Apical Surgery: Parts III and IV:
Access and Crypt Management and the Bevel and Retropreparation

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In Parts I and II of this article, patient preparation, the incision, and atraumatic flap elevation were discussed. These are the first three steps necessary to perform predictable apical microsurgery. It is of utmost importance that all steps are done completely before proceeding to the next step. If a step is omitted, or not done completely, the next step will be difficult, if not impossible, to complete properly. The operation will develop into a stressful experience for the patient, the staff, and the clinician, with an undesirable and unpredictable end result. If all of the steps are completed as outlined, all procedures can be performed without stress and a favorable postoperative result is predictable. The technique is gentle and predictable, as long as all of the steps are followed without compromise!

ACCESS AND CRYPT MANAGEMENT

Once the properly designed flap has been atraumatically reflected and retracted, the access preparation is ready to begin. Some important considerations are:

1. How much bone exists on the buccal aspect of the root being surgerized? If there is total dehiscence, guided tissue regeneration has to be considered. Ideally, there should be at least 3 mm to 4 mm of healthy, intact crestal buccal bone remaining after the access preparation is completed (Figure 1).

2. How much of the apex can be beveled or resected? Usually, there is an adequate amount of root length with which to work. The shorter the root, the more conservative the operator will have to be when beveling, and the closer the bevel should be to 0°, so less removal of the root end is possible. If an exceptionally long post is present and it is closer to the apical terminus than desired, not as much of the root end can be resected. Or, if the periodontal bone level is less than desired, a more conservative amount of apical root structure should be removed to preserve as much crown/root ratio as possible.

Fortunately, the dental operating microscope (DOM) and/or the endoscope allow the operator the luxury of being ultraconservative when necessary.

There are basically two different ways to begin the access:

1. Estimate the amount of the apex to be resected and with a Lindemann bone-cutting bur, remove the apex, and prepare the access opening in one general step. If there is any portion of the apex remaining in the crypt, it is curetted out and the access is more or less complete (Figure 2).

In general, a biopsy should be performed on all tissue removed from the body. Although the pathological diagnosis of the LEO is generally reliable, no chances should be taken, and a biopsy should be taken on a routine basis.

2. Estimate the location of the apex. Then using a #6 surgical length, round bur, slowly and gently remove the bone overlying the buccal surface of the root. When the buccal surface of the apex is uncovered, bone is removed until the coronal limit of the crypt is established and the general outline of the apex is readily observed. At this time, the lesion can usually be curetted and the entire apex exposed. If the lesion is more palatal, or lingual, the root apex may prevent the necessary access for curettage and will have to be partially beveled, or resected, as part of the access process.

FIGURE 1. An adequate amount of crestal bone should remain between the osseous crest and the coronal extent of the crypt.

A thorough curettage is important to allow appropriate hemostasis from within the crypt. In general, the amount of hemorrhage will be greatly reduced if all of the granulation tissue is removed. In turn, management of the crypt is easier to accomplish, and good visibility can be restored. Although this technique requires more time to complete, the increased visibility and ability to be more precise with the initial apiection makes it a desirable modality.

In general, a biopsy should be performed on all tissue removed from the body. Although the pathological diagnosis of the LEO is generally reliable, no chances should be taken, and a biopsy should be taken on a routine basis. The final dimension of the access opening varies, depending on several factors:

1. The size and position of the lesion. If the lesion is large then the access will, of necessity, be large in order to perform a complete curettage.

2. The position of the apex. The more lingual the apex, the more overlying bone has to be removed and the larger the access has to be for visibility.

3. The size of the instruments. The access has to be large enough to allow the instruments room to prepare the apical canal system without inhibiting their freedom of movement. The larger the instruments used, the larger the access must be.

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FIGURE 2. Three surgical burs are generally incorporated for proper access.

FIGURE 3. A slightly "streaked" piece of Telfa Pad was scheduled to be placed against the bony floor of the crypt.

FIGURE 4. Previously used and discolored Telfa Pads should be replaced for improved light reflection in the crypt.

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4. The thickness of overlying bone. If the buccal plate is thick, a wider access is necessary to eliminate a "tunnel effect" so that vision is not compromised.

5. The experience and ability of the surgeon as well as the equipment available. On many occasions, the endoscope may allow improved visualization of the surgical site due to increased lighting and magnification. It also increases the ability to view previously difficult, and sometimes inaccessible areas. The extents of defects or existing anatomical variations that are lingual to the involved root end are typical examples of the value of also having an endoscope during microsurgical procedures.

Crypt management is critical and the operator should take as much time as necessary to achieve the desired result. The clean and well-managed crypt is essential for good visibility and proper use of the retrofill materials. Ferric subsulfate, calcium sulfate, Telfa Pads, and epinephrine-soaked pellets are the most commonly used and effective agents for this purpose.

HEMOSTASIS AND HEMORRHAGE PREVENTION

Once all granulation tissue and debris have been thoroughly removed from the crypt, hemostasis is often achieved as a result of proper hemostasis staging injections. Then, only an appropriately cut of lining is necessary for the floor of the crypt to enhance lighting. However, this is not always the case and even slight bleeding must be addressed to preserve optimum visibility.

If the crypt exhibits slight hemorrhaging, the tissue surface of Telfa, trimmed to the correct size, can be lightly streaked with ferric subsulfate and pressed into the floor of the crypt for a short period of time until the hemorrhaging is completely controlled (Figure 3). As soon as there is complete control of all bleeding in the crypt, the Telfa should be removed and replaced with a fresh piece so there is as much "white" surface as possible to facilitate light reflection and enhance visibility (Figure 4).

If there is moderate hemorrhaging, the ferric subsulfate should be applied carefully with a microapplicator (Ultradent Products, South Jordan, UT). When ferric subsulfate is used to achieve hemostasis, a thick brownish-black coagulum is usually the result (Figure 5). The process is repeated until bleeding is controlled. Again, keep in mind that only a small amount is necessary. The resultant coagulum can be easily removed and visibility restored with a clean microapplicator,

FIGURE 5. A brownish-black coagulum is formed when the ferric subsulfate contacts blood.

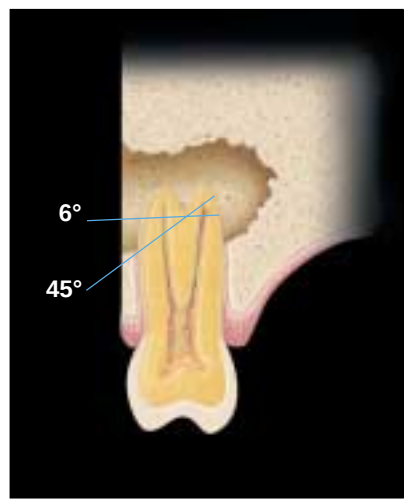

FIGURE 6. Illustration demonstrates the effect of different bevel angles on root length and potential lingual anatomy.

and the area can then be gently flushed with water using a Blue Tip on a Stropko Irrigator (Vista Dental, Racine, WI) as the assistant evacuates the edge of the crypt. As long as the coagulum has been cleaned out of the crypt after the completion of the surgery, its use has not been shown to affect the healing process.[1] Due to its extremely low pH, care must be taken to ensure that all forms of ferric subsulfate are kept well within the confines of the crypt to avoid instant chemical cauterization of any surrounding tissues. The buccal plate of bone, the periosteum, the soft tissues, and the schneiderian membrane should always be avoided, and only small amounts of this material should be used on the end of an applicator. **NOTE:** *There are two popular forms of ferric subsulfate: Monsel solution and Cutrol with a concentration of 72% and 53%, respectively.*

"On a few occasions, severe hemorrhaging may occur as a result of inflammation, a severed interdental artery, or a compromised clotting mechanism.... Pressure should be applied immediately over the crypt [to limit] hemorrhaging."

If hemorrhaging occurs on the surface of the exposed buccal plate, an assistant can evacuate the "bleeder" with a small surgical tip (Touch'N Heat, SybronEndo, Orange, CA) used to effectively cauterize the source of bleeding. Once hemorrhaging is completely controlled and the crypt relatively cleansed of the coagulum, a fresh piece of Telfa should be placed over the internal surface of the crypt. Keep in mind when using the DOM that light and dryness are the most important factors for good visibility. **NOTE:** *Never proceed to the next step until total crypt management has been accomplished*.

On a few occasions, severe hemorrhaging may occur as a result of inflammation, a severed interdental artery, accidental involvement with the greater palatine artery, or a compromised clotting mechanism. At any rate, when the blood flows faster than the evacuator can remove it, there is good reason for a little excitement and fast action! Pressure should be applied immediately over the crypt. This will stop the hemorrhaging long enough to calmly prepare the next few steps. First, in a low and controlled voice, instruct the assistant to insert a bigger tip into the evacuator

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and hold it close to the crypt. If after removing the pressure, hemorrhaging has not subsided, quickly replace a finger over the crypt. It is important that the operator has determined that no critical anatomical landmarks (eg, mandibular canal, greater palatine artery, maxillary sinus) are involved with the source of the hemorrhaging. The assistant should then take a piece of sterile cotton roll and make a "cotton plug" large enough to completely fill the crypt, lightly streaking the tissue surface with the ferric subsulfate, and insert it into the crypt. Hold it firmly in place for a minute or so. If any of the above anatomical landmarks are involved, the ferric subsulfate should not be used. Just plain pressure for an adequate time will usually suffice. After a few minutes, the cotton "plug" can be safely removed, and you can proceed without undue concern. A gentle irrigation with the Stropko Irrigator will remove most of the dark-colored coagulum. It is a good idea to take a radiograph and clinically re-evaluate the surgical area at this time to ensure that no unforeseen anatomical structures (eg, mandibular canal, palatine artery) have been infringed upon.

Once crypt management is completed, the clinician can refine the bevel and prepare the retropreparations with confidence and good visibility. At the end of this step, all hemorrhaging should be controlled, the grossly resected apical end of the root easily seen, and the floor of the crypt covered with a clean, white piece of Telfa. An apical microsurgeon's dream!

FIGURE 7. A long bevel with round bur preparations demonstrates angulation and orientation complications. Figure appears courtesy of Dr. Gary Carr.

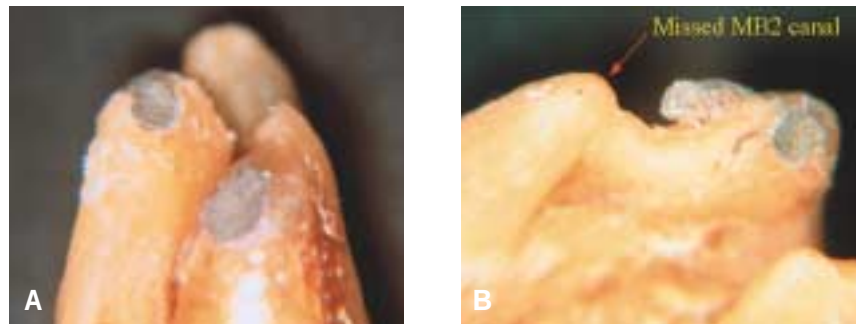

FIGURE 8A. Inadequate and acute 45° bevel clearly shows how perforations can occur and canals can be missed from the buccal aspect. **8B.** Actual perforations must be carefully located and treated.

BEVEL AND CRYPT MANAGEMENT

The amount, or degree, of the bevel is of utmost importance and should be precisely planned in advance. After considering the overall crown/root ratio, the presence of posts or other obstacles, the root anatomy, and the periodontal status of the tooth, the bevel can be done. According to previous research, 98% of canal system ramifications occur in the apical 3 mm.[2] If the bevel is long (traditionally 25° to 45°), an excessive amount of root structure would have to be removed to include the apical 3 mm on the palatal or lingual part of the root's apical canal system (particularly in roots with multiple canals). If the bevel is closer to 0°, the lingual 3 mm is easier to remove, and more root structure can be conserved to improve the crown/root ratio. With a long bevel, there is also an increased risk of completely missing some important palatal or lingual anatomy, especially if the operator is in any measure trying to be conservative in order to preserve the crown/root ratio (Figure 6). The long bevel creates a spatial complication that is generally impossible for the operator to overcome while trying to visualize the true long axis of the canal system (Figure 7). The longer the bevel, the greater the tendency for the operator to leave more of the palatal, or lingual, aspect of the root intact. Since it is difficult to visualize the long axis of the tooth, the resultant root-end preparation is not as likely to be within the long axis of the canal. This concept is of utmost importance and is the primary reason that, on occasion, the root-end preparation unintentionally perforates to the lingual or palatal aspect (Figure 8). Another important consideration is that with a bevel as close to 0° as possible, the cavosurface marginal dimensions of the root-end preparation will be considerably decreased. Therefore, the restoration will be easier to place and have less chance of leakage.

TREATMENT OF COMPLEX ROOT ANATOMIES

The root anatomy is especially important when there are more than two canals in one root. This occurs most commonly in maxillary premolars and in the mesial roots of nearly all molars. In fact, studies have shown that as many as 93% of the MB roots of the maxillary first molars have a second (MB2) canal.[3] The operator has to be constantly aware, however, that multiple canals can occur in any root, regardless of which tooth is being operated on. If there is an isthmus present, it can usually be seen with the DOM if the root has been adequately beveled and stained with methylene blue.

"There are multitudes of ultrasonic tips from which to choose.... The most important consideration is not the brand of the unit or the type of tip, but how the instrument is used."

The refinement of the bevel is best accomplished with an 1170 or 1171 carbide, surgical length, tapered fissure bur (Brasseler USA, Savannah, GA) in a 45° handpiece (Satelec USA, Cherry Hill, NJ) (Figure 9). These handpieces have no air exiting from the working end, which nearly eliminates the possibility of an air emphysema or air embolism beneath the flap. A standard high-speed handpiece should never be used for the above reason. On occasion, the refinement of the bevel can cause additional bleeding due to some enlargement of the crypt. The operator should address any newly created crypt management problem before proceeding any further. *Remember that it is of utmost importance to fully complete one step before proceeding to another!*

After the bevel is refined and crypt management is completely under control, the apical surface is rinsed and dried with a Blue-Flo in a Stropko Irrigator (Vista Dental, Racine, WI). The cleaned and dried surface is then stained with methylene blue. It is important to allow the methylene blue to remain on the tooth for a short period of time before gently flushing with sterile water. If there are any fractures, presence of isthmus tissue, or access present, the staining will

greatly enhance the operator's ability to visualize them. Also, the methylene blue will stain the periodontal ligament and enable the operator to be sure the apex has been completely resected (Figure 10). If there is an accessory canal present, the easiest solution is usually to bevel past it and restain. On occasion, the accessory can also be "troughed out" leaving the bevel as is.

When two canals are present in one root, it is necessary to prepare for an isthmus between the two canals, even if the staining did not reveal one. It has been shown that in the mesiobuccal roots of the maxillary first molars with two canals, the 4 mm section displayed a partial or complete isthmus 100% of the time.[4] In a recently published study of maxillary molars, there are two canals present clinically at least 93% of the time in the mesiobuccal root of the maxillary first

FIGURE 9. The handpiece does not direct exhausted air toward the working end of the bur.

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molar. The reason it is important to prepare the isthmus is because of postsurgical remodeling of the beveled root surface. Although staining doesn't reveal the presence of an isthmus, it may lie just below the surface, only to be exposed during the remodeling process of the beveled root that takes place postoperatively (Figure 11). *The rule is, therefore, to always prepare an isthmus when there are two canals in one root.*

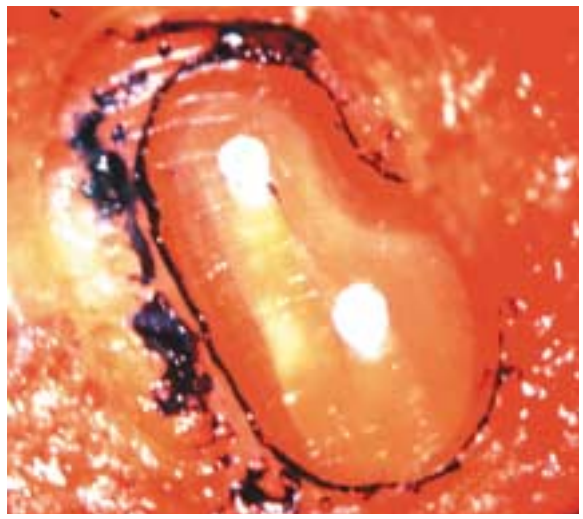

FIGURE 10. Staining allows the operator to be sure of complete root resection and to see if there is an isthmus, accessory, or fracture present. Figure appears courtesy of Dr. Gary Carr.

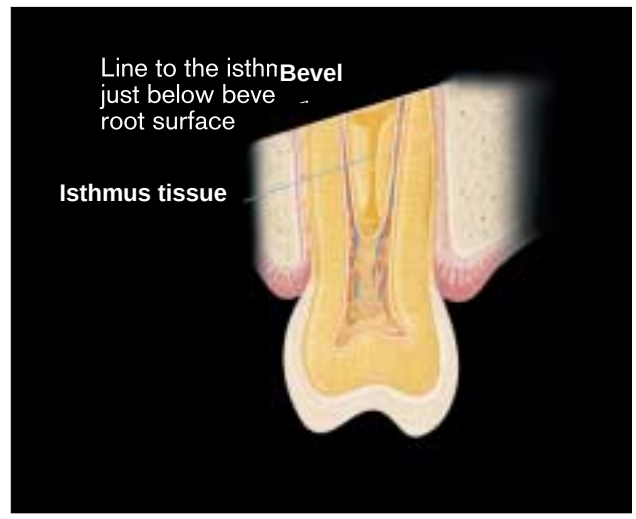

FIGURE 11. An illustration of an isthmus, lying just below the surface, which would not be evident even after staining with methylene blue.

USE OF ULTRASONIC DEVICES DURING APICAL MICROSURGERY

The root-end preparation is accomplished using various ultrasonic units and tips that vary in performance and reliability. The Satelec (Mount Laurel, NJ), EMS (SybronEndo, Orange, CA), and Spartan (Spartan/Obtura, Fenton, MO) units are currently the most popular ultrasonic units used for apical microsurgical procedures. For the most part, they are all dependable and have a good service record.

There are multitudes of ultrasonic tips from which to choose. The newer coated tips (eg, Amadent, ProUltra, Dentsply Tulsa Dental, Tulsa, OK; KIS, Obtura/Spartan, Fenton, MO) are much more efficient at removing gutta-percha. The most important consideration is not the brand of the unit or the type of tip, but how the instrument is used. The tendency for the new operator is to use the ultrasonic in the same manner (pressure-wise) as the handpiece. *The secret is an extremely light touch! The lighter the touch, the more efficient the cutting.* The correct amount of water is also important. If too much spray is used, visibility and cutting efficiency are both decreased. If too little is used, the necessary amount of cooling will not be available and burning and/or microcracks can be created.

If the canal is large and/or filled with gutta-percha, a larger coated tip can be used most efficiently. The various left and right tips are necessary on occasion, but in most cases, the anterior type tips will suffice. The key is to: 1) slow down, 2) be gentle, 3) use a light, brushing movement, and 4) carefully regulate the power setting of the ultrasonic unit. The power setting will vary greatly depending on the tip being used and nature of the preparation task at hand.

For the preparation of an isthmus, a CT-1 tip (SybronEndo, Orange, CA) can be used to create a series of multiple "dots" into the stained line between the two canals. With the ultrasonic unit set at a low power setting and the CT-1 tip inactivated with no water spray, place the pointed tip exactly where desired and just lightly "tap" the rheostat for an instant. Then repeat the process again, and again, as many times as necessary, until there are a series of "dots" (Figure 12). It is then a simple matter of connecting the dots to create the initial, shallow, and precise, "tracking groove." With the water spray turned on, a sharp-pointed, coated tip can be used to deepen the tracking groove. In this manner, accuracy is completely controlled and there is no chance of "slipping off" while preparing the isthmus in a very thin root.

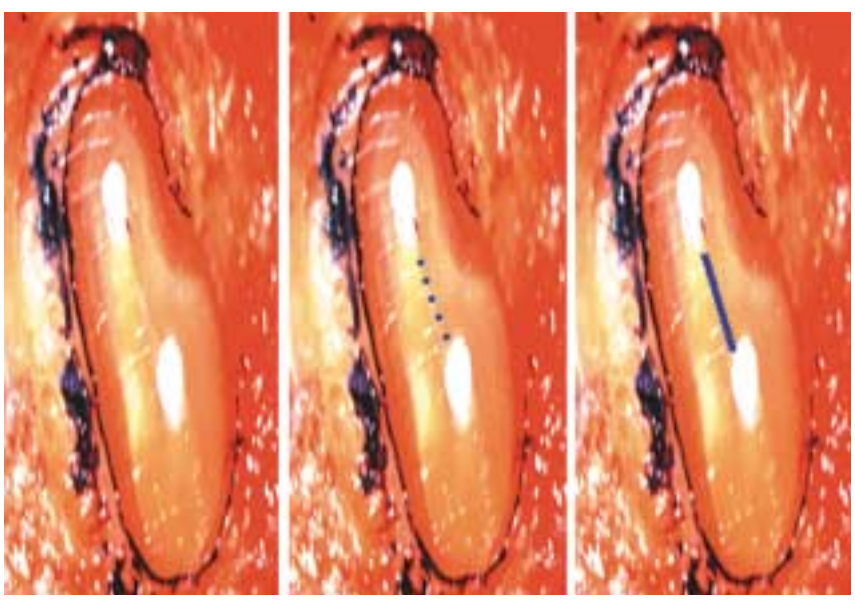

FIGURE 12. The "dot" technique permits easy and accurate preparation of an isthmus in a root end that is very thin.

THE ROLE OF IRRIGATION ON ACCURATE DEBRIDEMENT

Occasionally throughout the root-end preparation process, it is important to use an irrigator to rinse and dry the root-end preparation in order to be sure it is kept within the long axis of the canals and all debris is being removed as planned. Various sizes of micromirrors or an endoscope are used to periodically inspect the preparation and confirm accuracy. A precut and prebent 23-gauge endodontic irrigating needle works well for this purpose. The notched end is removed by rapidly bending one-third of the needle back and forth. The needle inserted into the irrigator is then bent similarly to the ultrasonic tip used for the root-end preparation. Always keep in mind that cleanliness and dryness are essential for good visibility when using the DOM.

Of particular interest is the buccal aspect of the internal wall of the preparation. Dr. Rubinstein was the first to point out that often this area is not debrided due to the angulation of the ultrasonic tip within the canal system during the root-end preparation. If there is some gutta-percha "streaming up" the side of the wall, and the root-end preparation is finished, the best thing is to take a small plugger and fold the gutta-percha coronally so the wall is clean once more. It is usually futile to try to "chase after" the gutta-percha with an ultrasonic tip.

After completion of the root-end preparation, the dentition should be rinsed and dried with the irrigator and inspected using micromirrors and the higher powers of the DOM and/or endoscope to be sure it is clean and within the long axis of the canal system. At this time, the root-end preparation is etched with a blue 39% phosphoric acid gel (Ultradent Products, South Jordan, UT) to remove the smear layer. After 15 seconds, the retropreparation is again thoroughly rinsed and dried (Stropko Irrigator, Vista Dental, Racine, WI) and re-examined under varying powers of the microscope. If all is as desired, the root-end preparation is ready to be filled.

The ideal root-end preparation should be: 1) within the long axis of the canal system, 2) formatted with parallel walls, 3) at least 3 mm in depth (including the isthmus portion of the preparation), 4) adequately extended to include any buccal/lingual variations of the canal system, 5) clean (free of a smear layer), and 6) dry and ready to accept any type root-end filling material.

CONCLUSION

The next issue of ***Endodontic Therapy*** will include Parts V (Retrofill Materials and Techniques) and VI (Sutures, Suturing Techniques, and Healing) of the apical microsurgery technique. ■

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