Apicoectomy: The Misunderstood Surgical Procedure

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INTRODUCTION

Mention “apicoectomy” and you’re bound to get a funny look from some dental colleagues. The fact is that this highly successful and predictable endodontic procedure has developed a bad reputation. The main reason is that most apicoectomy literature quoted in the profession and taught in dental schools is outdated and regurgitates old surgical techniques and outcome studies conducted several decades ago. These studies represent a time when the underlying causes of persistent periapical disease following root canal therapy were poorly understood and techniques to address the etiology of the disease were inadequate.

Furthermore, procedures performed during earlier studies were completed using antiquated armamentaria by surgeons who applied apicoectomy, with a broad stroke, to all conventional root canals that had failed. Not surprisingly, the results of many outcome studies prior to the modern era of endodontic surgery (ie, before the use of ultrasonics, operating microscopes, cone beam [CB] CTs, and modern retrofiling materials) were dismal.5-7

Today, the cause of persistent periapical disease is largely attributed to either inadequate cleaning and disinfection of the root canal space during the original root canal therapy, or recontamination of the whole root canal space after initial treatment due to a poor coronal seal (coronal leakage due to faulty filling, core, crown, etc). Root cracks and fractures as well as iatrogenic perforations, blockages, and missed canals can also act as microbial sources to the periapex. Sealing these sources from periapical egress has traditionally been the function of endodontic therapy. As a result, the apicoectomy procedure is more successful when correct diagnosis and case selection is combined with a 3.0-mm deep retrofiling and apical seal of the root end. Therefore, for the purposes of this article, the term apicoectomy procedure is defined not only as the cutting of the root end a minimum of 3.0 mm (apicoectomy portion of the procedure), but also the retrofiling and sealing of the remaining root with a minimum of a 3-mm deep retrofiling material.

Case Selection for Success

During the past 2 decades, a clearer diagnosis of the specific cause of persistent periapical disease has resulted in better treatment triage and case selection for teeth requiring nonsurgical revision, surgical treatment (apicoectomy plus retrofiling), or extraction.5 The source of persistent disease is now understood to be the persistence of microbes or microbial products in the root end and/or near a portal of exit. Nonsurgical revision is always the ideal treatment option to address the disease; as long as the procedure is feasible and restoration disassembly does not pose a significant risk of root fracture or other complications during treatment. For cases in which the periodontal condition of the tooth is poor, or when a root fracture is present, extraction and implant placement will be a more predictable option than apicoectomy. After thorough evaluation through clinical and radiographic assessment as well as verbal questioning of the relevant history, any remaining questionable cases can be treatment planned for an exploratory surgery instead of an apicoectomy, and the apicoectomy performed only after exploration and the ruling out of a fracture. If this does not seem feasible, the tooth should be removed and the area grafted immediately. This limits the...
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The surgical operating microscope had a significant impact on improving the success rate of endodontic surgery from the historically quoted outcome studies. This is due to the consequences of better visualization of the field at higher magnification, which in turn improves the clinician’s ability to find the source of pathology at the root end (e.g., discovery of additional canals, canal isthmuses, fine cracks, and fractures). This combination of light and magnification can greatly enhance visualization of the surgical field and show the microanatomy of the apex. The above retrograde fillings were accomplished with EndoSequence BC Root Repair Material (RRM) Fast Set (FS) Putty (Brasseler USA). (Photos courtesy of Dr. Bradley Trattner, Baltimore, Md.)

Figures 1a and 1b. The combination of light and magnification can greatly enhance visualization of the surgical field and show the microanatomy of the apex. The above retrograde fillings were accomplished with EndoSequence BC Root Repair Material (RRM) Fast Set (FS) Putty (Brasseler USA). (Photos courtesy of Dr. Bradley Trattner, Baltimore, Md.)

Figures 2a and 2b. (a) Cone beam (CB) CT imaging can show the 3-dimensional positioning of the tooth in a bucco-lingual direction and can allow the clinician knowledge of hidden roots, bucco-lingual inclination, depth of bone to access through to get to the roots, and any anatomical areas to pay attention to during the procedure. (b) In this section, the severe lingual orientation of the mandibular second molar shows the clinical challenge associated with apicoectomy. An intentional replantation was then chosen for treatment planning, instead of conventional apicoectomy.

Ultrasonic Apical Preparation

The advent of ultrasonic devices with surgical preparation tips that allow conservative bony access cavities while still allowing for deep retroreparation depths (following root resection) have further advanced the apicoectomy procedure. Piezo-ultrasonic devices with their associated diamond coated and non-diamond coated surgical tips allow the surgeon to prepare...
a +3.0 mm deep retropreparation into the root canal after sectioning off 3 mm of the apex (Figure 3). This combination results in cleaning and the elimination of an effective +6.0 mm of infected root canal space during the apicoectomy/retrofilling surgical procedure. The use of a piezoelectric ultrasonic unit is an absolute necessity for this kind of retropreparation (and for improving the long-term prognosis of the treated tooth).

Bioceramic-Based Retrofilling Materials
There are several endodontic cements currently on the market, but only a few that are categorized as bioceramics. While several retrofilling materials have been used historically, it has been understood that the ideal retrofilling material would not only fill, but also promote the healing of the tissue it directly contacts. The first material in this category was mineral trioxide aggregate (MTA).\textsuperscript{11-14} Pro-Root MTA (DENTSPLY Tulsa Dental Specialities) was originally released in the mid-1990s. Unfortunately, the clinical handling properties of MTA are not ideal, and predictable mixing and transferring of this material from the bench top into the retropreparation can prove a challenge. This makes the application of this material to the surgical site more complicated, requiring additional time and armamentarium.

Fortunately, advancements in material science have addressed these concerns with the development of a new class of nanoparticulate premixed bioceramic compounds: EndoSequence BC Sealer, Root Repair Material (RRM Syringeable), and Root Repair Material Putty (RRM Putty) (Brasseler USA). These compounds combine the biological advantages of these bioceramic cements with excellent clinical handling properties designed specifically for their intended purposes.\textsuperscript{15-27} The new cements are pure bioceramics, built \textit{de novo}, and composed of zirconium oxide, calcium silicates, calcium phosphate monobasic, calcium hydroxide, filler, and thickening agents.\textsuperscript{18} These bioceramics are available in 3 different consistencies: (1) a low-contact angle, highly flowable syringeable sealer; (2) a slightly more viscous syringeable RRM; and (3) an even higher viscosity putty material (RRM Putty), which is also available in fast set formulation (RRM Putty Fast Set [FS]) (Figure 4). These materials are as biocompatible as MTA\textsuperscript{16-21} and promote
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healing. They also demonstrate clinical handling far surpassing MTA and other bioceramics, making this class of cements the preferred choice for endodontists.22-30 In this article, we will use the superior clinical handling advantages of this class of bioceramics to describe a novel and more efficient retrofilling technique. This technique, named the Lid Technique,8 combines the advantages of material science (bioceramics) with the efficiency of technique made available by the use of the syringeable paste and putty formulations during the filling of the retropreparation.

The Lid Technique

This technique’s underlying theory takes advantage of the concept of using 2 chemically similar materials with different viscosities in order to get better adaptation of the overall material to a biological surface.31 Examples of this concept are seen in the often used and current techniques of combining flowable and bulk restorative composites during the filling of a cavity preparation and similarly the simultaneous use of a light- and heavy-body impression material during impression making for prosthodontics. Likewise, the Lid Technique8 utilizes the combined injection of the EndoSequence RRM Syringeable Paste into a retropreparation in order to fill the bulk of the cavity followed by the placement of the EndoSequence RRM Putty FS that acts as a lid over the injected material in order to seal the surface of the retrofilling and prevent any potential washout. The paste material flows extremely well but can potentially wash out in the presence of blood or contact with irrigation. The goal of the Lid Technique8 is to seal and prevent this washout by placing a layer of the washout-resistant Putty FS material on the cavosurface(s) of the retropreparation, thus allowing the material to set undisturbed. It’s important to understand that the RRM Paste does not wash out after setting (90-minute setting time). Therefore, the putty’s role is to allow this setting reaction to take place without blood contamination, and to that extent, the thickness of the Putty FS is inconsequential (Figure 5).

In order to achieve the goal of injecting the RRM Syringeable Paste deep into the retropreparation, it’s important that the delivery device’s inner lumen be wide enough to allow free flow of the flowable bioceramic material, yet the external diameter be thin enough so that the tip of the syringe can fit deep into the standard retropreparation without excessive binding. This will allow for the escape of air and any excess cement from its sides during the injection process (Figure 6). If the syringe is not inserted deep into the retropreparation prior to injection, a void may be trapped under the flowable material deep in the preparation (Figure 7). This is similar to trapping a void under a post during cementation in a root canal! This is why the delivery tip should be fitted after the retropreparation cavity is made; and the appropriate delivery tip thickness used (a tip that’s slightly loose in the canal) prior to prepping the site for injection. The RRM Paste, Sealer, and Putty use a standard Luer Lock attachment and are therefore compatible with a number of tips. Experience has confirmed that a Blue Micro dispensing Tip (Ultradent Products) or equivalent can fit in the standard retropreparation and still allow RRM Syringeable material or BC Sealer to flow through it.

By bending the first 3.0 mm of the syringe tip at 90° using either a hemostat or a pair of bird beak pliers, access can be achieved to the full depth of the retropreparation. After bending the delivery
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tip appropriately, the needle is screwed on to the EndoSequence RRM Paste Syringe (Brasseler USA) through its conventional Luer Lock attachment (Figure 8). This cannula’s diameter allows injection of the premixed syringeable RRM or BC Sealer material directly from the syringe deep into the retropreparation, thus bypassing any necessity to mix or dispense the material at the time of surgery. This time savings is significant, considering previously described techniques for placement of MTA during this phase of the retrofilling that have required sensitive mixing techniques and special delivery devices.

Once the flowable material has been injected, a small ball or cone of the RRM Putty FS is delivered to the site of the surgery using a typical microspatula. The ball/cone is placed directly over the flowable material, thus sealing the cavosurface area of the retropreparation (acting as the lid and protecting the flowable material until it sets). The RRM syringeable material’s setting time is about 1.5 to 3 hours, and RRM Putty FS sets in 20 minutes. However, there is no need to wait for the putty to set to complete the procedure. Immediately after placement, the retropreparation can be cleaned and any flash from the putty removed using a microbrush and a gentle spray of saline.

The Lid Technique can be summarized in the following way: After resection of ideally 3.0 mm of the root end in a failing root canal, a 3.0-mm retropreparation is made in the root canal using ultrasonics. Once the retropreparation is complete, the Micro Tip delivery syringe is fitted to the retropreparation, ensuring that the tip reaches the deepest portion of the retropreparation. Once this is confirmed, additional hemostasis is obtained inside the bony crypt, and the retropreparation is disinfected with a disinfectant of choice and dried thoroughly using micro air blast or small paper points. The syringeable EndoSequence RRM is injected using the fitted delivery tip, starting from the depth of the retropreparation and slowly moving the syringe out of the retropreparation while injecting. This process will discourage or eliminate any voids. Once the retroprep is filled to the cavosurface using the flowable material, the tooth is sutured closed.

Figures 10a to 10l. (a) Following apicoectomy and root canal identification, retropreparation was made using a piezoelectric ultrasonic tip. (b and c) A properly angled dispensing needle was fitted to make sure it reached the depth of the preparation. (d and e) The RRM Paste (or Sealer) was then injected slowly while the syringe was withdrawn, filling the retropreparation to the cavosurface margin. (f to h) Using a spatula, a small amount of the Putty FS was then placed over the syringeable material covering the surface of the retropreparation, and flash was removed using a small brush. (i) The surface and the bony crypt were cleaned with sterile saline and the tooth was sutured closed. (j and k) The immediate post-op and 2-year follow-up radiographs show the retrofilling in place. (l) Exposure for apicoectomy on the MB root of the posterior tooth visually confirmed healing of the bony crypt over the previous apicoectomy site.

Figure 9. Tooth No. 13 (with a previously retreated root canal, post, and crown) had a periapical radiolucency and was diagnosed with symptomatic apical periodontitis.
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material, a small ball or cone of the RRM Putty FS is used to seal the cavosurface area of the retropreparation by directly placing the putty over the flowable material and spreading it to the margins of the preparation using a microspatula. Any excess putty or paste material can be easily cleaned out of the bony crypt using a spoon excavator or microbrushes. Until experienced with the technique, a digital radiograph can be utilized to confirm an adequate fill without any voids. If significant voids are noted, a 10-second blast of ultrasonic and water inside the retropreparation will remove all of the bioceramic retrofil. Once done, the retrofilling process can be started again, paying particular attention to the fit of the syringe tip and the slow movement outward during injection to prevent voids. After confirmation, the crypt is cleaned of any hemostatic agent, and bleeding is initiated from the crypt prior to suturing the flap closed.

CASE REPORT

A patient, who presented with a history of previous nonsurgical root canal therapy and coronal restoration in tooth No. 13 within the past 2 years, was referred for evaluation of a symptomatic periapical radiolucency (Figure 9). Following clinical evaluation and testing, a diagnosis of symptomatic apical periodontitis was observed. The tooth already had a nonsurgical revision and adequate coronal restoration (no coronal leakage was observed). Given the healthy periodontal therapy, and the presence of a well-sealed coronal restoration, surgical treatment with apicoectomy and retrofilling was recommended.

Following the raising of a flap, surgical osteotomy to get access to the root end, and surgical excision of 3.0 mm of the apex using a Lindeman Surgical Bur (Brasseler USA), the root end was exposed. Ultrasonic tips (BEST TIPS 1 and 2 [Brasseler USA]) were used in a Forza V3 piezoelectric ultrasonic unit (Brasseler USA) and a 3.0 mm deep retropreparation was prepared (Figure 10). An acutely bent microdispensing tip (similar to the tip used for phosphoric acid etch [Ultradent Products]) was fitted in the retropreparation, making sure that the tip had reached the deepest portion of the retropreparation. Hemostasis was obtained in the osseous crypt, and then the retropreparation was disinfected and dried. Next, the fitted dispensing tip was placed on an EndoSequence RRM Paste Syringe, and the paste was then injected, very slowly in the retropreparation while the tip was being withdrawn. This technique allowed for the filling of the retropreparation (with the RRM Paste) without trapping any voids.

Once the entire retropreparation was filled with the RRM Paste, a small ball-shaped piece of RRM Putty FS was placed directly over the cavosurface area of the preparation using a microspatula. Next, a MicroBrush (Ultradent Products) was used to clean the excess material/flash from the bone crypt and a gentle stream of saline was used to wash away any loose debris (Figures 10a to 10h). A confirmation radiograph showed a lack of any voids in the retrograde filling. A small amount of flash remaining was then removed prior to suturing (Figure 10i).

Five RealWorldEndo Tips for Success

1. If during the apicoectomy you see a crack on the root, abandon the procedure, then extract and graft right away. It is important to have a high success rate, and cracked teeth have a very poor outcome in the long run. Wasting the patient’s resources with false hope is not good patient management.

2. Be sure to pay attention to the coronal aspect of the tooth while preparing the retropreparation. It is important to visualize the root anatomy from the radiograph and transpose that mentally over the patient’s bone. This way, you will be able to visualize and follow the path of the root canal better inside the root canal and end up having a more effective seal. Do not forget, you’re only preparing a seal if you are in the root canal space. If you go off course, you will not only have a poor seal, you will also predispose the tooth to fracture by weakening it unnecessarily.

3. Be sure that the tip of your syringe can reach the deepest part of your retropreparation to help prevent void formation.

4. Use adequate hemostatic agents (eg, aluminum chloride, ferric sulfate, or epinephrine pellets) and try to have a dry bony crypt at the time of the fill. It is important not to get too much bleeding that can obscure your view and contaminate your retropreparation during the retrofill.

5. Don’t forget that EndoSequence BC Sealer (Brasseler USA) can be a replacement for the EndoSequence RRM Paste.3 This is useful if you find the extrusion of the paste too hard through the syringe lumen necessary to fit your retrofilling size. For thinner retropreparations, the sealer will be easier to flow through the needle lumen and it will have the same chemistry as the paste material.
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A 2-year follow-up radiograph of the area shows complete healing of the bony crypt (Figures 10j and 10k). Unfortunately, the patient had received another conventional root canal from her other dentist, which had become symptomatic. The subsequent surgical procedure for treatment of that tooth exposed the surgical site for a second time, visually confirming complete healing of the alveolar plate over the original bony crypt of osseotomy (Figure 10l). The surgical procedure for that molar was also documented and is available for review.8

CONCLUSION

Based on the contemporary understanding of endodontic concepts for success and failure, assessment and subsequent treatment of apicoectomy procedures have greatly improved. Advances in apicoectomy armamentaria and materials (including bioceramic retrofitting materials and clinical techniques for their efficient use) have enabled endodontists to treat challenging cases with much greater efficiency. While successful outcomes are still predominantly a function of proper case section and triage, using the novel retrofitting technique, as described in this article, can make this previously challenging aspect of surgical endodontics much easier for clinicians.

References

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POST EXAMINATION QUESTIONS

1. Today, the cause of persistent periapical disease is largely attributed to either inadequate cleaning and disinfection of the root canal space during the original root canal therapy, or recontamination of the whole root canal space after initial treatment due to a poor coronal seal (coronal leakage due to faulty filling, core, crown, etc).
   a. True   b. False

2. Nonsurgical revision is always the ideal treatment option to address the disease; as long as the procedure is feasible and restoration disassembly does not pose a significant risk of root fracture or other complications during treatment.
   a. True   b. False

3. The surgical operating microscope has really not had a significant impact on improving the success rate of endodontic surgery from the historically quoted outcome studies.
   a. True   b. False

4. The advent of ultrasonic devices with surgical preparation tips that allow conservative bony access cavities while still allowing for deep retroreparation depths (following root resection) have further advanced the apicoectomy procedure.
   a. True   b. False

5. Unfortunately, the clinical handling properties of mineral trioxide aggregate are not ideal, and predictable mixing and transferring of this material from the bench top into the retroreparation can prove a challenge.
   a. True   b. False

6. The technique named the “Lid Technique” combines the advantages of material science (bioceramics) with the efficiency of technique made available by the use
of the syringeable paste and putty formulations during the filling of the retropreparation.

a. True    b. False

7. The Lid Technique utilizes the combined injection of the EndoSequence Root Repair Material (RRM) Syringeable Paste (Brasseler USA) into a retro-preparation in order to fill the bulk of the cavity followed by the placement of the EndoSequence RRM Putty Fast Set (FS).

a. True    b. False

8. In order to achieve the goal of injecting the RRM Syringeable Paste deep into the retro-preparation, it’s important that the delivery device’s inner lumen be wide enough to allow free flow of the flowable bioceramic material.

a. True    b. False

9. Experience has confirmed that a Blue Micro dispensing Tip (Ultradent Products) (or equivalent) do not fit in the standard retro-preparation.

a. True    b. False

10. Once the flowable material has been injected, a small ball or cone of the RRM Putty FS is delivered to the site of the surgery using a typical microspatula.

a. True    b. False

11. The RRM syringeable material’s setting time is about 1.5 to 3 hours, and RRM Putty FS sets in 20 minutes. However, the clinician must wait for the putty to set to complete the procedure.

a. True    b. False

12. Once the retro-prep is filled to the cavosurface using the flowable material, a small ball or cone of the RRM Putty FS is used to seal the cavosurface area of the retro-preparation by directly placing the putty over the flowable material and spreading it to the margins of the preparation using a microspatula.

a. True    b. False
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5. ☐ a. True ☐ b. False
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