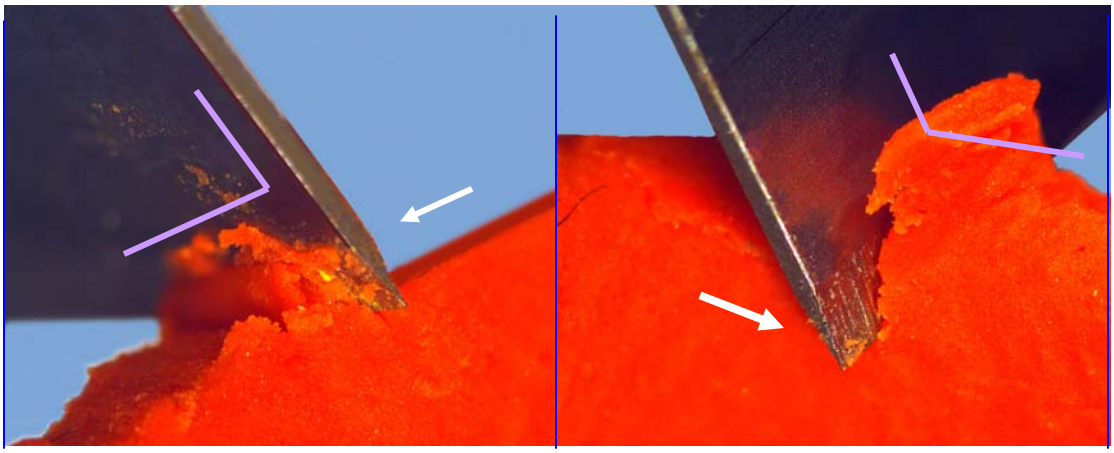
10. What is the difference between the rake angle and cutting angle?

If the file is sectioned *perpendicular to its long axis,* the ***rake angle*** is the angle formed by the leading edge and the radius of the file. 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***. However, the rake angle may not be the same as the ***cutting angle.*** The cutting angle***, effective rake angle***, is a better indication of the cutting ability of a file and is obtained by measuring the angle formed by the cutting (leading) edge and the radius when the file is sectioned *perpendicular to the cutting edge*. In some instances, as with some Quantec files, a file may have a blade with a negative rake angle and a positive cutting angle. If the flutes of the file are symmetrical, the rake angle and cutting angle will be essentially the same.

The ***pitch*** of the file is the distance between a point on the leading edge and the corresponding point on the adjacent leading edge, or it may be the distance between points within which the pattern is not repeated. The smaller the pitch or the shorter the distance between corresponding points, the more spirals the file will have and the greater the helix angle will be. Most files have a variable pitch, one that changes along the working surface, because the diameter increases from the file tip towards the handle the flute becomes proportionately deeper resulting in a the core taper that is different from the external taper. Some instruments, such as the Quantec and K-3 files, have asymmetrical cross-sectional designs in which case the pitch may be considered to be the distance between points that the pattern is not repeated.

The cutting angles, helix angles, external and core taper may vary along the working surface of the file and the ratios of these quantities can vary between instruments of the same series. Any change of any of these features can influence the file's effectiveness or its propensity for breakage as it progresses into the canal space and can account for some files to act uncharacteristically when compared to other files in the same series.

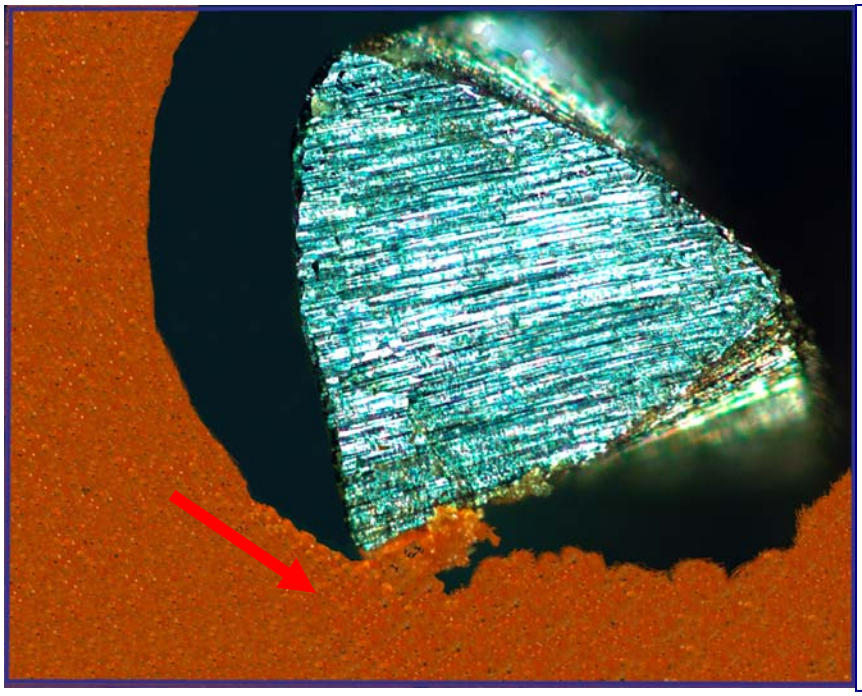
Direction and Action of the Leading Edge *(angle of incidence)*



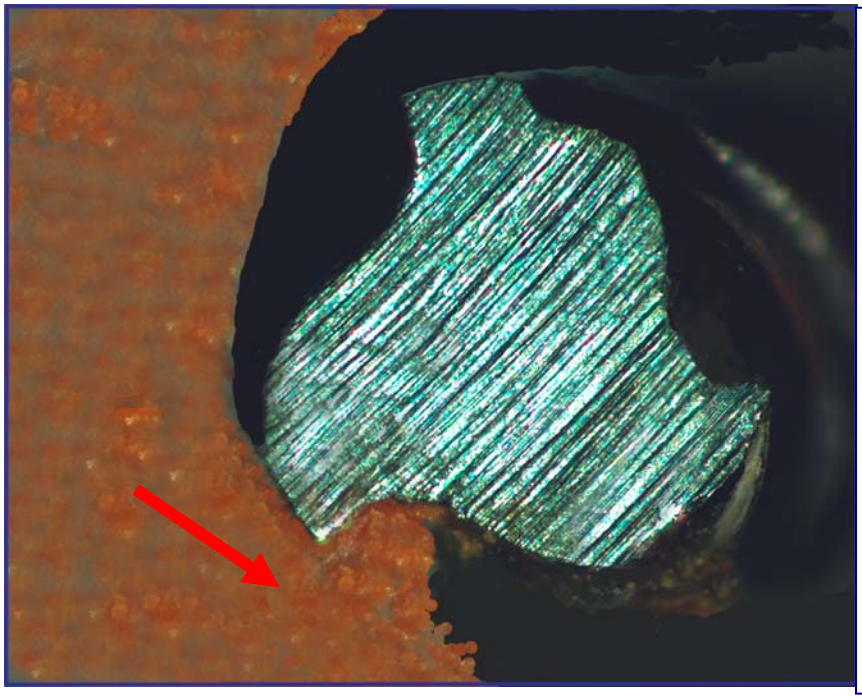
Negative Cutting Angle ***Positive Cutting Angle***

(acute angle) *(obtuse angle)*

Negative angles result in a "scraping" action. Positive angles result in a cutting action. Although cutting actions can be more efficient and require less force for enlarging a canal, a scraping action may have a smoother feel. The operator may erroneously confuse smoothness with efficiency. However, if excessive pressure is applied to a cutting file excessive torsion could be the result. (Arrows indicate the direction of the blade motion).



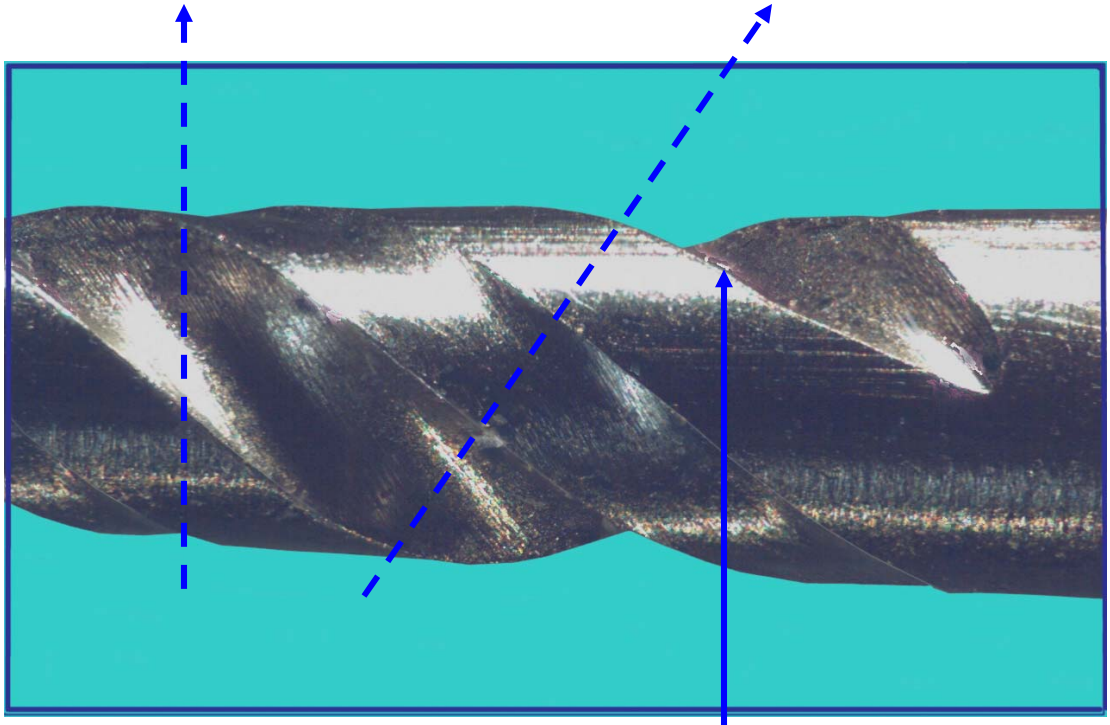
The ProTaper file utilizes a negative angle of incidence to enlarge the canal. The surface of the file blade meets the canal wall with an acute angle resulting in a scraping action. More pressure is required when enlarging the canal in this manner.



The K-3 file utilizes a positive angle of incidence to enlarge the canal. The file blade meets the canal wall with an obtuse angle resulting in a cutting action. Less pressure is usually required when enlarging the canal in this manner. Excessive pressure can cause excessive torsion by forming chips too large to be dislodged.

Section perpendicular to long axis determines rake angle

Section perpendicular to cutting edge determines cutting angle (effective rake angle)



Cutting edge

The cutting angle, effective rake angle, is a better indication for determining the cutting ability of a file than the rake angle because it shows the actual angle of incidence.