EDITORIAL

New Strategies and Instruments for Root Canal Shaping Procedure: An Overview

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Cone-beam computed tomography-based three-dimensional analysis of root canal trajectories and shapes have clearly shown that root canals are more complex in 3D, compared to traditional 2D visualization,[1–4] and consequently, these findings affect properties of the nickel–titanium (NiTi) files requiring the following factors:

- More flexibility to properly negotiate curvatures, avoiding iatrogenic errors.
- More mechanical resistance to avoid intracanal breakage.
- Changes in design or in the clinical use to increase performance in oval canals to improve debris removal and cleaning (by touching more canal walls).

Cleaning is obviously related to proper use of irrigants and irrigation techniques, but instruments also play a significant role to create more or less debris, remove them properly, vehicle the solutions and disrupt biofilm, and create a proper shape for obturation avoiding under- and over-instrumentation.[5–8]

Improving properties of NiTi files can be done mainly in three different ways as follows:

- Improving design, which has been for a few decades the main option.[9,10]
- Improving motors and motions,[11,12] to make them less stressful than continuous rotation.
- Improving alloy and manufacturing processes, including heat treatments.

The last option has recently become the most important feature to significantly improve flexibility and fracture resistance of the NiTi rotary files.[13–16]

In the first 20 years after the introduction of NiTi alloy in endodontics, all instruments have been superelastic, austenitic files. The superior properties of the alloy, compared to traditional stainless steel, were considered a huge advantage and allowed the clinical use of files of greater tapers in continuous rotation. However, such an increase of instruments dimensions and the greater stress induced by the motion resulted, especially for bigger sizes and tapers, in quite rigid instruments for the purpose and increased risk of failure, especially in complex curvatures.[14,15]

NiTi is a "delicate" alloy, very sensible to heat, and during the manufacturing process, the alloy is weakened by the grinding wheels that design the flutes and the geometry of the file, both externally and internally. External defects can be partially adjusted by electropolishing,[9] while internal defects can be partially adjusted by specific heat treatments after the manufacturing process. Heat treatments can vary a lot and each manufacturer has its own proprietary, undisclosed one. Generally speaking, all heat treatments can improve flexibility and fracture resistance to a certain effect, but there are huge differences in how they are performed and the resulting effects.[14]

Some companies, i.e., Edge Endo, have invested a lot in research to produce better heat treatments, which have become probably the most important manufacturing treatment to improve the mechanical properties of the instruments. For instance, changes in design could increase flexibility and resistance by 20–30%, while FireWire heat treatment (EdgeEndo) has been shown to increase flexibility up to three times (300%) and even more the fatigue resistance.[14–17] These new heat-treated files can also exhibit different shape memory effects and therefore are defined martensitic NiTi files: they can be precurved, if needed, and produce less bounce back, allowing easier negotiation and less canal transportation. These improvements have significantly changed clinical procedures, because such a difference between austenitic and martensitic files (some manufacturers provide the same file in the two versions, i.e. EdgeTaper and EdgeTaper Platinum) is currently modifying our clinical approach to instrumentation, depending on which type of instruments we are using. Martensitic files are ideal for minimally invasive endodontics and management of complex

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curvatures because they can more easily negotiate canal with less iatrogenic errors due to less bounce back, more flexibility, and resistance to bending stresses.[17–19] Moreover, they are less sensitive to interferences and can be precurved, making it easier to negotiate divergent canals, hidden curvature, and ledges.

Minimally invasive is obviously a trend, since we know that any endodontic treatment to a certain extent can weaken a tooth, and tooth fracture is the main cause for long-term failures (even if it depends probably slightly more on the quality and type of postendodontic restorations). However, when treating complex root canals, we should always make some compromise between the tendency to be more conservative[20–22] and the risk that poor access cavity design, or coronal flaring, may create interferences that lead to iatrogenic errors, such as canal transportation or intracanal breakage.

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