Ramifications of Design Considerations

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Careful examination of technique and design considerations identifies the limitations and usefulness of existing instruments and facilitates the development of a new generation of rotary instrumentation, one unencumbered by traditional concepts. Listed below are some of the considerations and ramifications of designs that are most important in formulating techniques in approaching difficult cases.

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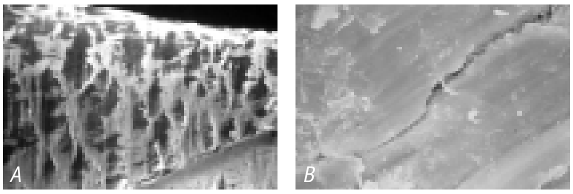
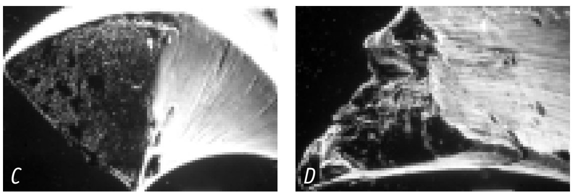
What causes breakage?

In the most basic terms, the strength of a file is due to the cohesive forces between atoms. As forces that tend to change the shape of the file are increasingly applied, the forces to separate atoms increase and their attraction decreases. Breakage occurs when the force of separation of the atoms exceeds the force of attraction. On a larger scale, the molecules of a metal are arranged in patterns denoting its crystalline structure or grain and the fracture of files usually can be characterized in two ways. The fracture may occur across the grain of the metal with little or no apparent deformation. This type of fracture can be seen as a result of fatigue most often caused from the excessive stresses of the repetitive rotation of a file during instrumentation around a curvature. The other cause of fracture shows apparent deformation of a file and the separation occurs as a result of slippage between the planes of its crystalline boundaries most often due to the excessive forces of torsion. Of course, most fractures are a combination of different forces of separation.



Irregularities in the surface of the leading edge of a file shown in image A act as stress concentration points for potential torque or fatigue failure. The force to propagate the crack shown in image B can be less than one half the force that was required to form it. Examining the SEM images of the quality of manufacturing can provide valuable information for the probability for breakage.



The fracture across the grain of the metal of file C was probably the result of fatigue. Note the faults along the blade that are particularly susceptible to stress concentration. The fracture resulting from slippage between the crystalline boundaries in file D was probably the result of excessive twisting.

What is torsion?

Torsion is the axial force of being twisted that results when one part of a file rotates at a different rate than another part. Any distortion of a file that results from twisting, such as un-winding is caused by stress of torsion. When a file resists rotation during hand instrumentation with conventional .02 tapered files, excessive torque can usually be perceived and file breakage can usually be avoided. On then other hand, even the use of torque control Handpieces during automated instrumentation does not provide the means for adjusting to varying circumstances, such as curvatures, the amount of file engagement, and which the diameters of the file that are engaged. Understanding the factors that cause excessive torque is the most reliable means for avoiding torsion failure.

What causes torsion stress?

Torsion stress on a file is primarily the result of (1) the force of cutting, how effectively a chip is formed and deflected from the wall of the canal, (2) the force of screwing-in due to the spiraled blades that become engaged in the wall of the canal without forming and deflecting chips, (3) the force of abrasion of the non cutting surface of the file against the wall of the canal, and (4) the force the debris exerts on the wall of the canal as it accumulates in the flutes. Incorporating designs to reduce any of these forces increases the file's efficiency and is one approach to advance instrument design. Another approach is to provide designs that can accommodate greater forces although the efficiency may remain unchanged.

A file with a larger diameter can resist more torsion stress than one with a smaller diameter. The relationship varies very