By Ove A. Peters, USA

The ultimate goal of endodontic treatment is the long-term retention in function of teeth with pulpal or periapical lesions. Depending on the diagnosis, this therapy typically involves the preparation and obturation of all root canals. Both steps are critical to an optimal long-term outcome. This article is intended to update clinicians on the current understanding of best practices in the two pillars of nonsurgical endodontics, canal preparation and obturation, and to highlight strategies for decision making in both uncomplicated and more difficult endodontic cases.

Prior to initiating therapy, a clinician must establish a diagnosis, take a thorough patient history and conduct clinical tests. Recently, judicious use of cone-beam computed tomography (CBCT) has augmented the clinically available imaging modalities. Verifying the mental image of tooth anatomy can go a long way to promote success in canal preparation. For example, a raised canal frequency is associated with endodontic failures.1 As most maxillary molars have two canals in the mesiobuccal root, case referral to an endodontist for management is recommended. Prepared teeth should be considered.

Endodontists are increasingly using CICHT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or age-related changes. The endodontist, supported by appropriate clinical strategies, can achieve good outcomes even in cases with significant challenges (Fig. 1).

Preparation of the endodontic space

The goal of canal preparation is to provide adequate access for diagnostic solutions without making major preparation errors such as perforations, canal transportations, instrument fractures or unnecessary removal of tooth structure. The introduction of nickel-titanium (Ni-Ti) instruments to endodontics almost two decades ago has resulted in dramatic improvements for successful canal preparation for generalists and specialists. Today, there are more than 50 canal preparation systems; however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation.

Several key factors have added versa-
tility in this regard, for example, the emergence of special designs such as orifice shapers and mechanized glide path files. Another recent development is the application of heat treatment to Ni-Ti alloy, both before and after the file is manufactured. Deeper knowledge of metallurgical properties is desirable for clinicians who want to capitalize on these new alloys. Finally, more recent strategies such as minimally invasive endodontics have emerged.2

Basic nickel-titanium metallurgy

What can Ni-Ti do so well? It is highly resistant to corrosion and, more importantly, it is highly elastic and fracture resistant. Ni-Ti exists reversibly in two transformations, martensite and austenite, on external tension and ambient temperature. While steel allows 3 percent elastic deformation, Ni-Ti in the austenitic form can withstand up to 7 percent without permanent damage or plastic deformation.3 Knowing this is critical for rotary endodontic instruments for two reasons. First, during instrument preparation of curvilinear canals, forces between the canal wall and advancing instruments are smaller with more elastic instruments, hence less preparation errors are likely to occur. Second, rotation in curved canals will bend instruments once per rotation, which ultimately will lead to work hardening and brittle fracture, also known as cyclic fatigue. Steel can withstand up to 20 complete bending cycles, while Ni-Ti can endure up to 1,000 cycles.4

Recently manufacturers have learned to produce NiTi instruments that are in the martensitic state and even more flexible than previous files. Figure 2 shows how instrument conditions (austenite vs. martensite) are determined in the testing laboratory, using prescribed heating and cooling cycles to austenitize martensite.6 Once these conditions are known, manufacturers can determine the stress and strain behavior of instruments and how they will react to different loading conditions. NiTi is recognized as having educational content for 1 CME Credit Hour.

Preparation strategies

Experimental and clinical evidence suggests that the use of NiTi instruments combined with rotary movement results in improved preparation quality. Specifically, the incidence of gross preparation errors is greatly reduced.7 Canals with wide oval or ribbon-shaped cross-sections present difficulties for rotary instru-
mants and strategies such as circumferential filing and ultrasonic bores should be used in those canals. Studies found that oscillating instruments recommended for these canal types did not perform as well in particular canals. 

Canal preparation and obturation: An updated view of the two pillars of nonsurgical endodontics

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more coronal is more vulnerable to file fracture.

In conclusion, root canal filling has been shown to be associated with file fracture. For example, a lower rotational speed and a smaller file size results in delayed build-up of fatigue and reduced incidence of taper lock.27

Material imperfections such as microfractures and milling marks are often clear with that additional support to these sites.14 Such surface imperfections after manufacturing can be removed by etching but it is unclear if this process extends fatigue life.15 Manufacturers' recommendations stress the importance of any rotary instrumentation and to use a delicate touch.

Clinical results

While results from in vitro studies on rotary systems have been abundant, clinical studies on these instruments are sparse. Comparing NiTi and stainless steel files, many reports do not show any difference between the two systems with an overall favorable outcome rate of about 85 percent.16,17 While most consistent clinical results are obtained when the manufacturer's directions are followed.18-23 While these are not the only methods, a set of common rules applies to root canal preparation. Root canal systems have expanded in the following sequence:

• Analysis of the specific anatomy of the case
• Canal scouting
• Coronal modifications
• Negotiation to patency
• Determination of working length
• Canal shaping
• Root canal shaping to desired size
• Gauging the formation, apical adaptation

Obturation of the endodontic space

A well-shaped and cleaned canal system should create the conditions for a high degree of success. On the other hand, this root canal system is incapable of the body's immune system to and therefore, cannot be protected from coronal leakage. Accordingly, best practices dictate that root canals should be obturated completely to prevent ingress of nutrients or oral microbiota.

None of the established techniques for root canal filling provides a definitive coronal, lateral and apical seal.24

Basic strategies in root canal obturation

Basic principles for root canal fillings should seal all foramina leading to the periosteum, be without voids, adapt to the irregular canal walls and end at the working length. There are various acellular or cellular materials that are used to obturate root canals, including:

• Sealer (cement/paste/resin) only
• Sealer and a single cone of a stiff or flexible core material
• Sealer combined with gutta percha
• Sealer coating combined with warm compaction of core materials
• Sealer coating combined with carried core-based materials

Several of these techniques have shown comparable success rates relative to maintaining apical sizes and support antimicrobial efficacy. There currently is no direct evidence regarding the working length. An experienced operator should work for him or her. Existing research directly directs clinicians toward preservation and disinfection of the root canal as the single most important factor in the prevention of re-infection and asepsis, and no particular sealing technique can claim superior healing success.16

Current developments in root canal obturation materials

Modern dentistry recognizes that the endodontic triad (aggregates group) as a maturer.

Many materials are used to obturate apical surgery more than two decades ago, materials with similar bioceramic properties are now available as root canal sealers. Bioceramic root canal cement (BC Sealer; Brasseler) has clinical evidence and is well-tolerated in cell culture experiments.16 How-

ertheless, there is no clinical evidence that using this cement leads to bet-
ter outcomes. In fact, most research has indicated the type of cement used has comparably minor role in the outcome.

In contemporary practice, heat gen-
erators are used to plastically gutta-
percha. These devices are versatile and
devices are available. Another type of obturation system is based on material, Guttacone (Dentsply Sirona), which uses modified gutta-percha to create a liner of the same base. Early data indicate that obturation with this new material is similar to cold lateral condensation or large coronal perforation.

Practical aspects of obturation

The main steps in the sequence of root canal obturation are:

• Analysis of the canal anatomy and timing the obturation
• Selecting master cones
• Root canal shaping and preparation
• Filming the apical portion (lateral and vertical condensation)
• Completing the filling
• Assessing the quality of the filling

The root canal system should be assessed before choosing an obturation technique. In the presence of open apex, systems that allow apical access, such as zipping and also filling into the canal teeth with apices in close proxim-
ity to the bone, can cause severe pain and is significant potential for failures. In order to avoid these failures, these cases may be better obturated with cold lateral condensation to avoid overfilling.25,26 The use of MTA, NTA may be placed as a barrier. In general, canals should be filled as soon as possible.

Summary and conclusions

Root canal treatment is still regarded as a definitive procedure in most cases for the management of pain and infection. A technique that is accurately reproducible and can be performed with a high success rate, which is why many clinicians follow the guidelines established below.

If the master cones are the carrier for the obturation material such as gutta-percha, a sealer or cement should be used. Most sealers are negatively charged and therefore, this toxicity is reduced after setting. When water contamination of dentin and tissue fluids, zine oxide eugenol-based sealers are absorbable while resin-based sealers are not absorbed.24 Some by-products of sealers may adversely affect and delay healing. Therefore, sealers should not be routinely extruded into the periradicular tissue.27 The amount of sealer is then deposited into the canal system via a mixing technique using a lentulo spiral. A K-file or the master cones themselves, each method is similar in their ability to displace an appro-

In conclusion, the author suggests that obturating the root canal is a vital step in the overall treatment of the root canal system, as it can prevent the propagation of bacteria and other pathogenic agents, thus reducing the risk of reinfection and improving the success rate of endodontic treatment.

References


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