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

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The optimal goal of endodontic treatment is the long-term retention in function of teeth with pulpal or periradicular pathology. 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 canal anatomy goes a long way to promote success in canal preparation for example, a missed 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 microscope-supported treatment should be considered. Endodontists are increasingly using panoramic CBCT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or iatrogenic alteration. The endodontist, using appropriate 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 disinfesting solutions without making major preparation errors such as perforations, canal transportations, instrument loss or canal enlargement. Case courtesy of Dr. Jeffrey Kawilarang. (Photos/Provided by American Association of Endodontists)

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 instrument fracture and preparation errors is greatly reduced.2 Canals with wide oval or ribbon-shaped cross-sections present difficulties for rotary instruments and strategies such as circumferential filing and ultrasonics should be used in those canals.3

Studies found that oscillating instruments recommended for these canal types did not perform as well par- ticularly toward the outside of the canal, were more susceptible to fatigue. The greater the amount and the more peripheral the distribution of metal in the cross section, the stiffer the file.4 Therefore, a file with a smaller cross-section and larger di- ameter is more susceptible to fatigue failure, a canal curvature that is more coronal is more vulnerable to file fracture.5

Several key factors have added versatility in this regard, for example, the emergence of special designs such as offkine shapers and mechanized glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. Deep knowledge of metallurgical properties is desirable for clinicians who want to capitalize on these new alloys. Finally, more recent strategies such as minimally invasive endo- dontics have emerged.6 Basic nickel titanium metallurgy

What makes NiTi so special? It is highly resistant to corrosion and, more importantly, it is highly elastic and fracture resistant. NiTi exists reversibly in two conformations, martensite and austenite, depending on external temperature and tension. While steel allows 5 percent elastic deformation, NiTi in the austenitic form can withstand deformation of up to 7 percent without permanent deformation or plastic deformation.7 Knowing this is critical for rotary endodontic instruments for two reasons. First, during preparation of curved canals, forces from the canal wall and abrading 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 hardening and brittle fracture, also known as cyclic fatigue. Steel can withstand up to 20 complete bend- ing cycles, while NiTi can endure up to 10,000 cycles.8

Manufacturers have learned to produce NiTi instruments that are in the martensitic state and even more flexile than previous files. Figure 2 shows how instrument conditions (austenite vs. martensite) are determined in the testing laboratory, using prescribed heating and cooling cycles.9 Heat-treated files with high martensite content typically do not have a silver metallic hue but are colored with an oxide layer, such as gold or blue.10

It is important to note that CM files frequently deform; however, with a delicate touch, cutting is adequate and even often superior to con- ventional NiTi instruments.11 It is imperative for clinicians to refrain themselves prior to using these new instruments to avoid excessive deformation and subsequent instrument fracture.

Instrument handling has been shown to be associated with avoid prepara- tion errors.

NITI instrument usage

As in general, NiTi instru- ments are not very resistant to tor- sional load but are resistant to cyclic fatigue. Conversely, more rigid files can withstand more torque but are susceptible to fatigue. The greater the amount and the more peripheral the distribution of metal in the cross section, the stiffer the file.12 Therefore, a file with a greater cross-section and larger di- ameter is more susceptible to fatigue failure, a canal curvature that is more coronal is more vulnerable to file fracture.13

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FIG. 1: Root canal treatment of tooth #3 diagnosed with pulp necrosis and acute apical periodontitis. The mesiobuccal root has a significant curve and two canals with separate apical foramina. Case courtesy of Dr. Jeffrey Kawilarang. (Photos/Provided by American Association of Endodontists)
glass ionomer. Case courtesy of Dr. Paymon Bahrami.

Prior to temporization, the orifices were protected with a barrier of light-curing

molar is not infrequent. Note multiple apical foramina in both the mesial and the distal

Fig. 3: Root canal treatment of tooth #19 with four canals diagnosed with irreversible

protein particles cannot completely

is not clear. It has been shown that

There are several concerns about

niTi instruments. The effec-

Fig. 3).

toir (Fig. 3).

There are several concerns about

routinely. Current recommendations

advise that clinicians are judicious

when using rotary instruments as

there is no conclusive evidence of
disease transmission occurring.

Recently, the term minimally inva-
sive endodontics has been used to

describe smaller than usual apical

sizes and, perhaps more important-

ly, an understanding that the long-
term success of root canal-treated

teeth will improve by retaining as

much dentin structure as feasible.3

The thought process for this was the

finding that most root canal-treated

teeth survive 50 years and longer.2

In studies, the reasons cited for the

extraction vary but in many cases

teeth are either fractured or non-re-

storable for other reasons.2,11

In consequence, a smaller coronal

preparation area will be used. This

way, surgical access to the canal

system with sodium hypochlorite

is recommended to flood the canal

orifice level. Glide path files, for

example less canal transportation and fewer

perforations. Subsequently, using

radiographic evaluation of the same

patient group, they demonstrated

better healing in the NiTi group.32

An earlier outcome study with three

rotary preparation paradigms did not show any difference between

the three systems with an overall

favorable outcome rate of about 87

percent.31

The most consistent clinical results are obtained when the manufactur-
er’s directions are followed.

While these vary by instrument, a set of common rules applies to root ca-
nal preparation. Root canal systems are best prepared in the following

sequence:

– Analysis of the specific anatomy of

the case.

– Canal scouting.

– Coronal modifications:

– Negotiation to patency.

– Determination of working length.

– Glide path preparation.

– Root canal shaping to desired size.

– Gauging the foramen, apical ad-

justment.

Obliteration of the endodontic space

A well-shaped and cleaned canal sys-

tem should create the conditions for

perfect apical leakage. On the other

hand, this root canal system is inac-

cessible to the body’s immune sys-
tem and therefore it cannot combat
coronar leakage. Accordingly, best
dinfect practices are: the root canals

should be filled as completely as pos-
sible to prevent ingress of nutrients

or oral microorganism. None of the

established techniques for root canal filling provides a definitive coronal,

lateral and apical seal.4,24

Basic strategies in root canal obtura-
tion ideally root canal fillings should seal all foramina leading to the peri-

odontium, be without voids, adapt to the instrumented canal walls and

end at working length. There are various acceptable materials and

techniques to obturate root canal
systems, including:

– Sealer (cement/paste/resin) only.

– Sealer and a single cone of a stiff or

flexible pre-mixed composite.

– Sealer coating combined with cold

compaction of core materials.

– Sealer coating combined with warm

compaction of core materials.

– Sealer combined with carrier-

based core materials.

Several of these techniques have

shown comparable success rates re-
garding apical bone fill or healing of

the periapical lesion.25

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The space created by the sprayer is included by inserting a small, lightly curved access cone. For lower canals, a slightly larger cone with a lenticulo spiral is used. Accessing canals conger larger than the taper of the sprayer will require the use of a larger obturating cone. Additionally, post-cone lateral canals are filled in a vertical direction. Compaction, electrically heated gutta-percha is used and is then shaped to fit within 0.5 mm of the apical constriction.

For both lateral and vertical compaction, the procedure is similar to that of a well-trained clinician following established guidelines. Cases with a high degree of difficulty that are best are referred to an endodontist. While many cases can be treated successfully, the practitioner may wish to further develop the technique. In the best long-term outcome, a well-shaped and correctly placed final restoration is placed as soon as possible after root canal treatment. Root canal systems may be filled through various methods, typically using a combination of a cement and a solid filling material such as gutta-percha. The specific obturation method used appears to have a smaller role on the final outcome. In conclusion, if the canal is not sufficiently filled, overfills are not only common, but also a potential for overfills. In addition, teeth with apices in close proximity to the mandibular canal, there is significant potential for overfills. In order to avoid such mishaps, these cases may better be obturated with techniques that consolidate the sealer and prevent overfilling, or in some cases, MTAs may be placed as a barrier. In general, canals filled obturated are not without signs of gross errors that are associated with coronal leakage, apical infection and excessive dentin removal during access and canal preparation. A summary of the outcomes is provided.

References
1. Karpicke B, Bunes, G. Gutta-percha cones are commonly used in modern endodontics for obturation.