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Ahead of the Curve: Using New Technology and Metallurgy to Address Endodontic Challenges

A safer, more predictable approach to instrumentation of curved root canal systems

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Every day, clinicians all over the world treat a wide variety of root canal systems, often with complex canal configurations. The primary objectives of endodontic treatment are the optimal removal of bacteria and their substrate while preserving the original shape of the root canal system and the original location of the apical foramen.[1]

Achieving these objectives in curved roots can be compromised due to one of several risks: instrument separation, canal transportation, ledging, apical zipping, or strip perforation of any given canal. In 1980, Walia introduced nickel-titanium (NiTi) rotary files in endodontics, which helped to address some of these challenges.[2]

Despite the metallurgical advantages over stainless steel, the inherent memory in the traditional NiTi used to instrument a curved canal has always been a concern, and there has been a “need to develop instruments with greater flexibility, no metal memory, and increased resistance to fracture.”[3] It is important to keep in mind that when a file rotates inside a canal, it goes through torsional and bending stresses, causing compression and flexion within the metal. This results in instrument fatigue, which can lead to a sudden instrument separation.[4,5]

The Glide Path

To minimize iatrogenic complications, clinicians should first explore the root canal system with small, pre-curved stainless steel files (usually size 6, 8, and 10 files of .02 taper). Once canal patency has been obtained, the canal can be enlarged with larger hand files (size 15 and 20 files of .02 taper) to establish a “glide path” before the first crown-down rotary instrument is introduced into the canal.[6-8] The glide path is defined as a smooth passage that extends from the canal orifice on the pulp chamber floor to the opening at the apex of the root.[9]

The main purpose of this glide path is to create a canal diameter that is the same size as (or larger than) the first tapered crown-down rotary instrument that is used.[10,11] To optimize safety in instrumentation, the more severe the curvature of a given canal, the wider the glide path should be from orifice to apex. The tip of the first tapered crown-down rotary instrument should move freely down the canal walls, serving only as a pilot without engaging the walls.

A recent method of establishing glide path in cases with severe curvatures has been described using rotary NiTi files[10] and is discussed below. Many instruments have been introduced to the market to serve this purpose, including PathFile® Root Canal Drills (DENTSPLY Tulsa Dental Specialties, www.tulsadentalspecialties.com) G-Files™ (Micro-Mega, micro-mega.com/en), ScoutRace files (FKG

IMAGE GALLERY

Figure 1

Figure 2

Figure 3

Figure 4

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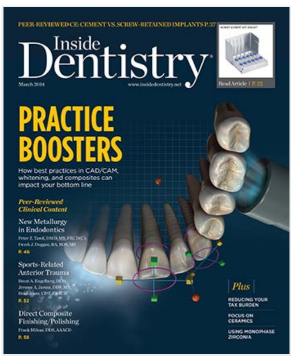

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Dentaire, www.fkg.ch), and X-PLORER™ canal navigation NiTi files (Clinician's Choice Dental Products Inc., www.clinicianschoice.com).

New Metallurgy

To optimize the instrumentation of curved canals in a safe, predictable manner, a revolutionary metal has recently been introduced to the market. Controlled memory files are manufactured with a new NiTi alloy that has been subjected to a patented thermo-mechanical process. These files demonstrate martensitic properties at room temperature, something not observed with conventional NiTi metal.[12]

The result is a file with tremendous flexibility and virtually no memory. This remarkable memory-free property allows the instrument to adapt to root canal curvatures, following the root canal anatomy without creating undesirable lateral forces on the outer canal walls (Figure 1). These files can be pre-curved in cases with limited access and can be pre-bent to allow the clinician to bypass ledges prior to attaching a rotary handpiece to the file handle.[13]

Moreover, controlled memory NiTi files have been shown in the literature to be up to 600% more resistant to fatigue failure than conventional NiTi.[14,15] Typhoon™ Infinite Flex NiTi Files (Clinician's Choice) are controlled memory NiTi files with an efficient cutting design. To further reduce the stress on the instrument and preserve dentin in the cervical portion of the root, Typhoon Infinite Flex files have a 12-mm cutting zone instead of the traditional 16-mm cutting zone.

This file has increased torsional strength with increased resistance to cyclic fatigue and is more likely to unwind than separate. The "unwinding" of the flutes is a valuable warning to clinicians to discard the instrument before separation occurs (similar to the stainless steel hand files with which clinicians are familiar). The Typhoon Infinite Flex files have a triangular cross section and a variable pitch.

Clinical Instrumentation Technique

The following is a presentation of a simple technique that addresses curved canal shapes simply and efficiently; it uses the X-PLORER NiTi glide path files followed by Typhoon Infinite Flex NiTi Files to complete canal enlargement. Throughout all phases of canal instrumentation, sodium hypochlorite should be used generously and can be supplemented with a lubricant like Tunnel Vision™ (Clinician's Choice) chelating gel.

Step 1. Achieve straight-line access

There should be a smooth, continuous pathway from the external surface of the tooth to the entrance of each root canal. This facilitates unimpeded access to the apical third of most root canals. If the entire access preparation is completed with a slight mesial inclination, this preserves distal tooth structure while allowing straight-line access to canal orifices to be achieved.

Step 2. Create a reproducible glide path

Canal exploration is ideally first achieved with No. 8 and No. 10 stainless steel hand files, which are taken to length. Whenever a clinician is dealing with a curvature, after a No.10 stainless steel hand file is taken to length, the glide path should be enlarged with flexible rotary NiTi files such as the X-PLORER Rotary Canal Navigation files.

These files are used at 400 rpm with 200 g-cm torque with a delicate in-out movement until working length is reached following this recommended sequence: 15/01 to length, 20/01 to length, 20/02 to length, and 25/02 to length (optional for severe curvatures).

A 10-mm fluted cutting zone characterizes the X-PLORER glide path files. This short cutting zone ensures that less of the file is engaged during glide path enlargement, minimizing both file stresses and the risk of file separation.[13]

Step 3. Crown-down and apical instrumentation sequence performed

The four-file instrumentation sequence for Typhoon is safe and predictable. The files are used at 400 rpm with 200 to 275 g-cm torque using a delicate in and out pecking movement in the following sequence: 35/06 to resistance, 30/04 to resistance or length, 25/06 to resistance or length, and 20/04 to length. The sequence should be repeated to achieve the desired apical size.

Note that this sequence uses alternating tapers to prevent "taper lock." For larger canals, Typhoon has 04 taper files up to size 50. Although the sequence discussed in this section addresses most endodontic cases, clinicians can also mix Typhoon Infinite Flex files in a hybrid fashion with some traditional NiTi files. Hybrid techniques use a stiffer traditional NiTi file to instrument the straight portion of the canal and new-generation memory-free files like the Typhoon Infinite Flex files for the curvier apical portion of the root.

Case Example

In the case shown, the patient's preoperative radiographs showed severe curvature of the mesiobuccal canals (Figure 2). Initial access showed inflamed hyperaemic pulp (Figure 3). Because the patient had a limited opening, gentle pre-bending was applied to the Typhoon Infinite Flex File to help position it into the mesiobuccal orifice and the access was successfully created using the techniques described above (Figure 4). Cone-fitting radiographs confirmed the severe curvatures of the mediobuccal canals

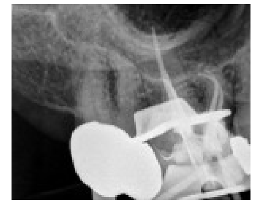
Figure 5


Figure 6


Figure 7


Figure 8


Figure 9


Figure 10

(Figure 5 and Figure 6). After warm vertical compaction, the gutta-percha was seared (Figure 7) and the orifices were sealed with composite (Figure 8). The access was then closed with IRM® (DENTSPLY Caulk, www.caulk.com) Postoperative radiographs show the preservation of the severe curvature of mesial canals that was facilitated by an established glide path and the enhanced flexibility of Typhoon Infinite Flex NiTi Files (Figure 9 and Figure 10).

Conclusion

Although each case presents different challenges and obstacles, and there is no one-size-fits-all sequence that will address all canal shapes and sizes in endodontics, this article describes a straightforward instrument sequence using Typhoon Infinite Flex files that is safe and predictable. The development of controlled memory files has helped to address concerns of instrument fatigue and failure when using NiTi files.

Clinicians should respect the limitations of each instrument and make sure to take sufficient time to learn how to use them following the manufacturer's instructions. By adopting a technique that encompasses a proper glide path sequence as discussed in this article and using new metal technologies, instrumentation of curved root canal systems should be more consistent, more predictable, and safer than it has been in the past.

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