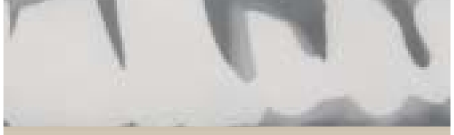

Nonsurgical Endodontic Retreatment

Clifford J. Ruddle, DDS

ABSTRACT

The purpose of this clinical article is to emphasize that although there is enormous potential for endodontic success, clinicians are, at times, confronted with post-treatment disease. A rationale for endodontic treatment is followed by the goals of nonsurgical retreatment. The focus of this article is to identify the various nonsurgical retreatment categories and provide an overview of the concepts, armamentarium and techniques available to disassemble roots, address deficiencies or repair defects that are pathological or iatrogenic in origin.

There has been a significant growth in endodontic treatment in recent years. This increase in clinical activity can be attributable to better-trained dentists and specialists alike. Necessary for this unfolding story is the general public's growing interest for root canal treatment as an alternative to the extraction.[1] Over time, patients have become more confident selecting endodontic treatment because of the changing perception that pain can be managed, techniques have improved and long-term success is achievable. During the last decade, significant procedural refinements have created greater promise for our profession to fulfill the public's growing expectations for long-term success. With all the potential for endodontic success, the fact remains clinicians are confronted with post-treatment disease. This article focuses on the concepts, strategies, and techniques that will produce successful results in nonsurgical endodontic retreatment.

Rationale for Retreatment

The root canal system anatomy plays a significant role in endodontic success and failure.[2-4] These systems contain branches that communicate with the periodontal attachment apparatus furcally, laterally, and often terminate apically into multiple portals of exit.[5] Consequently, any opening from the root canal system (RCS) to the periodontal ligament space should be thought of as a portal of exit (POE) through which potential irritants may pass.[6,7] Improvement in the diagnosis and treatment of lesions of endodontic origin (LEO) occurs with the recognition of the interrelationships between pulpal disease flow and the egress of irritants along these anatomical pathways (**Figure 1**).[8]

Endodontic failures can be attributable to inadequacies in shaping, cleaning and obturation, iatrogenic events, or reinfection of the root canal system when the coronal seal is lost after completion of root canal treatment.[9-12] Regardless of the etiology, the sum of all causes is leakage and bacterial contamination.[13,14] Except in rare instances, lesions of endodontic origin will routinely heal following the extraction of

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pulpally involved teeth because the extraction not only removes the tooth, but more importantly serves to eliminate 100 percent of the contents of the root canal system. Endodontic treatment can approach 100 percent success discounting teeth that are non-restorable, have hopeless periodontal disease or have radicular fractures.[8]

Goals of Nonsurgical Endodontic Retreatment

Before commencing with any treatment, it is profoundly important to consider all interdisciplinary treatment options in terms of time, cost, prognosis and potential for patient satisfaction. Endodontic failures must be evaluated so a decision can be made between nonsurgical retreatment, surgical retreatment, or extraction.[15-17] The goals of nonsurgical retreatment are to remove materials from the root canal space and if present, address deficiencies or repair defects that are pathologic or iatrogenic in origin.[18] Additionally, nonsurgical retreatment procedures confirm mechanical failures, previously missed canals or radicular subcrestal fractures. Importantly, disassembly and corrective procedures allow clinicians to shape canals and three-dimensionally clean and fill root canal systems.[19,20] Nonsurgical endodontic retreatment procedures have enormous potential for success if the guidelines for case selection are respected and the most relevant technologies, best materials and precise techniques are utilized.[21-23]

Coronal Access

Clinicians typically access the pulp chamber through an existing restoration if it is judged to be functionally designed, well fitting and esthetically pleasing.[24] If the restoration is deemed inadequate and/or additional access is required, then it should be sacrificed. However, on specific occasions, it may be desirable to remove the restoration intact so it can be re-cemented following endodontic treatment.[18] Several important technologies exist which facilitate the safe removal of a restoration. Coronal disassembly improves access, vision and the retreatment efforts.

The safe dislodgment of a restoration is dependent on several factors such as the type of preparation, the restorative design and strength, the restorative material(s), the cementing agent and knowing how to use the best removal devices. There are several important removal devices which may be divided into three categories: (1) Grasping instruments, such as K.Y. Pliers (GC America; Alsip, Ill.) and Wynman Crown Gripper (Miltex Instrument Company; Lake Success, N.Y.), (2) Percussive instruments like the Peerless Crown-a-Matic (Henry Schein; Port Washington, N.Y.) and the Coronaflex (KaVo America; Lake Zurich, Ill.), and (3) Passive-active instruments such as the Metalift (Classic Practice

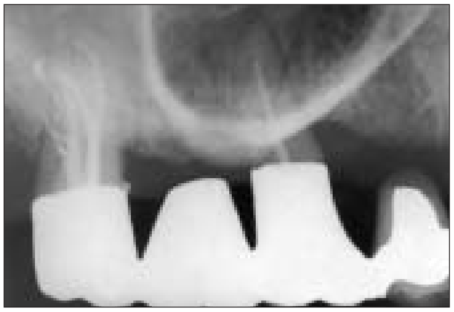


Figure 1a. A pre-operative film shows the maxillary right first molar's remaining palatal root is endodontically failing.

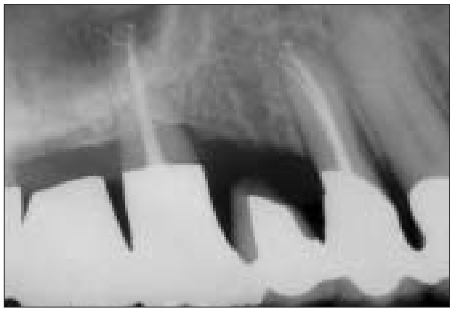


Figure 1b. Nonsurgical retreatment demonstrates a mesiocrestal lateral canal, a loop and an apical bifidity.

Figure 2a. A photograph demonstrates removal of a crown utilizing the K.Y. Pliers. Note the grasping pads have been dipped in emery powder to reduce slippage.

Figure 2b. A photograph demonstrates bridge removal utilizing the Coronaflex. The air-driven hammer generates the removal force against various prosthetic attachment devices.

Figure 2c. A photograph demonstrates the removal of a PFM crown utilizing the Metalift. This system applies a force between the crown and the tooth.

Resources; Baton Rouge, La.), the Kline Crown Remover (Brasseler; Savannah, Geo.) and the Higa Bridge Remover (Higa Manufacturing; West Vancouver, BC, Canada). Clinicians must clearly define the risk versus benefit with patients before commencing with the safe and intact removal of an existing restoration (**Figure 2**).

Missed Canals

Missed canals hold tissue, and at times bacteria and related irritants that inevitably contribute to clinical symptoms and lesions of endodontic origin.[9] Oftentimes, surgical treatment has been directed towards "corking" the end of the canal with the hopes that the root-end filling material will incarcerate irritants within the root canal system over the life of the patient.[14] Although this clinical scenario occurs anecdotally, it is not as predictable as nonsurgical retreatment. Endodontic prognosis is maximized in teeth whose root canals are shaped and root canal systems cleaned and filled in all their dimensions (**Figure 3**).[5,8]

There are multiple concepts, armamentarium and techniques that are useful to locate canals. The most reliable method for locating canals is to have knowledge regarding root canal system anatomy and appreciation for the range of variation commonly associated with each type of tooth.[3] Frequently used methods for identifying canals include: radiographic analysis, magnification and lighting (microscopes), complete access, firm explorer pressure, ultrasonics, Micro-Openers (Dentsply Tulsa Dental; Tulsa, Okla.), dyes, sodium hypochlorite, color and texture, removing restorations, and probing the sulcus. However, if a missed canal is suspected but cannot be readily identified and treated, then an endodontic referral may be prudent to avoid complications. Caution should be exercised when contemplating surgery due to the aforementioned concerns.

Obturation Materials

There are four commonly encountered obturation materials found in root canals. These materials are gutta-percha, carrier-based obturators, silver points and paste fillers. Generally, it is necessary to remove an obturation material to achieve endodontic retreatment success or to facilitate placing a post for restorative reasons. The effective removal of an obturation material requires utilizing the most proven methods from the past in conjunction with the best presently developed techniques.

Gutta-Percha Removal

The relative difficulty in removing gutta-percha varies according to the obturation technique previously employed and further influenced by the canal's length, cross-sectional dimension, curvature and internal configuration. Regardless of technique, gutta-percha is best removed from a root canal in a progressive manner to prevent inadvertent displacement of irritants periapically. Dividing the root into thirds, gutta-percha may be initially removed from the canal in the coronal one-third, then the middle one-third, and finally eliminated from the apical one-third. At times, single cones in larger and straighter canals can be removed with one instrument in one motion. For other canals, there are a number of possible gutta-percha removal schemes.[18] The removal techniques include rotary files, ultrasonic instruments, heat, hand files with heat or chemicals, and paper points with chemicals.[25] Of these options, the best technique(s) for a specific case is selected based on preoperative radi-

Figure 3a. A radiograph of a maxillary right second bicuspid reveals pins, a post, incomplete endodontics and an asymmetrical lesion.

Figure 3b. A photograph at 12x shows the post is out of the buccal canal, thread marks in the gutta-percha from the screw post, and evidence of a missed palatal canal.

Figure 3c. A photograph at 12x demonstrates complete access and identification of the orifice of palatal canal.

Figure 3d. A 10-year recall radiograph shows excellent osseous repair, the importance of good quality endodontics, and a well-designed and sealed restoration.

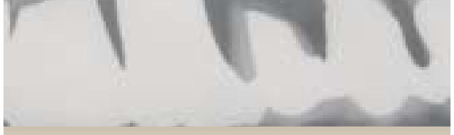


Figure 4a. A pre-operative radiograph of a maxillary right central incisor demonstrates inadequate root canal treatment, resorption and an apical lesion.

Figure 4b. A photograph at 8x shows a 45 hedstroem mechanically removing the heat softened single cone of gutta-percha.

Figure 4c. A post-operative radiograph shows the nonsurgical retreatment has resulted in three-dimensional obturation.

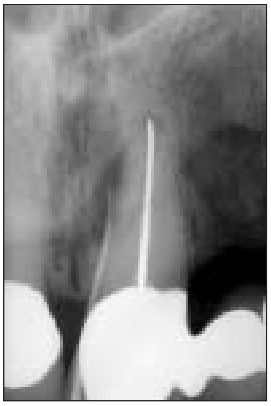


Figure 5a. A pre-operative radiograph depicting an endodontically failing maxillary central incisor bridge abutment, a gutta-percha point tracing a sinus tract to a large lateral root lesion, and a canal underfilled and slightly overextended.

Figure 5b. Magnification at 15x reveals lingual access and restorative build-up around the coronal-most aspect of the exposed silver point.

Figure 5c. A working radiograph during obturation reveals complexity of the root canal system.

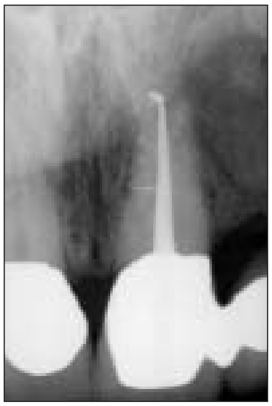


Figure 5d. A five-year post-operative radiograph demonstrates that three-dimensional endodontic treatment has resulted in complete healing.

ographs, clinically assessing the available diameter of the orifices after re-entering the pulp chamber, and clinical experience. Certainly, a combination of methods are generally required and, in concert, provide safe, efficient and potentially complete elimination of gutta-percha and sealer from the internal anatomy of the root canal system (**Figure 4**).

Silver Point Removal

The relative ease of removing a silver point is based on the fact that chronic leakage reduces the seal and hence, the lateral retention. Access preparations must be thoughtfully planned and carefully performed to minimize the risk of inadvertently foreshortening any given silver point. Initial access is accomplished with high speed, surgical-length cutting tools, then oftentimes ultrasonic instruments are used to brush-cut away remaining restorative materials and fully expose the silver point.

Different techniques have been developed for removing silver points depending on their lengths, diameters, and positions they occupy within the root canal space (**Figure 5**).[23,26,27] Certain removal techniques evolved to address silver points that bind in unshaped canals over distance. Other techniques arose to remove silver points with large cross-sectional diameters, approaching the size of smaller posts. Finally, other techniques are necessary to remove intentionally sectioned silver points lying deep within the root canal space. The more effective methods for removing silver points include: grasping pliers utilizing the principles of fulcrum mechanics, indirect ultrasonics, files, solvents, chelators, the hedstroem displacement technique, tap and thread option using the microtubular taps from the Post Removal System kit (SybronEndo; Orange, Calif.), and microtube mechanics such as the Instrument Removal System (Dentsply Tulsa Dental).[18]

Figure 6a. A radiograph of a maxillary left first molar demonstrates "Coke bottle" preparations and carrier-based obturation of three canals.

Figure 6b. A post-operative radiograph reveals the retreatment efforts, including the identification and treatment of a second MB root canal system.

Figure 7a. A pre-operative radiograph of an endodontically failing paste-filled mandibular left second molar. Note the extra distal root.

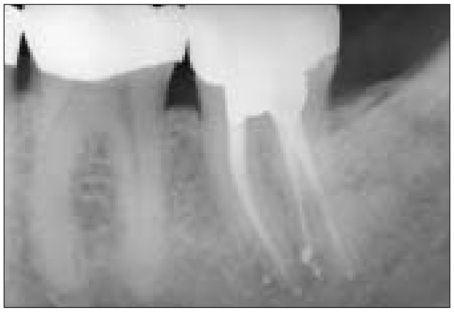


Figure 7b. A five-year recall film shows the treatment of multiple apical portals of exit and excellent osseous healing.

Carrier Removal

Gutta-percha carriers were originally metal and file-like, yet over the past several years they have been manufactured from easier to remove plastic carriers that have a longitudinal groove. Metal carriers, although no longer distributed, are occasionally encountered clinically and can be more difficult to remove than silver points because their cutting flutes at times engage lateral dentin.[28] Successful removal is enhanced by recognizing that the carrier is embedded in hardened gutta-percha and sealer. The successful removal of carrier-based obturators utilizes the same techniques described for removing gutta-percha and silver points.[18] However, successful removal poses additional challenges to the aforementioned obturation techniques in that the clinician must remove *both* the gutta-percha *and* the carrier (**Figure 6**). Oftentimes, the biggest secret to remove a carrier is to appreciate the importance of first removing circumferential gutta-percha that will facilitate removing the carrier-based obturator.

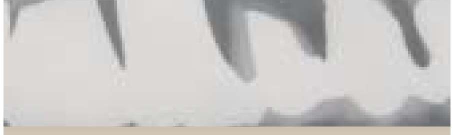
Paste Removal

When evaluating a paste case for retreatment, it is useful to clinically understand that pastes can generally be divided into soft, penetrable and removable versus hard, impenetrable, and at times, unremovable. Fortuitously, the paste is denser in the coronal portion of the canal and the material is progressively less dense moving apically due to the method of placement (**Figure 7**). Before retreating a paste-filled canal, the clinician should anticipate calcifications, resorptions, and the possibility that the removal efforts may be unsuccessful. Importantly, patients should be advised there could be a higher incidence of flare-ups associated with these retreatment cases.

An excellent technique for the safe removal of hard, impenetrable paste from the straightaway portion of a canal utilizes abrasively coated ultrasonic instruments in conjunction with the microscope. To remove paste apical to canal curvature, hand instruments should first be utilized to establish or confirm a safe glide path. Pre-curved stainless-steel hand files may be inserted into this secured region of the canal and when attached to a "file adapter," may be activated utilizing ultrasonic energy.[18] Other removal methods include heat, judicious use of end-cutting rotary NiTi instruments and small sized hand files with solvents such as Endosolv R and Endosolv E (Endoco; Memphis, Tenn.).[29] Additionally, Micro-Debriders (Dentsply Maillefer; Tulsa, Okla.) and paper points in conjunction with solvents play an important role in removing paste from canal irregularities.

Post Removal

Endodontically treated teeth frequently contain posts that need to be removed to facilitate successful nonsurgical retreatment.[30] Factors that will influence post removal are post diameter, length and the cementing agent. Other factors that will influence removal are whether the post is parallel versus tapered, stock versus cast, actively engaged versus non-actively retained, metallic versus non-metallic compositions, and the post head configuration. Additionally, other considerations include available interocclusal space, existing restorations and if the post head is supra- or sub-crestal. Over time, many techniques have been advocated for removal of posts.[31] Before initiating any post removal method, all materials circumferential to the post must be eliminated and the orifice to the canal visualized (**Figure 8**).



Ultrasonic Option

The first line of offense to remove a post is to utilize piezoelectric ultrasonic energy. An ultrasonic generator in conjunction with the correct insert instrument will transfer energy, powerfully vibrate, and dislodge most posts. A frequent and intermittent air/water spray is directed on the post to reduce heat buildup and transfer during ultrasonic removal procedures. The majority of posts can be safely and successfully removed with ultrasonics in about 10 minutes.[32]

PRS Option

The Post Removal System (PRS) is a reliable method to remove a post when ultrasonic efforts using the *10-Minute Rule* prove unsuccessful.[18] In this removal method, a trephine is used to machine down the most coronal aspect of the post 2 mm to 3 mm. The correspondingly sized tap is selected and an appropriately sized protective bumper is inserted onto this instrument. The tap is turned in a counter-clockwise direction to form threads and securely engage the post head. Once the tap is firmly engaged on the post and the protective bumper seated, then the extracting pliers are used to safely and progressively elevate the post out of the canal.

Separated Instrument Removal

Technological advancements have significantly increased the predictability in removing separated instruments. These advancements include the dental operating microscope, ultrasonic instrumentation, and microtube delivery methods.[18] The ability to access and remove a separated instrument will be influenced by the cross-sectional diameter, length and curvature of the canal, and further guided by root bulk and form including the depth of external concavities. In general, if one-third of the overall length of an obstruction can be exposed, it can usually be removed. Instruments that lie in the straightaway portions of the canal or partially around the curvature can usually be removed if safe access can be established to its most coronal extent.[33,34] If the entire segment of the separated instrument is apical to the curvature of the canal and safe access cannot be accomplished, then removal is usually not possible.

The techniques required to remove a separated instrument begin with establishing straight line coronal access. To create radicular access, hand files may be used serially small to large, coronal to the obstruction, to create sufficient space to safely introduce gates glidden (GG) drills. GG's are used like "brushes" and at a reduced speed of about 750 rpm. Importantly, in multi-rooted teeth, GG's may be used from small to large to cut and remove dentin on the outer wall of the canal and away from furcal danger. Each larger GG is stepped out of the canal to create a uniform tapered and smooth flowing funnel. The goal of radicular access is to optimally prepare a canal no larger than if there was no separated instrument.

Ultrasonic Option

In combination, microscopes and ultrasonics have driven "microsonic" techniques that have improved the potential, predictability and safety when removing separated instruments.[18] When access and visibility to the head of the separated instrument are achieved then contra-angled, parallel-walled and abrasively-coated ultrasonic instruments (ProUltra Endo Tips No. 3, 4, 5) may be employed. When energized, these instruments may be used to precisely sand away dentin and trephine circumferentially around the obstruction. During the ultrasonic pro-

Figure 8a. A pre-operative radiograph of a mandibular right second molar bridge abutment demonstrates three posts, previous endodontics, and apical pathosis.

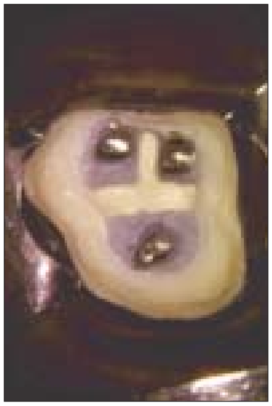


Figure 8b. Following coronal disassembly, the isolated tooth reveals the core sectioned and reduced.

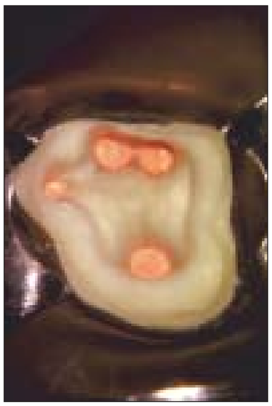


Figure 8c. The pulpal floor is shown following three-dimensional cleaning, shaping, and obturation procedures. Note the displaced most lingual orifice.

Figure 8d. A mesially angulated post-operative radiograph confirms the disassembly and retreatment efforts.

Figure 9a. A pre-operative radiograph shows a strategic and endodontically failing mesial root of a mandibular left first molar. Note a short screw post, a separated instrument and amalgam debris from the hemisection procedures.

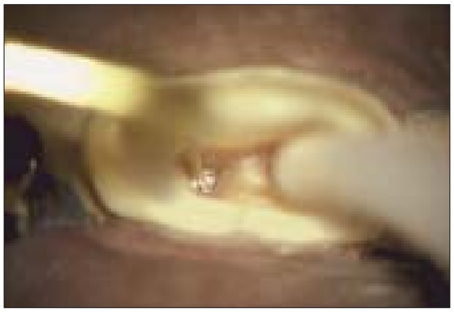


Figure 9b. A photograph shows the splint removed, the post out and an ultrasonic instrument trephining around the broken file.

Figure 9c. An eight-year recall film demonstrates three-dimensional retreatment, a new bridge and excellent periradicular healing.

Figure 10a. A pre-operative radiograph of a maxillary canine demonstrates a temporized canal with an instrument separated deep in the apical one-third.

Figure 10b. A working film shows that the 21-gauge iRS has successfully engaged and partially elevated the deeply positioned file segment.

Figure 10c. A post-operative film demonstrates the retreatment steps and a densely filled system that exhibits three apical portals of exit.

cedure, the separated instrument will typically loosen, unwind and spin, then "jump out" of the canal (**Figure 9**).

IRS Option

When ultrasonic techniques fail, the fall-back option is to use the Instrument Removal System (iRS) (Dentsply Tulsa Dental). The iRS is composed of variously sized microtubes and screw wedges. Each microtube has a small handle to enhance vision and its distal end is constructed with a 45-degree beveled end and side window. The appropriately sized microtube is inserted into the canal and, in the instance of canal curvature, the long part of its beveled end is oriented to the outer wall of the canal to "scoop-up" the head of the broken instrument and guide it into its lumen. The screw wedge is then placed through the open end of the microtube and passed down its internal lumen until it contacts the separated instrument. Rotating the screw wedge handle tightens, wedges, and oftentimes, displaces the head of the file through the microtube's side window.[18] With the separated instrument strongly engaged, it can generally be rotated counter-clockwise and removed (**Figure 10**).

Blocks, Ledges, Transportations and Perforations

Failure to respect the biological and mechanical objectives for shaping canals and cleaning root canal systems predisposes to needless complications such as blocks, ledges, external transportations and perforations. These iatrogenic events can be attributable to working short, the sequence utilized for preparing the canal, and the instruments and their method of use.[19]

Techniques for Managing Blocks

Techniques for managing blocked canals begin by confirming straight line access and then pre-enlarging the canal coronal to the obstruction.[18] A 10 file provides rigidity and is pre-curved to simulate the expected curvature of the canal. The unidirectional rubber stop is oriented to match the file curvature. With the pulp chamber filled with a viscous chelator, efforts are directed toward gently sliding the 10 file to length. If unsuccessful, the file is used with an apically directed picking action while concomitantly re-orienting the unidirectional stop which serves to redirect the apical aspect of the pre-

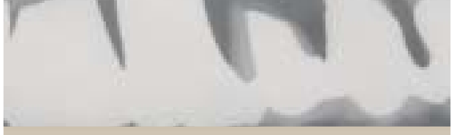


Figure 11a. A pre-operative radiograph of a maxillary left second bicuspid reveals previous access and pre-enlargement of the canal in its coronal two-thirds.

Figure 11b. The post-operative radiograph provides an explanation as to the etiology of the original block. Note the canal bifurcates apically and this system has four portals of exit.

Figure 12a. A pre-operative radiograph shows an endodontically failing posterior bridge abutment. Note the amalgam in the pulp chamber and that the mesial root appears to have been ledged.

Figure 12b. A post-treatment film demonstrates ledge management with the obturation materials following the root curvature.

curved file. Short amplitude, light pecking strokes are best utilized to ensure safety, carry reagent deeper, and increase the possibility of canal negotiation. If the apical extent of the file "sticks" or engages, then it may be useful to move to a smaller sized hand file. A working film should be taken and the file frequently removed to see if its curve is following the expected root canal morphology. Depending on the severity of the blockage, perseverance will oftentimes allow the clinician to safely reach the foramen and establish patency (**Figure 11**). If the blocked canal is not negotiable, then the case should be filled utilizing a hydraulic warm gutta-percha technique. Regardless of the filling result, the patient needs to be advised of the importance of recall and that future treatment options include surgery, re-implantation, or extraction.

Techniques for Managing Ledges

An internal transportation of the canal is termed a "ledge" and frequently results when clinicians work short of length and "get blocked." Ledges are typically on the outer wall of the canal curvature and are oftentimes bypassed using the techniques described for blocks.[13,18] Once the tip of the file is apical to the ledge, it is moved in and out of the canal utilizing ultra-short push-pull movements with emphasis on staying apical to the defect. When the file moves freely, it may be turned clockwise upon withdrawal to rasp, reduce, smooth or eliminate the ledge. During these procedures, try to keep the file coronal to the terminus of the canal so the apical foramen (foramina) is handled delicately and kept as small as practical. When the ledge can be predictably bypassed, then efforts are directed toward establishing patency with a 10 file. Gently passing a .02 tapered 10 file 1 mm through the foramen ensures its diameter is at least 0.12 mm and paves the way for the 15 file.[22]

A significant improvement in ledge management is the utilization of nickel-titanium (NiTi) hand files that exhibit tapers greater than ISO files.[18] Certain NiTi instruments have multiple increasing tapers over the length of the cutting blades on the same instrument (ProTaper, Dentsply Tulsa Dental). Progressively tapered NiTi files can be introduced into the canal when the ledge has been bypassed, the canal negotiated and patency established. Bypassing the ledge and negotiating the canal up to a size 15, and if necessary to a 20 file, creates a pilot hole so the tip of the selected NiTi instrument can passively follow this glide path. To move the apical extent of a NiTi hand file past a ledge, the instrument must first be pre-curved with a device such as Bird Beak orthodontic pliers (Hu-Friedy; Chicago, Ill.). Ultimately, the clinician must make a decision based on pre-operative radiographs, root bulk and experience whether the ledge can be eliminated through instrumentation or if these procedures will weaken or perforate the root. Not all ledges can or should be removed. Clinicians must weigh risk versus benefit and make every effort to maximize remaining dentin (**Figure 12**).

Techniques for Managing Apical Transportations

A canal that has been transported exhibits reverse apical architecture and predisposes to poorly packed canals that are oftentimes vertically overextended but internally underfilled.[8,13] In these instances, a barrier/restorative can be selected to control bleeding and provide a backstop to pack against during subsequent obturation procedures. The barrier of choice for a transportation is generally mineral trioxide aggregate (MTA) (Dentsply Tulsa Dental), commercially known as ProRoot. MTA is an extraordinary material which can be used in canals which exhibit reverse apical architecture, such as in transportations or immature roots, nonsurgical perforation repairs, or in surgical repairs.[18,35,36] Remarkably, cementum oftentimes grows over this nonresorbable and radiopaque material, thus allowing for a normal periodontal attachment apparatus.[37-39] Although a dry field facilitates visual control, MTA is apparently not compromised by moisture and typically sets hard within four to six hours, creating a seal as good as or better than other materials.[40-42]

Figure 13a. A pre-operative film of the maxillary right central incisor bridge abutment depicts a post and an empty system that exhibits reverse apical architecture.

Figure 13b. A photograph shows tamping MTA into the apical one-third with a gutta-percha cone used as a flexible plugger.

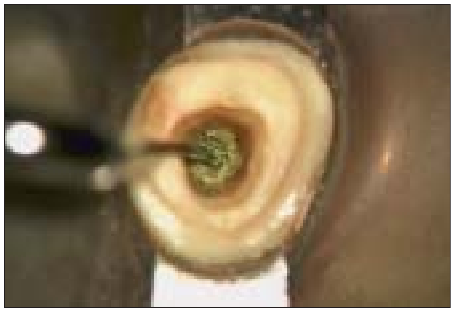


Figure 13c. A photograph shows the ProUltra ENDO-5 ultrasonic instrument vibrating MTA densely into the apical one-third.

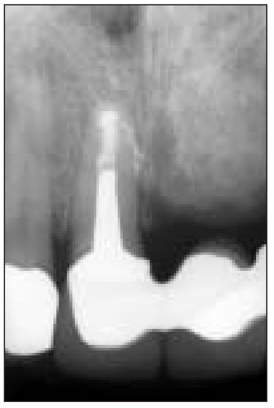


Figure 13d. A six-year recall demonstrates a new bridge, post and excellent osseous repair.

Techniques for managing apical transportations are facilitated when the coronal two-thirds of the canal is optimally prepared and radicular access is available for placing a barrier. ProRoot is easy to use and the powder is mixed with sterile water to a heavy cake-like consistency. MTA may be picked up and efficiently carried into more superficial regions of the tooth on the side of a West Perf Repair Instrument (SybronEndo). To more precisely introduce MTA deep into a prepared canal microtube carrying devices or the Lee carrier method (G. Hartzell & Sons; Concord, Calif.) are appropriately sized to accomplish this task.[18,35,43] ProRoot is then gently tamped down the canal to approximate length using a customized nonstandard gutta-percha cone as a flexible plugger. In straighter canals, ProRoot can be gently vibrated, moved into the defect and adapted to the canal walls with ultrasonic instruments (ProUltra Endo Tips, Dentsply Tulsa Dental) Direct ultrasonic energy will vibrate and generate a wave-like motion which facilitates moving and adapting the cement into the apical extent of the canal. Prior to initiating subsequent procedures, a dense 4 mm to 5 mm zone of ProRoot in the apical one-third of the canal should be confirmed radiographically (**Figure 13**).

In the instance of repairing a defect apical to the canal curvature, ProRoot is incrementally placed deep into a canal then shepherded around the curvature with a flexible, trimmed gutta-percha cone utilized as a plugger. A pre-curved 15 or 20 stainless-steel file is then inserted into the ProRoot and to within 1 mm to 2 mm of the working length. Indirect ultrasonics involves placing the working end of an ultrasonic instrument, such as the ProUltra Endo Tip No. 1, on the shaft of the file. This vibratory energy will encourage ProRoot to move and conform to the configurations of the canal laterally as well as control its movement to and gently against the periapical tissues. Again, the clinician should radiographically confirm that there is a dense 4 mm to 5 mm zone of ProRoot in the apical extent of the canal.

MTA needs moisture to set and become hard. Fluids are present external to the canal and will fulfill the moisture requirement for the apical aspect of the positioned MTA. However, a cotton pellet or paper point will need to be sized, moistened with water, and placed against the coronal most aspect of the MTA that is within the canal. The tooth is then temporized and the patient dismissed. At a subsequent appointment, the temporary filling and wet cotton pellet are removed so the MTA can be probed with an explorer to determine if

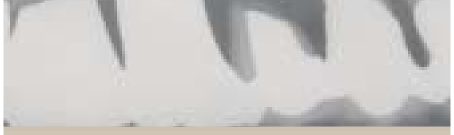


Figure 14a. A pre-operative radiograph of an endodontically involved mandibular left second molar bridge abutment. Note the previous access and possible floor perforation.

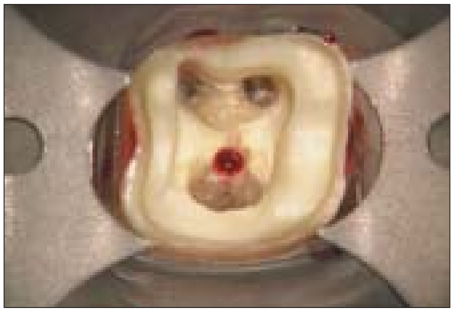


Figure 14b. A photograph demonstrates the identified orifices and a frank furcal floor perforation.

Figure 14c. This photograph shows the perforation repair utilizing a calcium sulfate resorbable barrier and a dual cured composite restorative.

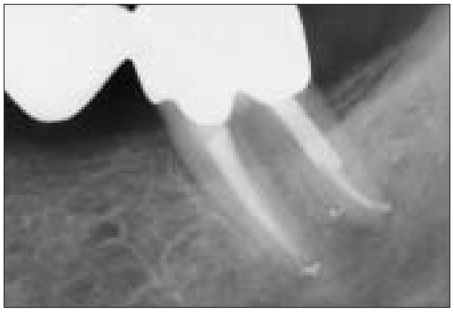


Figure 14d. A five-year recall film shows a new bridge and osseous repair furcally and apically.

it has set-up and is hard. Typically, the material is hard and the clinician can then obturate against this nonresorbable barrier. If the material is soft, it should be removed, the area flushed, dried, and a new mix of MTA placed. On a subsequent visit, when the inflammatory process has subsided, then a hard barrier should exist which will provide a backstop to pack against.

Techniques for Managing Perforations

A perforation represents a pathologic or iatrogenic communication between the root canal space and the attachment apparatus. The causes of perforations are resorptive defects, caries, or iatrogenic events that occur during and after endodontic treatment. Regardless of etiology, a perforation is an invasion into the supporting structures that initially incites inflammation and loss of attachment and ultimately may compromise the prognosis of the tooth. When managing these defects the prognosis will be impacted by the level, location and size of the perforation, and further influenced by its timely repair.[18]

Techniques and materials for managing perforation defects have been described earlier under the heading “Techniques for Managing Transportations.” However, on occasion, tooth-colored restoratives may be the material of choice for repairing certain perforations. Tooth-colored restoratives, such as a dual cured composite, require the placement of a barrier so the material is not contaminated during use. A barrier serves as a “hemostatic” and a “backstop” so a restorative material can be placed into a clean, dry preparation with control. Calcium sulfate is an excellent absorbable barrier material when using the principles of wet bonding because it is biocompatible, osteogenic, and following placement, sets brick-hard.[44-46] When set, calcium sulfate is internally trimmed back to the cavo surface of the root. A dual cured, tooth-colored restorative can now be placed against the barrier and utilized to seal a root defect (**Figure 14**).

Conclusion

This article has identified a variety of techniques to successfully retreat endodontically failing teeth. It should be recognized certain endodontically failing teeth are not amenable to successful retreatment. In these instances, the various interdisciplinary treatment options can be thoughtfully considered to ensure each patient is best served. However, as the potential for health associated with endodontically treated teeth becomes fully appreciated, the naturally retained root will be recognized as the ultimate dental implant.

Summary

In the United States alone, tens of millions of teeth receive endodontic treatment annually. Regardless of the enormous potential for endodontic success, certain teeth exhibit post-treatment disease. Many endodontically failing teeth are either surgerized or extracted. This article emphasized the importance of case selection, interdisciplinary treatment planning and the role of nonsurgical endodontic retreatment in preserving strategic teeth. Properly performed, endodontic treatment is a cornerstone of restorative and reconstructive dentistry. CDA

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