The ultimate goal of endodontic treatment is the long-term retention in function of teeth with pulpal or periapical symptoms. Depending on the diagnosis, this therapy typically involves the prevention 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, base the choice of instruments on the operator’s experience and knowledge of metallurgy, and verify the mental image of the tooth’s anatomy. Most maxillary molars have two or three roots, with two canals in the mesiobuccal root, which is critical for successful treatment. Errors in this regard, such as over- or under-preparation, may lead to the need for retreatment.


canals treated to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


case referral to an endodontist for further treatment. As most maxillary molars have two or three roots, with two canals in the mesiobuccal root, which is critical for successful treatment. Errors in this regard, such as over- or under-preparation, may lead to the need for retreatment.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.


canals are increasingly using CCKT and the operating microscope to diagnose and treat anatomically challenging teeth, such as those with unusual root anatomy, congenital variants or kerosene fractures. The introduction of nickel-titanium (NiTi) instruments to endodontics almost two decades ago has led to dramatic improvements in successful treatment outcomes for generalists and specialists. Today there are more than 5000 canal preparation systems, however, not every instrument system is suitable for every clinician and not all cases lend themselves to rotary preparation. A number of factors have added versatility in this regard, for example, the emergence of special designs such as orifice shapers and mechanical glide path files. Another recent development is the application of heat treatment to NiTi alloy, both before and after the file is manufactured. The NiTi alloy is usually very small. This is due to a number of factors, including the material properties of NiTi and the manufacturing process. NiTi is a shape memory material, which means that it can be forced into a new shape and will return to its original shape when heated.
more coronal is more vulnerable to file fracture.
In consequence, root canal filling has been shown to be associated with file fracture. For example, a lower rotational speed (~250 rpm) results in delayed overfilling, or in some cases, MTA may be placed as a barrier.

Basic strategies in root canal obturation
Root canal fillings should seal all foramina leading to the periodontal ligament, be free of voids, adapt to the canals and walls and end at the apical working length. There are various ac- cess techniques and obturation materials now available to obturate root canals, including:

1. Sealer (cement/paste/resin) only
2. Sealer and a single cone of a stiff or flexible core material

Feasibility studies have shown comparable success rates re-
garding apical bone fill or healing of periodontal lesions, as a clinician may choose from a variety of tech-
niques and materials, working best for him or her. Existing research and clinical studies toward the preparation and disinfection of the root canal as the single most important factor in the outcome of endodontic success, and no particular sealing tech-
nique can claim superior healing success.23

Current developments in root canal obturation materials
Manufacturers’ recommendations advise against filling any rotary instrumentation and to use a deliberate touch.

Clinical results
While results from in vitro studies on root canal obturation are abundant, clinical studies on these instruments are sparse. Comparing NITI and stain-
less steel files, Pettiette et al. found that the NITI canal transportation and fewer perforations. Subsequently, using radiographic evaluation of the same patient after treatment showed better healing in the NITI group.17 An earlier outcome study with three different instruments did not show any difference between the three systems with an overall favorable outcome rate of about 87 percent.18

The most consistent clinical results are obtained when the manufactur-
er’s directions are followed.19 While these studies by instrument, a set of common rules applies to root ca-
nal preparation. Root canal systems appear to expand in the following sequence:
• Analysis of the specific anatomy of the case
• Canal scouting
• Canal modifications
• Negotiation to patency
• Filling the apical portion (lateral and vertical compaction)
• Completion of the fill
• Assessing the quality of the fill

The root canal system should be as soon as possible after root canal preparation. Root canal obturation with this new material is similar to warm vertical compaction but produces voids or sealer pools in the apical area.26

Practical aspects of obturation
The main steps in the sequence of root canal obturation are:
• Instrumentation and timing of the obturation
• Sealing of root canals
• Obturation material overfill and careful adaptation
• Obturation of the entire space

A well-shaped and cleaned canal sys-
tem should create the conditions for obturation and healing. On the other hand, this root canal system is in-
cessible to the body’s immune sys-
tem and therefore cannot be treated with any antibiotic. Leukocytes are not able to penetrate into the area of the inferior alveolar nerve, specifically in the mandible. Since no medicament is put on the inferior alveolar nerve, there is no risk of causing any perforation or nerve damage. In general, the primary reason for perforation is infection and excessive dentin re-
sealing.4

In cases where placement of a post is planned, gutta-percha is confirmed to the apical 4 mm. All root canals that do not receive a post may benefit with an orifice barrier (Fig. 3) to protect from leakage prior to placement of a definitive restoration.

This has been shown to promote healing of apical periodontitis. Materials that are suitable for such a barrier include light-curing glass ionomer, flowable or resin-based sealers, MTA may be placed as a barrier. In general, canals should be filled, the sealer should be removed from acute apical periodontitis or an apical abscess, since significant pain on percussion or not due to secretion into the canal. Gutta-per-
cha cones first should be disinherited by submerging them in an NaOCl so-
lution for about 60 seconds to act as a barrier, especially as gutta-percha, a seal or cement should be used. Most sealers are nontoxic, but some contain heavy metals, but this toxicity is reduced after setting. When the medicament is composed of inorganic and organic tissues, zine oxide eugenol-based sealers are absorbable while resin-based sealers are not absorbed.27 Some products of sealers may adversely affect and del-
eying teeth. Therefore, sealers should not be routinely extruded into the periodontal tissues.

Administration of the obturation material should be done with a lentulo spiral, K or the master cones themselves, each method in a combination with a core material. The amount of sealer is delivered into the root canal system without applying excessive pressure to the lentulo spiral. K or the master cones, each method is equally efficacious.28 Another approach is to avoid over-extension of root filling material into the peri-
cular, specifically in the man-
dibular canal, it is recommended to accurately determine working length to prevent destruction of the apical constriction. For infected root canal systems, it seems that the best treatment plan is a working length no more than 3 mm, where the working length is slightly shorter than the length of the root, as visible on a radiograph.29

Determination of apical canal anatomy is a require-
ment for the correct length of the root canal fill. It is imperative to provide for second mandibular molars that are in close proximity to the inferior alveolar nerve and should be managed by a specialist. Overfills are not only an impediment to healing but in the worst case can be associated with permanent nerve damage. In gen-
eral, extrusion of sealer in excess of 1 mm from the apical terminus of the root canal treatment, identifiable on the final radiographs, is considered to indicate extrusion.

• Excessive dentin removal during access and instrumentation
• Preparation errors such as perfora-
tion, ledge formation and apical zip-

Summary and conclusions
Root canal preparation with con-
sideration of the specific anatomy is a predictable procedure in most cases for proper obturation following established guidelines. Cases with a recognized high degree of difficulty are best referred to an endodontist. While many cases can be treated suc-
cessfully in routine practice, the ad-
dvantage is that with a short-term endodont-
tology of endodontics is necessary in cases that are beyond the typical scope of a general practitioner. The outcome of root canals is obtained when the manufactur-
er’s directions are followed.19 While these studies by instrument, a set of common rules applies to root can-
nal preparation. Root canal systems appear to expand in the following sequence:
• Analysis of the specific anatomy of the case
• Canal scouting
• Canal modifications
• Negotiation to patency
• Filling the apical portion (lateral and vertical compaction)
• Completion of the fill
• Assessing the quality of the fill

The root canal system should be as soon as possible after root canal preparation. Root canal obturation with this new material is similar to warm vertical compaction but produces voids or sealer pools in the apical area.26

Practical aspects of obturation
The main steps in the sequence of root canal obturation are:
• Instrumentation and timing of the obturation
• Sealing of root canals
• Obturation material overfill and careful adaptation
• Obturation of the entire space

A well-shaped and cleaned canal sys-
tem should create the conditions for obturation and healing. On the other hand, this root canal system is in-
cessible to the body’s immune sys-
tem and therefore cannot be treated with any antibiotic. Leukocytes are not able to penetrate into the area of the inferior alveolar nerve, specifically in the mandible. Since no medicament is put on the inferior alveolar nerve, there is no risk of causing any perforation or nerve damage. In general, the primary reason for perforation is infection and excessive dentin re-
sealing.4

In cases where placement of a post is planned, gutta-percha is confirmed to the apical 4 mm. All root canals that do not receive a post may benefit with an orifice barrier (Fig. 3) to protect from leakage prior to placement of a definitive restoration.

This has been shown to promote healing of apical periodontitis. Materials that are suitable for such a barrier include light-curing glass ionomer, flowable or resin-based sealers, MTA may be placed as a barrier. In general, canals should be filled, the sealer should be removed from acute apical periodontitis or an apical abscess, since significant pain on percussion or not due to secretion into the canal. Gutta-per-
cha cones first should be disinherited by submerging them in an NaOCl so-
lution for about 60 seconds to act as a barrier, especially as gutta-percha, a seal or cement should be used. Most sealers are nontoxic, but some contain heavy metals, but this toxicity is reduced after setting. When the medicament is composed of inorganic and organic tissues, zine oxide eugenol-based sealers are absorbable while resin-based sealers are not absorbed.27 Some products of sealers may adversely affect and del-
eying teeth. Therefore, sealers should not be routinely extruded into the periodontal tissues.

Anatomical spaces that may be filled include the following that are most common in the apical root third (Fig. 3): the mesial and distal root canals, but may be present in other lo-
lacations such as the mesial, but not the distal root canal. There may be an accessory foramen or dentinatomy may contribute to periapical periodontitis30 but clinical experi-
ence suggests that they are not present.31 Sealer placement in bone resorption is comparatively small.32

It is believed that the space filled accessi-

References
1. Karabacak B, Bunes A, Chebud C, Kohli HK, Setzer F. Prevalence of apical peri-
2. Stanley WA, Gersten H. An initial investigation of the bonding and toni-

This article originally appeared in ENDODONTICS: Colleagues. You are granted permission from the American Asso-