Non-surgical root canal treatment can be a highly successful procedure if all the criteria for success are accomplished. Even unresolved periradicular lesions should heal with retreatment over 70-80% of the time. However, there are situations when periapical surgery is the treatment of choice. They are, and not limited to:

1) Retreatment option has been exhausted. (Persistent symptomatic cases or non-healing lesions.
2) The choice of retreatment is not possible due to unmovable post, or patient’s wish not to access through or disassemble full coverage restorations.
3) Complex root anatomy.
4) Incomplete apical development or root resorption.
5) Iatrogenic materials left in the root canal (ex: separated file) or grossly overextended filling material.
6) Iatrogenic procedures preventing ideal root canal treatment (ex: transportation, perforation, ledges, blockages).
7) Refractory lesions and need for biopsy
8) Suspicions of a fracture.

Apico surgery (apicoectomy and retrofilling) has always had a negative image, most likely due to its invasive nature as well as its poor success rate. Since we are operating in a very restricted and diminutive space, we were making it difficult for ourselves with instruments too large and magnification too insufficient. Operators had to make the osteotomy site larger for access of mirrors or direct visualization, and as a result, patients had increased post-operative pain. Larger osteotomy sites resulted in more endo-perio lesion failures (Figure 1). Beveling of the root had to be at a 45 degree angle in order for direct visualization or mirror reflection. (Figure 2) At times where visualization was not possible, we had to use tactile sensation and knowledge of root canal anatomy to resect, inspect, retroprep and retrofill. Because of this, failure rates and recurrence of infection were high, and patients ended up needing another apico surgery or resulted in losing the tooth. Failures were high also in part to the inability of the operator to visualize microfractures. Extracted teeth from failed surgeries showed that clinicians could not predictably locate, inspect, and treat the apical segment with the techniques traditionally used.

In this past decade, many advances have changed the way we approach and perform surgery. As a result, enhanced illumination and magnification as well as the miniaturization of our armamentarium have now properly dubbed apico surgery as endodontic microsurgery.

The greatest advancement in microsurgery is the use of the operating microscope (OM). The OM has been used in various fields of medicine where precision is required in a delicate working field, such as otolaryngology, ophthalmology, and neuro- and vascular surgery. It was just a matter of time that dentistry would embrace the technology. The coaxial lighting and improved optics of the OM provide better distinction between bone and tooth structure. Structures that are barely visible to the naked eye or loupes become more evident with the
Root–End Filling Materials: As our armamentarium evolved, so did the retrosealing materials. The retrofill seal could be arguably debated as the most important step, since it prevents bacteria and its byproducts from passing into the canal. It should be biocompatible with the body and resist breakdown by tissue fluids. For decades, amalgam had been the standard of choice. However we now know it is considered an inappropriate root end filling material due to its corrosive and leaking properties. (Long term, how often have you seen an amalgam tattoo develop from periapical surgery?) Over the years, composite, ZOE, and eventually Super-EBA surpassed each other in its sealing abilities. Although Super-EBA studies show superiority over all the others, it still comes a distant second to Mineral Trioxide Aggregate (MTA). MTA, basically a tri-calcium compound, meets most of the criteria for an excellent retrofill material. Histologic studies have even shown cementum regeneration over the MTA retrofill.

Long gone is the notion that apical surgery is just a procedure that cuts off the root tip and places a big enough filling to cover the resected root surface. Through the advent of the microscope, we now know that microendodontic surgery involves sealing all portals of exit, removing the offending agents, and stimulating the periradicular tissues to regenerate.

Fortunately, microendodontic surgery has become more predictable. This has resulted in a better understanding of the apical anatomy, better surgical and resection techniques, better patient response, and greater treatment success.

- by Timothy Lin, DMD

References:
1) Microsurgery in Endodontics, Saunders Company. Kim, et. al.
2) Advances in Endodontic Surgery - AAE Spring/Summer 2003

*Some photos courtesy of Dr. Syngcuk Kim and the University of Pennsylvania, Department of Endodontics.

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>TRADITIONAL SURGERY</th>
<th>MICROSURGERY</th>
</tr>
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<tbody>
<tr>
<td>Identification of the apex</td>
<td>Difficult</td>
<td>Precise</td>
</tr>
<tr>
<td>Osteotomy</td>
<td>Large (10 mm)</td>
<td>Small (&lt;5mm)</td>
</tr>
<tr>
<td>Root surface inspection</td>
<td>None</td>
<td>Always</td>
</tr>
<tr>
<td>Bevel angle</td>
<td>Large (45 degrees)</td>
<td>Small (&lt;10mm)</td>
</tr>
<tr>
<td>Isthmus identification</td>
<td>Nearly impossible</td>
<td>Easy</td>
</tr>
<tr>
<td>Retropreparation</td>
<td>Approximate</td>
<td>Precise</td>
</tr>
<tr>
<td>Root end filling</td>
<td>Imprecise</td>
<td>Precise</td>
</tr>
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The endodontic access for maxillary central incisors is that of a rounded triangle. For maxillary lateral incisors, the access is ovoid. For mandibular incisors, the access is also ovoid. One of the goals of endodontic treatment is to achieve straight line access, to ensure proper cleaning and shaping. However, straight line access would mean accessing either through the incisal edge or sometimes from the buccal. Due to esthetic purposes, we access from the lingual above the cingulum and sacrifice some of the lingual dentin under the access. We then use a round bur to remove pulp tissue from the pulp horns by sweeping out toward the incisal edge.

In cases of trauma, there are two leading theories as to why teeth discolor. When a pulp degenerates, the resultant necrotic tissue releases various protein degradation products to create the grayish-black discoloration. Another theory states that when the red blood cells undergo hemolysis and emit hemoglobin, the hemoglobin further degrades, releasing iron. The iron combines with hydrogen sulfide to become iron sulfide, which forms a black compound color. Often, visualization with an operating microscope will often show residual pulp tissue and/or deeply stained dentin remaining after the access is made, especially coronal to the incisal access. Other than pulp necrosis, the most frequent cause of discoloration is poorly executed root canal therapy, primarily the failure to remove all pulp remnants. This proposes a challenge for successful long term internal bleaching. However, to excessively widen the access with a round bur to remove the pulpal remnants would remove more tooth structure and weaken the tooth. Throw in a traumatized tooth with longer and wider pulp horns and you may end up widening the access closer to the incisal and interproximal edges. I find the round burs unable to reach up into and behind the incisal access area. I ultimately widen or elongate the access preparation to do so. (Figure 1.)

What I am proposing is to still make a normal access preparation with a bur, and finish with the use of an ultrasonic, such as a surgical ultrasonic tip with a water port. The anterior apicoectomy surgery tips like the SJ-1 tip or the Enac Osada anterior tip are good. What I found to be better are the KiS #1 or #2 tip (by Obtura Spartan, which fits their ultrasonic unit, Spartan MTS) or the ProUltra

**Helpful Tip:**

**A Modified Endodontic Access for Anterior Teeth**

**Fig 1.**

A. Maxillary incisor with normal size pulp chamber and normal access preparation.
B. Larger than normal pulp chamber or traumatized pulp tissue would require an unwanted larger access.
C. Proximal view of access. Note the dotted line showing an increased access preparation if longer pulp horns or pulp byproducts were to extend further.
D. Surgical ultrasonic tip removing the pulp tissue behind a normal access.
Surgical Tip #1 or #2 (by Tulsa Dental, which fits their ultrasonic unit, Satelec P5). (Figure 2.)
Both brands are really the same surgical tips and are compatible with each other's ultrasonic unit. They have a 90 degree angle with a 3-4 mm tip. These tips are able to reach behind the incisal and interproximal access area. I make my typical access. (Figure 3)
I then use the anterior surgical tip with water. I am literally creating a retention groove as well as preserving tooth structure. The jet stream water vent flushes the debris away quite nicely, and more efficiently than any irrigation syringe.

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Fig. 2. KiS surgical tip #2.

Fig. 3. Pulp tissue remnants behind the incisal access area. (Note: a smaller access was made for this photograph to make the pulp tissue visible.)