Predictable apical microsurgery (Part I)

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_Surgery will never replace solid endodontic principles and should always be a last resort. Apical microsurgery consists of nine basic steps that must be completely performed in their proper order so we can achieve the desired result for our efforts.

The nine steps are as follows:

1. Instruments, supplies and equipment are ready.
2. Patient, doctor and assistants positioned ergonomically.
3. Anesthetic and hemostasis staging completed.
4. Incision and atraumatic flap elevation.
5. Atraumatic tissue retraction.
6. Access, root-end bevel (root-end resection, RER, and REB) and crypt management.
7. Root-end procedures: root-end preparation (REP).
8. Root-end fill (REF) techniques and materials.
9. Sutures, healing and post-op care.

Predictable microsurgery requires the use of an operating microscope (OM) and a team committed to operating at the highest level. The six-handed team approach optimizes the instruments, equipment, techniques and materials that today's level of technology presents for the benefit of all — especially the patient!

Dr. Berman, an old retired general surgeon, and one of my senior-year dental school instructors, would begin each general surgery lecture by tapping the lectern with his pencil, and after getting our attention, he would say, "Treat the tissues with tender loving kindness and they will respond in a like manner." I have heard those very words many times while performing apical microsurgery. It is truly a gentle technique when the steps are followed in the proper order.

_Preparation of the patient

A thorough past medical history and dental examination, using as many diagnostic aids as possible, is a requirement for a predictable microsurgical event. Being thorough can also avoid un-

Fig. 1_The six-handed team approach enables us to maximize today's technology today. (Photos provided by Dr. John Stropko)

Fig. 2_The six-handed team creates an environment for ergonomics and the most efficient use of time.

Fig. 1

Fig. 2


Fig. 3


Fig. 4

Fig. 3_Smaller straight Tempur pillow can be used for the neck, lower back or knees to give added support for patient comfort.
Fig. 4_Patient's head and chest are draped and the patient's vital signs are constantly monitored using a Pulsoximeter.

favorable experiences. For example, if the patient, or the physician, states he or she is sensitive or allergic to epinephrine, to any degree, the author highly recommends that apical microsurgery not be performed. One of my golden rules of thumb is, "No epi, no surgery ... Period!" If the doctor chooses to proceed with the microsurgical procedure, it will be exceptionally more difficult for both the doctor and the patient.

The technology that exists today presents us with so much more presurgical information than was available even a few years ago, and the recent advances should be included in the diagnostic process whenever possible. A good example of current technology is cone-beam computed tomography (CBCT). The radiological images we have been using for many years were the best we had, but were very limited. Now, CBCT enables the microsurgeon a view of all angles of areas of concern in the maxillofacial region and supplies much of what was missing in the field of dentistry.[1]

The preparation of the patient not only takes the patient into consideration, but also the entire surgical team. The microsurgical protocol we teach involves four people: the doctor (pilot), the scope assistant with the co-observer oculars for evacuation and retraction (co-pilot), the surgical assistant using the monitor as a visual reference (flight director) and the patient (first-class passenger).

The medical history and all necessary premedications are reviewed with the patient to be sure that the latter are taken at the appropriate times before the surgery appointment. The patient is also instructed to rinse with Peridex and take an anti-inflammatory (preferably 600 mg of Motrin, if no allergies are present) the night before and also on the morning of the surgery. At the time of the appointment and before the patient is seated, he or she is once again asked to rinse with Peridex. The dental chair should allow the patient to recline comfortably and even allow the patient to turn to one side or another. Small Tempur pillows placed beneath the patient's neck, small of the back or knees make a big difference when used.

After the patient is completely comfortable in the chair, he or she is coached on how to make slow and small movements of the head, if necessary during surgery. The patient is appropriately draped for the surgery. It is especially important to wrap a sterile surgical towel around the head and over the patient's eyes for protection from the bright light of the microscope and any debris from the surgical procedure.

An important psychological point is being sure to not tell the patient he or she "can't move"! To an already tense patient, saying "don't move" would probably cause unnecessary apprehension, stress or panic. In more than 500 surgeries, I've only had one patient who didn't hold nice and still during the procedure once he was relaxed and had profound anesthesia.

Now is the time for the surgical team to get comfortable with the position of the patient, the microscope, endoscope and associated equipment. Modern OMs have many features to enhance comfort and proficiency during their use. Accessories like beam splitters, inclinable optics, extenders, power focus and zoom, variable lighting and focal length, etc., all contribute to ease of use, ergonomics and proficiency for the entire surgical team. The mutual comfort of the patient, the surgical assistants and the doctor is of the utmost importance. The microsurgical technique may take an hour or more, so unnecessary movements or adjustments for comfort's sake during the operation may cause considerable inconvenience.

The doctor's surgical stool must have adjustable arms to allow the elbows to support the back and serve as a reference point, or fulcrum, if the doctor has to reach for an instrument during

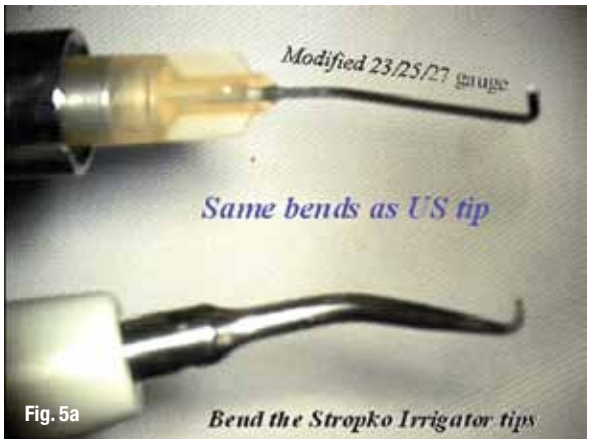

Fig. 5a


Fig. 5b

Fig. 5a_Modified Monoject needle bent similar to the ultrasonic tip used for the REP.

Fig. 5b_Set of three Stropko Irrigators with a variety of tips in place for possible use during the surgical procedure.

the procedure. Ideally, neither the doctor nor the scope assistant have to remove their eyes from the oculars of the OM during the entire operation. The task of directing the whole operation belongs to the second surgical assistant. The second surgical assistant is the choreographer for the procedures that take place with the OM. He or she is in a position to observe, coach and/or pass instruments to either the doctor or the scope assistant. The second surgical assistant can see the entire surgical environment and is the only one on the team who has an overview, to keep track of everyone's needs. It is important that all possible surgical instruments are organized for ease of access during the operation.

While the anesthesia is getting profound, this is a perfect time to modify the needles that will be placed into the tips of the Stropko Irrigators (*www.stropko.com*) for use during the surgery. The notched ends of 25 gauge Monoject Endodontic irrigating needles (SybronDental) are removed by bending with Howe Pliers and placed into the end of the Stropko Irrigators.

One tip is used with an air/water syringe and the other tip is used on the dedicated "air-only" syringe (DCI). The endodontic irrigating needles are then bent in the same configuration as the ultrasonic tip that is being used for the root-end preparation. After the needle is bent, the ergonomics of the bend can be verified quickly and easily because the patient is in the proper position and so is the doctor. Optimally, there are three Stropko Irrigators available for any surgical procedure: one three-way syringe fitted with a larger blue tip (Sybron Endo) for more general flushing of the surgical area (we call it the "Big John"); another three-way syringe fitted with a modified 25-gauge needle for more precise cleaning and drying ("Little John"); and one with an "air-only" syringe, fitted with a modified 25-gauge needle, for precise and dependable drying of the specific area without worry of moisture contamination.

Also, because the lumen of the high-speed evacuator tips (Young's Surgical) is small, be sure to have extra tips readily available if one should become clogged. A beaker of water should be available so the scope assistant can occasionally clear the evacuator system of blood and tissue debris from the evacuator tip.

After topical anesthetic is placed, local anesthesia is started using less than one carpule of warmed 2 percent lidocaine containing 1:50,000 epinephrine. This small amount is done to anesthetize the injection sites that will be used next for the blocks and infiltrations. The 1:50,000 lidocaine is used prior to the 0.5 percent bupivacaine (Marcaine) because the Marcaine tends to burn upon injection, whereas the lidocaine is much friendlier to the patient. This is then followed with one or two 1.8 cc carpules of warmed Marcaine for nerve blocks and/or infiltrations. All anesthetic is warmed and injected very slowly to avoid any unnecessary trauma to the tissue, which also creates much less discomfort for the patient.

After the completion of administering the local anesthetics, it is time to perform hemostasis staging using 2 percent lidocaine containing 1:50,000 epinephrine. It has been shown that 2 percent lidocaine containing 1:50,000 epinephrine produces more than a 50 percent improvement in hemostasis compared to 2 percent lidocaine containing 1:100,000 epinephrine.[2]

While keeping the bevel of the needle toward the bone and directed apically toward the root ends, small amounts of 2 percent lidocaine 1:50,000 are slowly injected into the free gingival tissue in two or three sites to the buccal of each tooth (MB, B, DB), approximately 3 mm apical to the muco-gingival line. Slow injection of just a few drops of the anesthetic causes a slight "ballooning" and blanching of the tissue in the immediate area. This is an important step because it causes the muco-gingival line to become more pronounced, allowing the operator to have better vision, resulting in more accuracy with the following hemostasis injections.

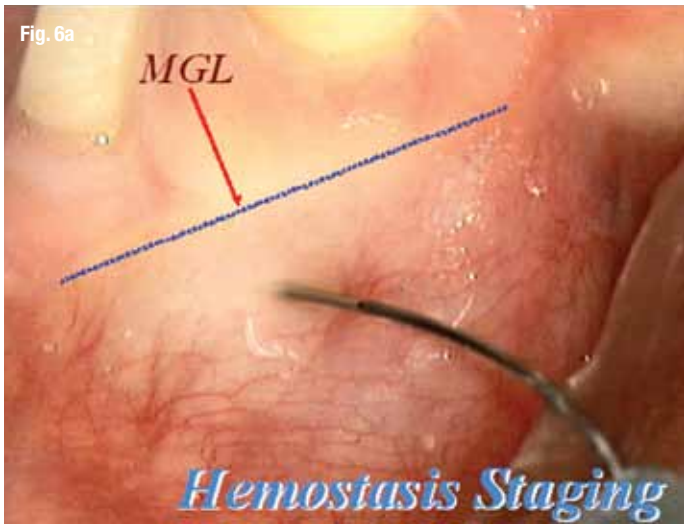

Fig. 6a_Due to the ballooning and blanching effect, the muco-gingival line becomes more pronounced during the hemostasis staging injections.
Fig. 6b_When the buccal portion of the hemostasis staging is complete, the operator can easily plan the incision.

As the anatomy of the tissue unfolds during the injections, the operator should begin visualizing and planning the incision. The amount and nature of the attached gingiva is an important consideration whether a full sulcular or a mucogingival (Leubke-Oshenbein) flap is used. In general, a full thickness, sulcular flap is routinely used unless esthetics is a concern and there is an adequate zone of attached gingiva present. To ensure optimum hemostasis, the lingual tissues should also be infiltrated.

If doing surgery on the posterior quadrant of the mandible, special attention should be given to the apical region of the mandibular second molar. On occasion, a small foramen, called the foramen coli, may be present. The foramen coli, if present, contains an ascending branch of the mylohyoid nerve. This added step, "lingual hemostasis staging," can contribute to more profound anesthesia, enhance crypt management, and, as a result, contribute to a more predictable event with less stress for the entire team.

If the surgery is to be performed on the maxillary, the patient is instructed to close on approximately eight layers of sterile gauze, (four 2x2s folded over once) for stability of the jaws and to keep any debris from inadvertently entering the oral cavity. A single piece of a sterile 2x2 is also gently placed distal of the tooth/teeth to be operated on. If the surgical procedure is on the mandible, especially when a full sulcular flap is used, the operator may want to make the incision with the mouth slightly open before placing the gauze.

In either case, with the aid of the OM and using a pre-filled 3 ml. syringe fitted with a 20-gauge needle, the entire surgical site is rinsed with Peridex to make sure the area is clean of debris and free of plaque before the incision is made. The surgical site is now ready for the next important step in the procedure: Flap design, the incision and atraumatic flap elevation.

_The incision and atraumatic flap elevation

Using a disposable CK2 microsurgical blade (SybronEndo), the incision is made. With the smaller size of this blade, very accurate incisions can be made that have a cleaner cut than those of the much larger BP #15 or BP #15S blade. As the incision is being made, the operator needs to visualize the suturing process.

Sometimes just a small variation in the design of the incision can make a big difference in the ability to achieve easier and less traumatic closure of the surgical flap. In general, the surgeon is working with relatively healthy tissue and no attempt should be made to remove or alter the periodontium. This is especially applicable when making a full sulcular flap.

All flaps are full thickness and the incision must be complete, so there is no inadvertent tearing upon retraction of the flap. The split thickness flap is to be avoided, as it is the most traumatic and healing is compromised. The periosteum does not survive the flap reflection procedure. It has been postulated that depolymerized periosteal collagen plays a role in rapid reattachment of the flapped tissues to cortical bone.[4] In general, all flaps should be extended, at a minimum, to the mesial of the second tooth anterior to the apex of the root being surgerized.

The flap design differs depending on the integrity of the bone over the roots, the amount and nature of the attached gingival tissue, the anatomy of the jaw and the absence or presence of fixed dental appliances.

Basically, there are two flap designs: triangular (one releasing incision) and rectangular (two releasing incisions). They are normally either a full sulcular flap, or a mucogingival flap, depending on the location and situation. In general, the longer

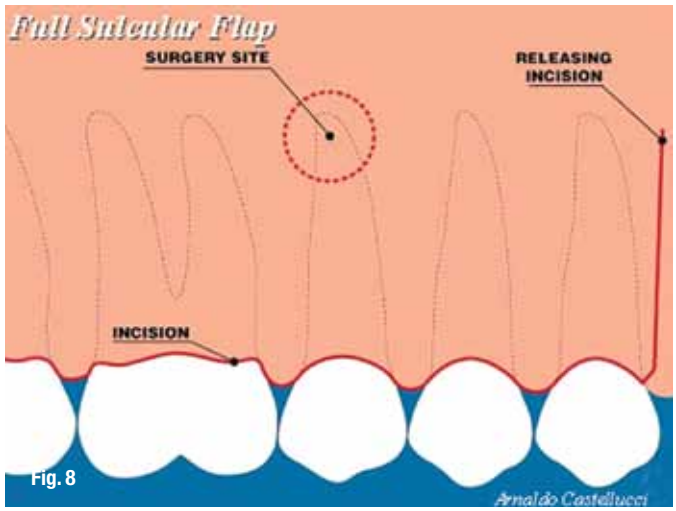

Fig. 7_Rinsing the entire surgical site with Peridex.
Fig. 8_The full sulcular flap.

the length of the flap, the easier it is to control, and it has no effect on the healing process.

The full sulcular flap:

This design is routinely used in all posterior quadrants. The full sulcular flap should be used in the anterior if there is a thin zone of attached gingival tissue or there is a concern about the possibility of a dehiscence over the root of the tooth being operated on.

The incision is made through the gingival crest, following the curvature around the cervical of the teeth involved in the surgical area. The operator should attempt to incise the tissue through the crest of gingival to the osseous crest of bone, leaving the healthy gingival attachment intact. The advantage of the full sulcular flap is the ability of the operator to easily visualize the "emergence form" of the involved teeth.

The Leubke-Ochsenbein or Mucogingival Flap:

This flap is used only when there is an adequate amount of attached gingival tissue present and the periodontal probing is within normal limits. The incision design should be scalloping in nature and generally follows the architecture of the teeth, which allows for easy repositioning upon completion of the apical microsurgical procedures.

All releasing incisions are made parallel to the long axis of the teeth. This is important because the blood supply to the area is also parallel to the long axis. If a "wide base" type flap is made, the blood supply to the tissue adjacent to the flap is compromised and healing may not be as predictable and uneventful. The reflection of the flap is accomplished using the Molt, or Ruddle R or Ruddle L (SybronEndo) periosteal elevators. The working end of the instrument is gently inserted into the releasing incision, line into the free gingival tissue apical to the mucogingival attachment, and as far apically as the incision and bony contours will gently permit.

The instrument is manipulated in a gentle apical-to-coronal movement within the unattached gingival portion of the flap. Maintaining the same motion, the instrument is moved slowly toward the same apical position at the more distal extent of the flap. The working end of the elevator should be sharp so the reflection will be a "dissecting" process, so crushing or tearing of the tissue is avoided. Occasionally, especially in the posterior quadrants of the mandible, the mucogingival line will clinically seem to be firmly attached to a microscopic boney ridge. The attached tissue must be gently dissected from it.

Once the mesial few millimeters are elevated, the rest will generally "peel away" without much effort at all and easily release from the osseous surface. The time spent initially, to gently free the attached gingiva, will be rewarded by a more uneventful healing process.

This atraumatic elevation and reflection of the flap is a major contributor to the rapid healing response routinely observed only 24 hours postoperatively. It is important the approximating surfaces of the flap are never touched after the incision is completed, so there are no crushing injuries to inhibit or retard the healing process. An instrument such as the old wax spatula-shaped periosteal elevator has no place in the armamentarium of the endodontic micro surgeon.

Once the flap is gently and cleanly reflected, any "tissue tags" should be left intact, as they will aid in the healing process. It is not necessary to clean the flap and exposed bone because these efforts are time consuming, could be traumatic to both the hard and soft tissue, and ultimately compromise the healing process.

The retraction of the flap must also be accomplished in a gentle and atraumatic manner. The

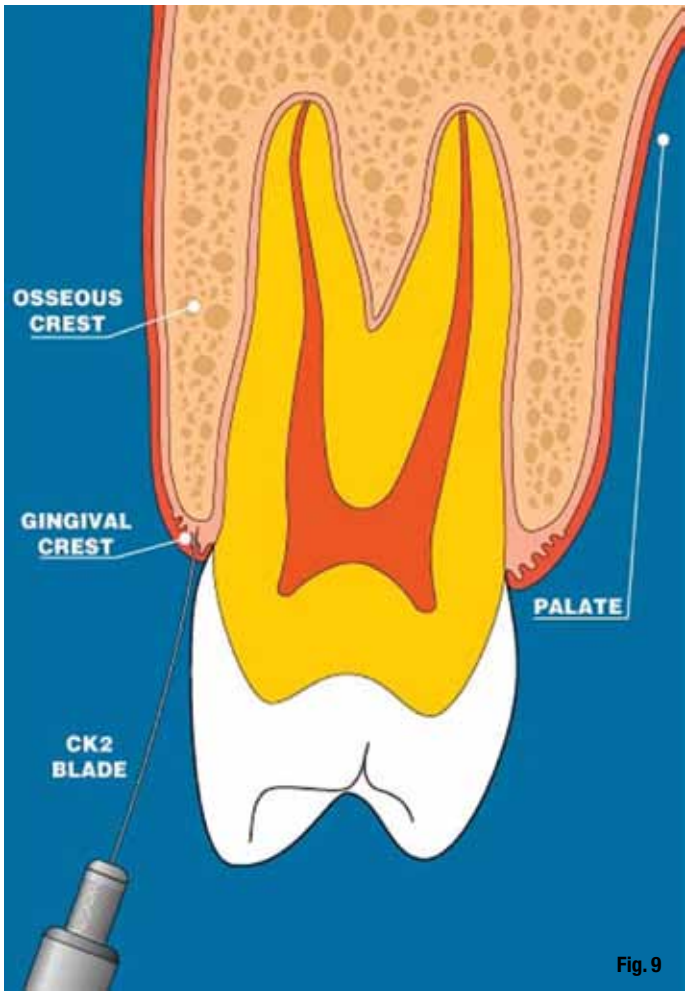

Fig. 9

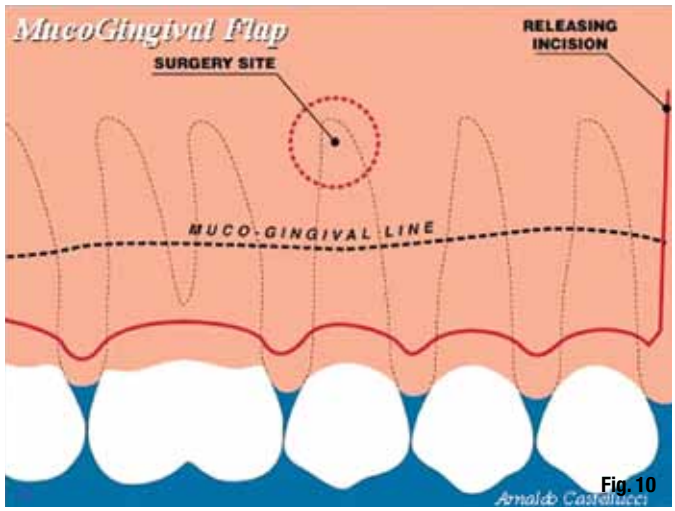

Fig. 10


Fig. 11

most common cause of postoperative pain and swelling arises from impingement of the tissue during the retraction process. The surgeon has to constantly monitor the end of the retractor to make sure there is no inadvertent impingement on the flap. This is when the "scope assistant" is most helpful because he or she is observing the surgical site with a different set of eyes! An effective way to achieve atraumatic retraction is to prepare a groove in the cortical plate of the bone, well apical to the anticipated access to the root-end.

A surgical length #8 round bur, on a high speed Innovator handpiece (SybronEndo), is used to make the groove. A high-speed handpiece that has air escaping from the working end should never be used because of the danger of air embolism. The "groove" creates a definite place for the retractor instrument to seat into and is easily maintained in position, by either the doctor or the assistant, and eliminates the problem of inadvertently slipping during the surgery. Impingement of the tissue is also more predictably avoided by using a groove to hold the retractor.

Retraction can be accomplished using either the Carr or Rubinstein Retractors; however, there are many styles of retractors to choose from. The retractor is chosen that will best maintain clear visibility to the surgical area and is comfortable for the operator.

After the flap is retracted and if there is any tension on the flap, the vertical releasing incision can be extended, or an additional "releasing incision" at the opposite side of the flap can be considered. The releasing incision is usually very minimal, only 3–4 mm long, and many times does not require suturing.

It is imperative the operator keeps in mind there should be no tension or stretching of the tissues. One should not hesitate to extend or modify the incision to eliminate tension on the tissues. When there is tension, there is usually an opportunity for crushing or ischemia of the tissue and a resultant delay in the healing process. Generally speaking, the larger the flap, the easier it is to maintain atraumatically during the surgical procedure.

It is important the tissues and osseous surface must be kept as moist as possible during the entire procedure. This can be accomplished with a fine stream of water from the Stropko irrigator (*www.stropko.com*).

Fig. 9_The incision ideally preserves the healthy periodontal attachment.
Fig. 10_The Leubke-Ochsenbein Flap, or Mucogingival Flap, is used when cosmetics are a concern and there is an adequate zone of attached gingiva.
Fig. 11_The Molt, or Ruddle elevators, are inserted into the vertical releasing incision to begin the atraumatic flap elevation.


Fig. 12


Fig. 13

Fig. 12_The most common cause of postoperative pain is tissue impingement by the retractor.
Fig. 13_Rubenstein retractor placed into the prepared groove.
Fig. 14_ An adequate amount of crestal bone should remain between osseous crest and the coronal extent of the crypt.

_Access and crypt management

As was mentioned earlier, 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 do properly. The operation will develop into a stressful experience for the patient, the staff and the clinician with an end result not as desirable or predictable.

If all of the steps are completed as outlined, all procedures can be performed without stress, and a favorable post-operative result can be expected. I have completed hundreds of apical microsurgical operations and all results were the same with just a few exceptions. The technique is very gentle and predictable, if all of the steps are followed without compromise.

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

How much bone exists on the buccal aspect of the root undergoing surgery?

If there is total dehiscence, guided tissue regeneration has to be considered. Ideally, there should be at least 3–4 mm of healthy, intact crestal buccal bone remaining after the access preparation is completed (Fig. 14).

How much of the apex can be beveled or resected?

Usually, there is an adequate amount of root length to work with. The shorter the root, the more conservative the operator will have to be when beveling, and the closer the bevel should be to 0 degrees so less removal of the root end is possible.

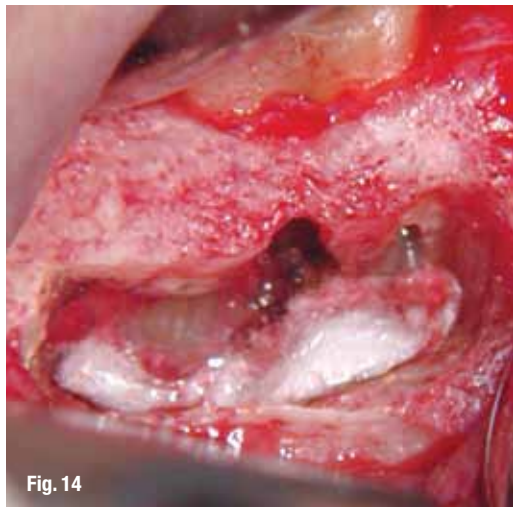
Fig. 14

If an exceptionally long post is present, that 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 operating microscope (OM), and/or the Endoscope (JedMed), allows the operator the luxury of being ultra-conservative when necessary.

The access to the root end is done most effectively with a high-speed handpiece that has no air exiting the working end (Fig. 15a). The usual air-driven handpiece does have air at the working end and using it could result in an air embolism. It is important to use as much water coolant as vision will permit to maintain the moisture in the tissues. Using a fine stream of water from the Stropko Irrigator fitted with a 27-gauge needle, the scope assistant can keep the area moist and evacuate excess fluids at the same time. The initial access and apiection can be accomplished with just three

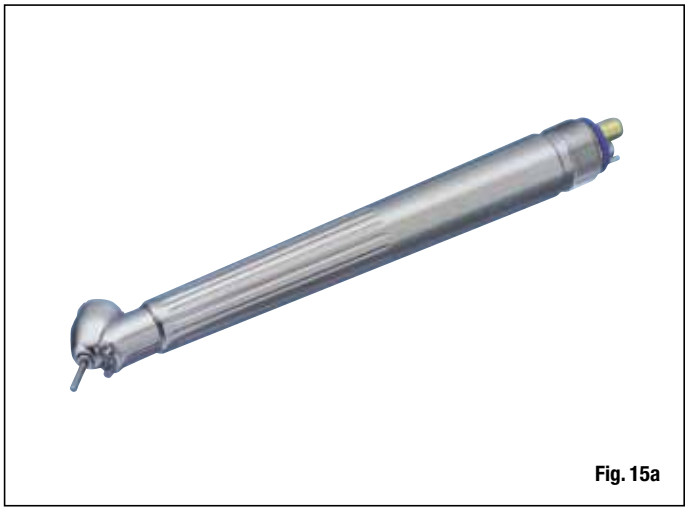

Fig. 15a

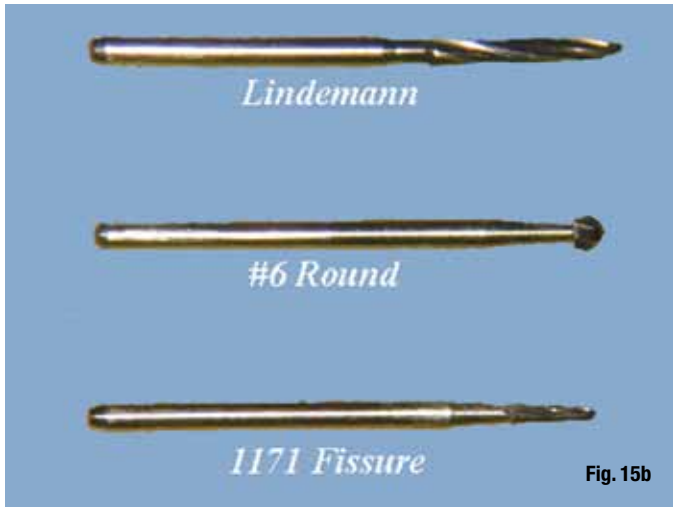

Fig. 15b

surgical length burs: the Lindemann bone bur, a #6 round bur and an 1171 fissure bur (Fig. 15b).

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 curretted out and the access is more or less complete.

2. A more accurate procedure is to 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 and can be apiected at this time. Often, especially with larger periapical involvement, the lesion can 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.

A thorough curettage is important because it is the first stage of achieving hemostasis from within the crypt. In general, if all of the granulation tissue is removed, the amount of hemorrhage will be greatly reduced, the management of the crypt is easier to accomplish and good visibility can be restored. This technique takes more time but results in better visibility and the ability to be more precise with the initial apiection. The finished bevel will be discussed in detail later.

In general, a biopsy should be performed on all tissue removed from the body. We are usually quite confident of the pathological diagnosis of the LEO, but my feeling is even if the odds are 1 in 100,000 that we are incorrect, no chances should be taken and a biopsy should be taken on a routine basis.

The final dimension of the access opening varies and is dependent on several factors:

- The size and position of the lesion. If the lesion is larger, the access will of necessity be larger in order to perform a complete curettage.
- The position of the apex determines the size of the access. The more lingual the apex, the more overlying bone has to be removed and the larger the access has to be for good visibility.
- 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.
- The thickness of overlying bone is also important. If the buccal plate is thick, a wider access is necessary to eliminate a "tunnel effect" so vision is not compromised.

The experience and ability of the surgeon, and equipment available, is a great determinant on how large the access will need to be. I use both an Endoscope and the OM when performing apical microsurgery. On some occasions, the Endoscope permits a better view of the surgical site due to increased lighting and magnification. It also increases the ability to view previously difficult, and sometimes impossible, areas to see with the OM. The extent of a defect 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.

The management of the crypt is one of the most important steps, 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 (Monsels Solution, Cutrol), calcium sulfate (Capset, SurgiPlaster), Telfa pads and epinephrine-soaked pellets (Epidry from Pascal) are the most com-

Fig. 15a_The Impact Air surgical handpiece.**34**
Fig. 15b_The three surgical burs.


Fig. 16

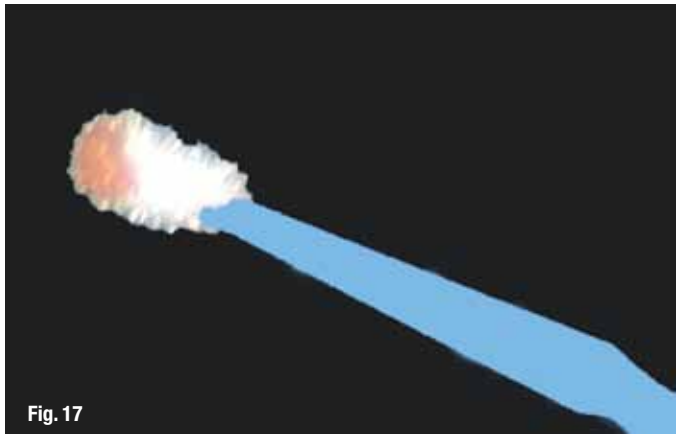
Fig. 17

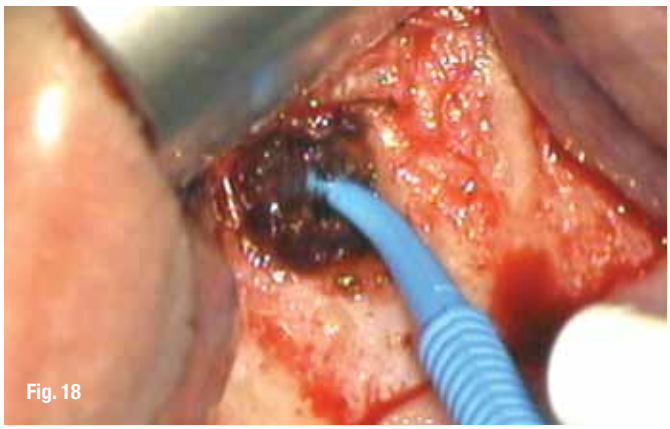
Fig. 18

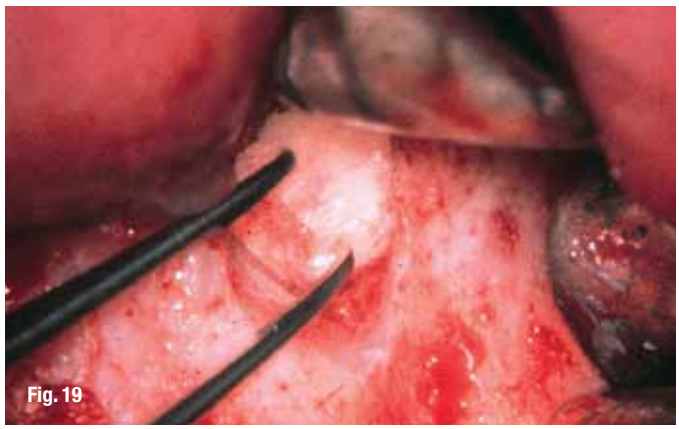
Fig. 19

Fig. 16_A slightly 'streaked' piece of Telfa pad to be placed against the bony floor of the crypt.
Fig. 17_Only a small amount of ferric sulfate is used on the micro applicator.
Fig. 18_ A brownish-black coagulum is formed when the ferric sulfate contacts blood.
Fig. 19_The Telfa pad should be replaced, as necessary, to maintain good light reflection in the crypt.

monly used and effective agents for this purpose.

After all granulation tissue and other debris have been thoroughly removed from the crypt, hemostasis is often achieved as a result of proper "hemostasis staging injections" discussed previously. If that is the case, only an appropriately sized piece of Telfa pad lining the floor of the crypt is necessary to enhance lighting. However, this is not always the case and even slight bleeding must be addressed.

If the crypt exhibits slight hemorrhaging, the tissue surface or piece of Telfa trimmed to the correct size to fit can be lightly streaked with Monsels Solution and pressed into the floor of the crypt for a short period of time until the hemorrhaging is controlled (Fig. 16).

If there is moderate hemorrhaging, the Monsels Solution is carefully applied with a micro applicator (Ultradent) directly to the problem area in the floor of the crypt. Keep in mind that only a small amount is necessary (Fig. 17).

When ferric sulfate is used to achieve hemostasis, a thick brownish-black coagulum will usually result (Fig. 18). The resultant coagulum can be easily removed from the crypt with a clean Microapplicator (Ultradent), gently flushed with water using a larger tip on a Stropko Irrigator as the assistant is evacuating any debris during irrigation of the crypt. The process is repeated until the bleeding is controlled. 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 vision.

As long as the coagulum resulting from the use of Monsels Solution has been cleaned out of the crypt after the completion of the surgery, its use has not been shown to affect the healing process.[5]

Caution: All forms of ferric sulfate must be kept well within the confines of the crypt. It has an extremely low pH and will instantly chemically cauterize anything it touches. The buccal plate of bone, the periosteum, soft tissue and the Schenideran membrane should always be avoided! It is important to keep in mind that "If a little bit is good, a lot is not better!" Use only small amounts on the end of an applicator because a small amount goes a long way (Fig. 17).

Note: There are two popular forms of ferric sulfate: Monsels Solution has a concentration of 72 percent and Cutrol is 53 percent. I like the Monsels Solution because it is very effective, readily available and less costly to use.

On a few occasions, severe hemorrhaging occurs. This can be a result of inflammation, a severed interdental 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! The first thing to do is to apply pressure over the crypt with a finger. This will stop the hemorrhaging long enough to calmly prepare the next few steps. In a low and controlled voice, instruct the assistant to insert a bigger tip into the evacuator and hold it close to the crypt. If after removing your finger, the hemorrhaging has not subsided, quickly replace your finger over the crypt as before.

It is a good idea at this time to take a radiograph and clinically re-evaluate the surgical area to make sure no unforeseen anatomical structures (mandibular canal, palatine artery, etc.) have been infringed upon.

Now have your assistant 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 Monsels Solution and insert into the crypt, holding it firmly in place with your finger for a minute of so.

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. The above technique has worked all three times I found myself in that situation. In two of my cases, an interdental artery was the cause and the other was highly inflamed granulation tissue remaining in the crypt.

If hemorrhaging occurs on the surface of the exposed buccal plate, a Touch and Heat (SybronEndo) can be used. The scope assistant can evacuate the "bleeder" with a small surgical tip, so its exact source can be determined, and the Touch and Heat can be used to effectively cauterize it. After the 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 (Fig. 19). Keep in mind when using the OM 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.

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

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_about the author roots

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