ROOT CANAL TREATMENT: A CLINICAL GUIDE FOR DENTAL STUDENTS, GENERAL DENTISTS WHO LIKE DOING RCTS AND GENERAL DENTISTS WHO HATE DOING RCTS ©2016

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This document is intended to be an easy-to-read guide for dental students and general practitioners of different clinical capacity who seek to improve their root canal treatment skills and obtain a more consistently predictable outcome in their everyday practice. Doing a root canal treatment (RCT), for the most part, is not a complicated task and the procedure should become easier and more systematic as the clinician gains more experience. There are, however, different components of development in becoming a more skilled clinician, and becoming technically good is only one aspect of it. In order to be truly proficient in this field, a clinician must also improve his/her diagnostic skills and understanding of its biological principles. This guide is divided into different topics and subtopics which are deemed important for understanding of those fundamental endodontic principles.

DIAGNOSIS

Good diagnostic skills are undeniably important for better management of endodontic cases. Day in and day out, we see a whole slew of errors associated poor diagnosis, whether it be prescribing wrong medications or treatment-planning for a wrong procedure. The importance of this first step of treatment can't be stressed enough. Starting out with a good diagnosis at the onset can really spare the dentist of unnecessary headaches during follow-up phase. For the purpose of this guide, different pulpal and periapical diagnoses are not going to be discussed comprehensively, but some of the **most common errors** associated with either doing an erroneous diagnosis or NO diagnosis deserve a discussion here.

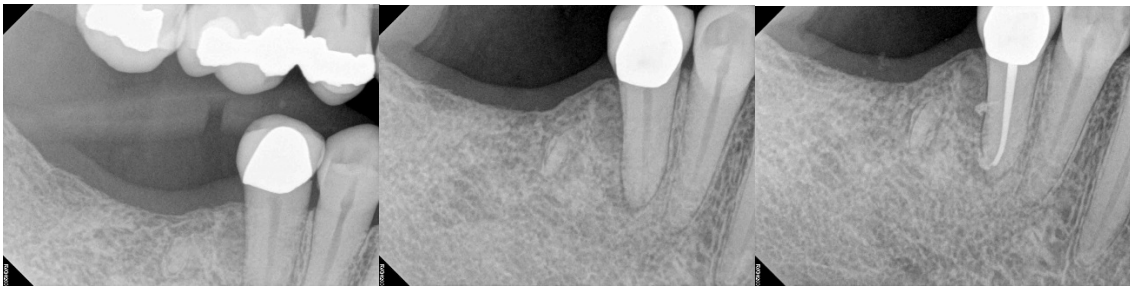
- *Prescribing Antibiotics for Pulpitis*

  Pulpitis by definition is an inflammation of the pulp tissue and could be exceedingly painful under acute inflammatory conditions. For pain relief, either this inflamed pulp tissue needs to be removed or the tooth needs to be removed. When the pulp is still vital and inflamed (note: blood upon access opening), taking antibiotics actually does nothing for pain relief and only adds the hassle of having to take medications for multiple days for an already distressed patient. In my office, I have seen a patient given antibiotics for pulpitis, and when symptoms did not improve, she was administered to the ER and given even higher dosage of IV antibiotics. This would be a hard-to-defend case if she decided to see you at the court. **For antibiotics to be effective at reducing symptoms, the pulp must be necrotic and infected for the most part (note: absence of blood upon entering pulp space).** Now, it should be noted that

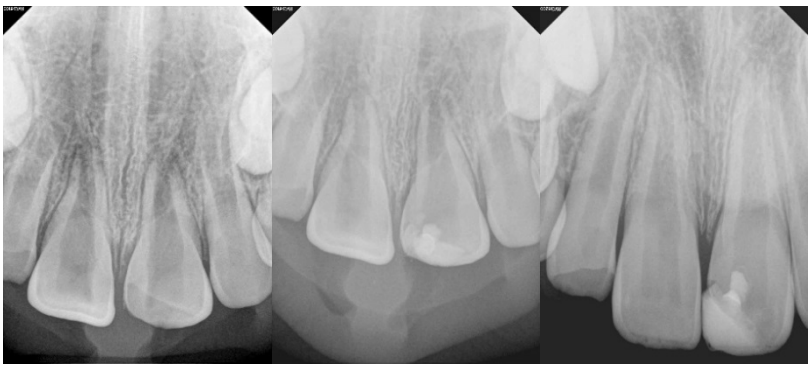
percussion sensitivity could present with both vital and non-vital pulp. But, in general, the cases where antibiotics can work for pain relief do not respond to thermal stimuli (endo ice, hot coffee, etc.) but instead display marked percussion sensitivity that can be localized well by the patient. Tenderness of soft tissue in the vestibule near the apices of the associated tooth may be present as well. On the other hand, if a patient's chief complaint is experiencing severe pain upon drinking something cold or hot, do not give that patient antibiotics for the purpose of addressing that chief complaint. At least do a pulpotomy if you have time, or find an endodontist who can provide an emergency treatment for you. **Another key indication of pulpitis, other than pain on thermal stimulus, is a type of pain that seems to jump around and cannot be localized well by the patient. Pulpitis cannot be localized well by the patient because there are no significant proprioceptive nerve fibers in the pulp.** Be sure to do a thorough diagnosis as many patients will present with a tooth that is necrotic and infected but will also complain of thermal sensitivity from adjacent vital teeth as well. The key is to address the tooth that is the main cause of acute symptoms (targeting the chief complaint).

- *Not Instrumenting the Canals for a Necrotic Tooth with Infected Root Canals*

  This is another error commonly encountered. When pulpal inflammation progresses and the pulp becomes necrotic, full instrumentation of the canals is required to eliminate the infection and reduce symptoms. A necrotic tooth has infection in the canals, the most common cause of which is bacterial insult from caries. These patients can present with swollen gums and/or face. Instrumenting to at least size 30/04 with a good amount of sodium hypochlorite irrigation is recommended. Otherwise, give the patient antibiotics (or you can do both) and the patient will typically see relief of symptoms within a day or two.



Before initiating this treatment, I asked myself the following questions—why is there a lesion on mid-distal part of the root? Is there a root fracture? Is there a localized deep probing depth in this area? If a root canal procedure is carried out, then will it help resolve this pathology? The post-op PA shows that there is a lateral canal in this part of the root, confirming the endodontic origin of the lesion.



DIAGNOSIS DICTATES TREATMENT. An 8-year-old boy presented with a pinpoint exposure of #9 from trauma. Patient's history of chief complaint and diagnostic tests indicated that the pulp was still in a reversible state of inflammation. The tooth structure immediately adjacent to the site of exposure was cleaned out with a small round bur and disinfected with sodium hypochlorite. This area was capped with Bioceramic Putty material and the patient was referred back to the general dentist for a composite restoration. A 9-month follow-up showed (despite foreshortening in the first two x-rays) that the tooth maintained its vitality and continued its normal development. If RCT had been done without properly diagnosing the state of the pulp and the periapex, the tooth would have stopped its normal development and would have resulted in a clinically more complicated situation. (1st PA: Pre-op, 2nd PA: Immediate Post-op, 3rd PA: 9-Month Follow-Up)

ANTIBIOTICS

- The go-to medication for an odontogenic infection is Pen VK 500 mg (bactericidal, narrower spectrum of action than amoxicillin, taken 4 times per day). For patients with amoxicillin/penicillin allergy, Clindamycin should first be considered.
- For patients with a large, noticeable swelling: Refer to an oral surgeon if you are not totally comfortable dealing with the situation. If you give 2 different antibiotics together, the most effective combination may be **2 bactericidal antibiotics**, such as Pen VK and metronidazole. A combination of bactericidal and bacteriostatic antibiotics (such as penicillin with clindamycin) might potentially counteract the effectiveness of each other and may not be as helpful.

THE TREATMENT: STEP BY STEP

Before initiating any treatment, take a long, close look at the x-rays. Most of the worst experiences associated with root canal procedures, by *you* and by *the patient*, can be avoided by choosing NOT to do the most complicated cases. Older patients have a higher likelihood of presenting with calcified canals and may not be able to tolerate longer treatment sessions at the same time. If you have difficulty discerning the canals due to calcification, it may be advisable to refer to a specialist. Looking at bitewing x-rays as well as periapicals can also give you additional information as to what kind of difficulty level to expect.

- *Access*

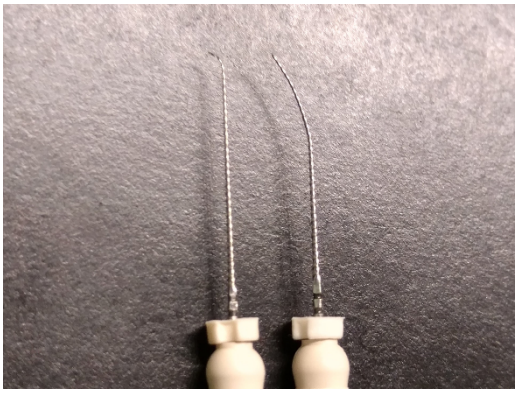
  A good access can facilitate the rest of the procedure. A poor access, by the same token, can make the procedure more difficult than needed. Study the bitewing x-ray before picking up a high-speed motor to gauge how much you need to go down to be in the pulp chamber. **It should always be remembered that**

the coronal pulp tissue *volume* is largest on top of the bigger canals, meaning that it would be easier to expose this part of the chamber first and then peel away from here (Note: This is not necessarily the *highest* point of the pulp chamber. Mandibular molars have high mesial pulp horns but the mesial canals are smaller than distal canals). For upper molars, it's easiest to expose the palatal canal first because it's the largest canal with the most amount of coronal pulp chamber space on top of it. This is especially helpful to remember if you are working on a calcified tooth with a reduced pulp space. As you peel away the roof of the pulp chamber, a dark pulpal floor reveals itself and the other canals are found at the outer edges of this darker floor. It also helps to remember that the pulp chamber is centered and concentric with the tooth outline at the level of the CEJ. Make a habit of looking at the CEJ outline and envisioning the pulp chamber at the center of this cross section. Doing this occasionally while access-prepping can help you get reoriented if you are drilling in a wrong direction. **Caution: This information regarding the CEJ and its relation to pulp chamber may be distorted in crowned teeth.**

- *Measuring Working Length*

  The very first files placed in a canal must always be pre-curved with the smallest possible radius. That is, all K10 and K15 files have to be curved (there are instruments specifically used for this purpose but if you don't have those, a college plier will do) at the tip in order to negotiate around the curvature of the canal and to preserve that natural curvature with the least amount of transportation. **This curving of the tip of a small file is utterly, critically important.** Once the tip of a small file is curved, it is placed in the canal and gently worked with a circumferential watch-winding motion until it is able to reach the apex. It is important to remember that, in your endeavor to get to the apex, the circumferential watch-winding motion may prove to be much more effective than a straight up-and-down filing motion. For narrower canals, you may not be able to reach the apex immediately. **The goal is to work yourself down *incrementally* without distorting the canal anatomy.** When you are successfully working yourself down to reach the apex, the canal feels sticky and this is a good indication that you can continue to carefully work yourself down to establish the length. A canal that no longer feels sticky but feels like a hard wall indicates that you could be transporting the canal out of its natural anatomy. This means that you are making your own canal, and success rate typically nosedives in those cases with a *man-made-canal*. If you no longer feel the stickiness of the canal, back step for one second, take a deep breath, and do the following three things: open up the coronal part of the canal (more on this later), irrigate copiously, and pick up the smallest file that you have available (K6 or K8) and again give it a small curve at the tip. Place the small file in the canal while keeping an eye on it as K6 and K8 files are very delicate and will crimple easily if you hit any other hard surface while trying to place them in the canal. Once it is in the canal, gently keep rotating them back and forth to see if you can find the sticky spot again. Virtually no apical pressure is needed while doing this. Once a sticky spot is found, you may have to keep working in the

same manner while frequently irrigating. Again, the small files can separate easily in a narrow canal if handled carelessly, and it may be wise to inspect them frequently and to go through a few of them instead of using one until it separates.



A K15 file curved with a small radius of curve at the tip and with a large radius of curve at the tip. ALL small files (6,8,10,15) must be pre-curved with a **small radius curve** at the tip. A file should **not** be bent with a large radius curve like the one shown on the right because curving a file this way has only limited benefits.

- *Coronal/Orifice Widening*

  How we achieve this coronal widening of the canal has changed somewhat over the years. First, the rationale for coronal canal widening: **In smaller canals, opening up the coronal portion of the canal allows you to reach the apex more easily, again with less transportation in the critical apical 1/3 of the canal.** In other words, you are more likely to preserve the natural canal anatomy when the coronal portion of the canal has been opened up first. In larger canals where you are able to reach the apex easily, orifice/coronal canal widening is actually not that important. It must be pointed out that the gates glidden is no longer routinely used for this purpose, at least by today's educators' standards. There are a few studies in the literature that showed removing excessive tooth structure from the coronal part of the canal can reduce the resistance of the tooth to root fracture. Obviously, there is no good reason to remove more tooth structure than necessary especially when it's more likely to lead to a more adverse outcome. Personally, I seldom use the gates glidden, and I only use 04 taper rotary files, even for coronal flaring.

  - **Advanced Tip:** Incorporating some degree of "crown-down" technique may give you better results in many cases. I usually pick up a bigger rotary file, such as a 40/04 or a 35/04 file, to initiate crown down for most of my cases. This is actually done even before I measure my working length. Knowing that the majority of root canal working lengths fall under 19mms – 22mms range, I will use the rotary in a crown-down fashion, starting with a 40/04 and then using a 35/04 and a 30/04 to about 14mms – 16mms. I measure my length at this point, hand-file a little bit and then begin the rotary instrumentation at full working length. This is listed as an advanced tip because you have to be

proficient at doing RCTs before you can effectively take advantage of this technique. Choosing the right size rotary file to initiate your crown-down is a judgment call as your initial file size may be different for different cases. You must have built some speed into your treatments, and you also must be able to perceive when to change the rotary file to a smaller one while going down apically when certain amount of resistance is met.

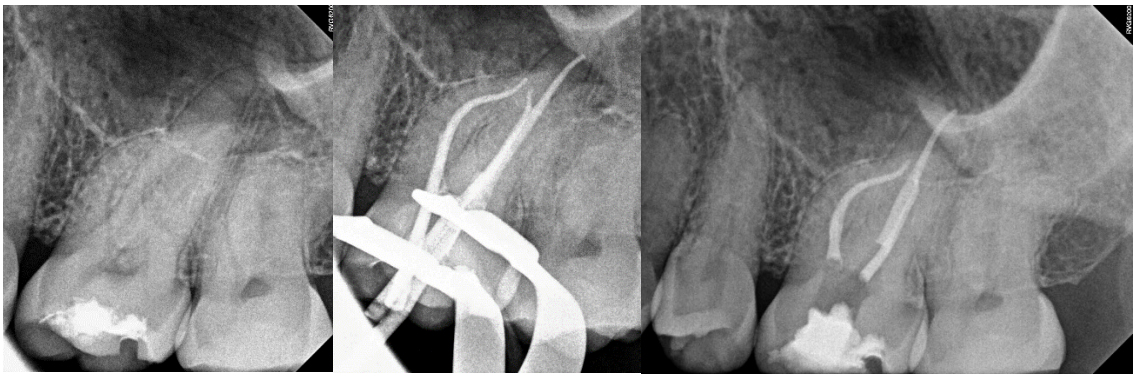
#19 WITH SEVERELY CALCIFIED MESIAL CANALS. These cases can take 2-3 times longer than a straightforward case, and patients should be informed of that before initiation of treatment.

#19 WITH LONG ROOTS. Working length (26mms) was measured after at least coronal half of the canals have been opened up with rotary files. Management of curve in the apical 1/3 would have been much more difficult without first instrumenting the coronal portions of the canals.

- *Instrumentation*

The general rule is to hand-instrument to size K15 before switching to rotary files. One of the most disturbing experiences a practitioner doing a RCT can have is to have a file separation. To prevent this mishap and other iatrogenic errors, it is important to remember a few things. First, always have some form of lubrication such as sodium hypochlorite or RC Prep inside the canal. Continuous instrumentation inside a debris-filled dry canal can be a main cause of all sorts of troubles. Second, just like the hand files, if you are not getting to the measured length in one attempt with a rotary file, then the length should be attained incrementally. This means removing the file when resistance is met, irrigating, and wiping the files with an alcohol-soaked gauze to remove the debris stuck in the flutes of the file. Sometimes irrationality could take over and we can push a little too hard (It's Friday afternoon, 4:30 PM and you had a late start with the last case of day) in an attempt to reach the working length quickly, but doing so can inevitably result in a separated file at some point.

- One of the significant but less talked about benefits of a modern endodontic rotary instrument is that it removes debris from the canal as it rotates clockwise. Observe the file to see if it is accumulating too much debris in the flutes and wipe them off to prevent generating excessive torque and stress.
- The effect of a large-taper instrument is not a well understood concept. We typically associate increased stiffness and decreased flexibility of a rotary file with the increase in tip size only. That is, we say that size 30 is stiffer and less flexible than size 25 because it is bigger, and size 40 is less flexible than size 35, and so on. **But increasing the taper of the instrument can also have a dramatic negative effect on the overall flexibility of the instrument.** Thus, an 06-taper file is much stiffer and less flexible than an 04-taper file, and **because of that inflexibility it may not be able to bypass a curved part of the canal that an 04-taper file of the same tip size can.**



CHALLENGING INSTRUMENTATION. For MB and D canals, working length could not be reached with a pre-curved K10 hand file. Instrumentation was done using the following sequence: 40/04 to open up the very coronal portion of the canal, then 35/04, 30/04, and 25/04 to resistance (advancing further apically using incrementally smaller rotary files), then K8, and then C6 hand files to measure length. Then, incrementally bigger instruments were used at working length for complete instrumentation: K8 again, K10, 15/04, 20/04, 25/04, 30/04, and finally 35/04. It may have been impossible to instrument the MB canal to the same tip size 35 using any taper larger than 04.

- **On Efficient Instrumentation, RPM, and Contact Time:** An argument could be made that using a rotary file at a high RPM (>500) is dangerous for less experienced clinicians. An argument could be made that using a rotary file at a low RPM (<300) is also dangerous for less experienced clinicians (which probably indicates that what's dangerous is the person). It is often overlooked how using a higher RPM can dramatically increase the contact time of the instrument with the walls of the canal, but this is another important concept to understand. A straight file inserted into the canal wants to straighten itself inside a canal. This is how transportation of the canal occurs. **Therefore, in order to minimize transportation, a file's contact time with the walls of the canal should be kept as minimal as practically possible.** Thus, when a file has done its job of reaching the apex, the canal should be irrigated to remove debris, and the next larger file size must be used. There is a tendency for less experienced clinicians to repeatedly instrument the

canals, over and over. This habit is especially deadly when the repeated instrumentation is done under a high RPM, as the most common undesirable outcome would be either a severely transported canal or a blown-out apex.

- *Instrumentation Size*

  This is an area of fierce controversy and there are varying opinions about how big a canal needs to be instrumented to (I once had a rep from the largest dental product company in the US ask me why I instrument the canals to certain sizes). One thing that most endodontists do agree on, however, is that the irrigating solution must be able to reach the apex to remove debris and disinfect the canals. A small canal (instrumented to size 25/04 or smaller) may not have the irrigating solution reach the critical apical 1/3 of the canal and also may be difficult to fill properly in some cases. Conversely, in a heavily infected root canal system it may be necessary to instrument the canals to a bigger size than when the pulp is still vital (vital means sterile). The following is a list of my usual instrumentation sizes as of this writing:

  - Upper Centrals: 45/04 or 50/04
  - Upper Laterals: 35/04 or 40/04 (This tooth has an apical distolingual curve that is oftentimes mismanaged, leading to many failed treatments.)
  - Lower Incisors: 30/04, 35/04, or 40/04 (Considered the most difficult tooth by some specialists)
  - All Canines: 40/04 or 45/04
  - Single Canal Premolars: At least size 40
  - Two Canal Premolars: 30/04 or 35/04
  - Mesial Canals of Lower Molars: 30/04 or 35/04
  - Distal Canals of Lower Molars: 40/04 or 45/04
  - MB and DB of Upper Molars: 30/04 or 35/04
  - Palatal of Upper Molars: 40/04 or 45/04
  - This is, of course, a loose guideline. A final decision on the size of instrumentation is made while the canals are being instrumented. In some rare cases, a very large canal with a long standing infection and a resorbed root end may have to be instrumented to even higher than size 50. Some canals with wicked curves may not be able to be instrumented to anything bigger than size 25. At any rate, it is important to remember that the discussion of apical size should be carried out along with a consideration for the instrument's taper. A file with a size 25 tip and 08 taper would be more aggressive in removing root dentin than a file with a size 35 tip and 04 taper. It must again be noted that large taper instruments (06 or greater) remove more dentin from the coronal half of the root, which unnecessarily weakens the root.

- *Root Filling/Obturation*

  Vertical compaction of gutta percha using a heated plugger and backfilling with thermoplastic gutta percha has become more or less the standard obturation technique over the years. The basic premise of this technique is based on creating a "small apex" and a continuously tapered, flaring canal using a large tapered instrument. Those two principles about creating an apex as small as possible and instrumenting the canal with a continuously tapered instrument represent the "inborn" characteristics of this vertical compaction technique at its origin. However, in past and present, this particular obturation technique has had a somewhat unfortunate influence on the overall design of rotary instruments (small tip, larger/progressive taper) in the market. It must be pointed out that this is probably the opposite of what we should be thinking, because **our first priority in doing a root canal treatment should be proper debriding and disinfection of the canals**, not filling the roots according to the mandates of a specific obturation technique. Obturation techniques will evolve and get modified over time. Moreover, some clinicians may take a stand that it is not possible to create a "continuously tapering funnel" in all the canals. As stated before, the size of instrumentation remains an area of open discussion, but what everybody agrees on is the fact that by instrumenting the canals we must create a *stop* or a *box* just short of the apical constriction. Let's look at some of the techniques that may facilitate the root filling process.

  - Indiscriminately using a large quantity of the sealer can make things more difficult. It should be remembered that excess sealer just comes back out during backfilling with gutta percha, making things messier, especially when large amount of the sealer is all muddled up with thermoplastic gutta percha.
  - The sealer can also be placed in the canal before cone placement either with a file or with a smaller size gutta percha, but this is not mandatory. Then, a small amount of sealer could be placed on the 3-4mm tip of the gutta percha cone and placed in the canal.
  - Any paste type material, such as the sealer or calcium hydroxide paste used as inter-appointment medicament, can be placed in the canal by rotating a file in a ***counterclockwise*** motion. Remember that the default **clockwise rotation of a rotary file removes debris** up and out of the canal.
  - Treat the gutta percha cone with care while placing it in the canal with a college plier to make sure that the tip doesn't get folded over. Keep an eye on the tip until it disappears into the orifice. Then, using your fingers, gently rotate the cone back and forth until it advances all the way to working length. Strictly using a vertically directed motion without any rotation may prevent the gutta percha cone from seating all the way in some canals.

- **Two canals that join:** In this morphology, separately placing a gutta percha cone in each canal will allow it to advance to working length, but when placed together, the first cone will prevent the second cone from getting to length. This happens frequently in the two mesiobuccals of maxillary molars, the two mesials of the mandibular second molars, upper premolars, and lower incisors. You may also get a hint of this particular anatomy if you are looking at the orifices with a high-powered magnification while drying the canals, as you may be able to notice the fluctuation of irrigant in the 2nd canal while the 1st canal is being dried with a paper point. Place the first cone in the canal that is assumed to be larger or straighter (e.g., in MB1 before MB2 in upper molars, in the palatal before the buccal in upper premolars, in the mesiolingual before the mesiobuccal in mandibular molars), and then place the 2nd gutta percha cone to the point of joining. Now, sear off the 2nd cone that is not reaching the apex at the orifice level, then burn off the 1st cone that was initially placed to length. In summary, the steps are as follows: Place the 1st cone to length, place the 2nd cone to joining level, burn off the 2nd cone, then burn off the 1st cone.
- One of the more frequently asked questions regarding obturation technique is about filling the canals that branch into 2 or more canals further apically. For all intents and purposes, strongly consider referring these cases to a specialist. The level of difficulty is exceedingly high in some cases, especially when one canal branches out at a sharp angle, and proper management may only be possible with the use of a microscope.

MANDIBULAR PREMOLARS WITH THREE CANALS. These cases are typically much more difficult than maxillary premolars with three canals. Proper management of a tri-furcating mandibular premolar may require the use of a microscope. Each gutta percha cone needs to be seared off at the level of branching, and this can only be done if there is clear visualization of all three orifices. (1st PA: Pre-op, 2nd PA: 2 gutta percha cones have been seared off and a 3rd cone has been placed to length, 3rd PA: Post-op)

- ***Help! My gutta percha doesn't go to my working length!*** Sometimes we realize that despite having fully completed the instrumentation, the gutta percha cone doesn't fit all the way to working length. There are a number of possible explanations for this, but whatever you do, resist the temptation to fill it 3mms short and make the all-too-common defensive statement—*Well, my apex locator told me that that was the working length*. It needs to be pointed out that the canal constriction is short of the radiographic apex and in some cases the root filling could look a little short. Yet, if the apex locator initially indicated that the working length was 20mms, and if I filled it to 18mms, then the machine most certainly did not tell me that 18mms was the length. What's responsible for that discrepancy is the human error in proper execution. Let's look at some of the reasons why a gutta percha cone may not go fully to working length:

    - *Debris in the canal*: A file may still go to working length in presence of some debris because it is metal, but a soft gutta percha cone may not. Hit the apex one more time with the largest rotary file you used (wipe the file clean before you do this) and then irrigate the canal one more time.
    - *Discrepancy in manufacturing*: If you took 5 different brands of gutta percha and compared the exact tip size using a gauge, then it would show us that some brands of gutta percha are bigger or smaller than the others. Now, if you opened up a packet of gutta percha from one brand and then compared the gutta percha cones *in that packet*, you are still likely to get some discrepancy in size despite the cones being made by the same manufacturer. At any rate, if one cone does not fit to your desired length, try another one of the same or smaller size (which may have to be modified to create tug-back).
    - *Using a strictly vertical motion to place the cone*: As explained before, incorporate a rotating motion when placing the gutta percha to more easily get it down to the apex of a curved canal.

FINAL THOUGHTS

Back in the days when I was a dental student, a respectable periodontist who was the head of the periodontics department had said something that I remember to this day—that he didn't *learn* to SRP until 2 years after he became a periodontist. This statement was so striking to me that I still remember the tone of the professor's voice when he said it. Not 2 years after he graduated dental school, but 2 years after he became a specialist. My perspective about the endodontic specialty is similar. And I say this not to make it seem like learning about root canals is a daunting task, but as a reminder that continuously learning to improve yourself and

putting in the effort can result in a level of proficiency that adds layers of satisfaction to your practice of dentistry. If you continue to do RCTs in your practice, you are bound to have difficult and frustrating cases at some point. But getting better at anything worthwhile is a humbling experience because it goes hand in hand with failure. It is only human to be discouraged by these experiences, but the most important thing is to see what could be learned from these challenging cases. Stand up, dust yourself off, and don't stop doing your carefully selected cases. I wish you the best of luck!