You're short. Again.

How many times have you instrumented a canal completely, went to fit your gutta percha point, and it was short? Even worse, you proceed smoothly through a root canal treatment, and leave your assistant to take a final radiograph. Upon returning to the treatment room, after removing the rubber dam, after placing the provisional and telling the patient that the worst is over, your root canal fill is not quite what you had expected.

We can pretend it doesn't happen. But it does. A lot. The ability to establish and maintain working length is critical to complete debridement, disinfection and obturation of the root canal system. Successful completion of these steps is essential in the long-term success of endodontic therapy. So why does this scenario occur, day after day, to dentist after dentist while performing endodontic therapy? It happens to both experienced and neophyte clinicians. It happens while treating vital teeth, necrotic teeth and in retreatment as well. The truth is, there are a number of reasons this can occur. Let's talk about why, and how we can prevent it in the future.

**Reason 1: You Never Had an Accurate Working Length**

The establishment of working length is a critical step in delivering predictable endodontic care. The first aspect of this is length determination. The most common method of length determination is the use of a periapical radiograph taken with a file placed to the desired length.

The use of an apex locator, such as the Root ZXII shown in figure 1, is another means of length determination. The simple explanation of the modern apex locator is that it measures the relationship of two inputs providing visual and auditory feedback to the operator in realtime. The resistance of the oral mucosa and the periodontal ligament are measured, and the apex locator compares these inputs. Upon the completion of a circuit, the operator is notified by the apex locator. Unlike the sole use of working length radiograph, the apex locator can accurately provide feedback on the location of an anatomical structure, the periodontal ligament.

Another method of working length determination is the tactile method. This involves the use of small files to feel the apical constriction. While this method can be effective, it is not recommended as a sole means of length determination. In addition, in many necrotic cases the apical constriction is not present, making this method less than desirable.

*Fig. 1: Root ZXII*
Whatever method is selected, it is imperative that working length is established, documented and the operator takes every step to ensure that this length is maintained throughout the procedure. The approach of estimating the working length is a recipe for unpredictable outcomes. I prefer to use the periodontal ligament as my landmark, as it is the only reliable anatomic measurement available. When using a Root ZXII, this is the full-tone or apex reading. I typically will subtract 0.5mm from this measurement to determine where I should terminate instrumentation in vital cases. In necrotic cases, I will usually instrument to the periodontal ligament.

**Reason 2: Poor or Non-existent Glide Path**

Procedural errors can occur at any stage of non-surgical endodontic therapy. However, the incidence of such errors is significantly lower after a smooth, progressive, repeatable glide path has been established. The first step in glide path formation is coronal shaping, which can be performed using a variety of instruments. I prefer to use the Gates Gliddens (particularly #2) in conjunction with the ProTaper shaping instruments, taking the tip of the instrument no further than the junction of the coronal and middle third of the canal. Following this, the operator has three options: hand instrumentation, reciprocation or the use of rotary nickel titanium instruments.

The most technique-sensitive approach is hand instrumentation. This requires a great deal of time and precise fine motor movements. Out of the techniques, it is the most difficult to perform well. The second method, and one that is a nice compromise, is hand instrumentation, followed by the use of reciprocation. I favor working each hand instrument to length, starting with size eight or 10, and then using a reciprocating handpiece at working length to expand the shape apically. I recommend using each handpiece for approximately 10 seconds at working length, followed by another 10 seconds using a 1-2mm vertical component. I strongly discourage the use of reciprocation at any length short of full working length, in an attempt to bypass initial placement of the handfile at full working length. I have not had success with this approach. The handpiece I most favor using is the ER10/TEP-Y combo which is a 10:1 reduction, available from Brasseler USA (Fig. 2). This is compatible with an E-type slow-speed handpiece.

The final method for glide path formation involves the use of rotary nickel titanium instruments. A popular system is the PathFile (Fig. 3), created by Tulsa. This includes the use of a 10 handfile to working length, then using a 13/02, 16/02 and 19/02 file to establish a glide path. A regimen that includes initial handfiling and reciprocation using size eight and 10 files followed by PathFiles would allow practitioners to use a rapid, user-friendly method to establish a bulletproof glide path prior to proceeding with canal preparation.

**3. Working Length Reference Point Not Well Defined**

One of the most common errors is the failure to define a coronal reference point. This is challenging on nearly all posterior teeth, as there are cusp tips and fossae that don’t behave as reliable reference points. As a referral-based practice, all of the patients I see are returning to their referring doctor, usually for a full-coverage restoration. As such, I try to ensure that the tooth remains as intact as possible to facilitate the fabrication of a provisional restoration or the fabrication of a CAD/CAM restoration. For those of you who are performing endodontics on your own patients, take a pre-operative impression or image for fabricating a provisional crown or CAD/CAM restoration. After accessing and locating the canals, don’t hesitate to flatten the occlusal surface in order to establish an easily repeatable plane to use as a reference point. I prefer to use an 909 diamond wheel, available from SS White. It is both fast and efficient.
4. Ledging

At any given length along the canal, if an instrument is allowed to linger in the same position longer than a couple of seconds, or is coupled with excessive apical pressure, a new path can be cut that deviates from the original canal form. I commonly see this with the over-enthusiastic use of non-landed rotary files. This is one of the reasons I tend to favor the use of files with a radial land (i.e. K3 or ProFile) when instrumenting apically. A well-defined glide path is also helpful in preventing ledge formation. For those of you who can drive a car with a manual transmission, imagine that you put your car in first gear on level ground. The sensation you get from releasing the clutch slowly without pushing the gas is the same sensation you should have when using rotary files. These instruments are designed to cut and it is our job to position them and hold them steady with very slight pressure to allow them to engage and progress.

5. Debris Packing

We attempt to remove debris created during canal preparation by the use of irrigation. In addition, many of the nickel titanium files we use have flute designs that facilitate the coronal movement of such debris. Unfortunately, this debris can collect apically, creating a barrier that prevents access to the apical third. It can also deflect instruments, creating other iatrogenic errors. Presuming that a solid glide path was initially formed, the placement of a small diameter instrument to working length after using each rotary instrument can ensure that this debris is broken up. It is then easily removed using irrigating solutions. An EndoActivator (Fig. 4) is also helpful in removing debris.

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6. Predictability is Lacking

I love the working length radiograph. The primary benefit is that it allows the clinician to establish a working length relative to the radiographic apex early in the procedure. The reason this is beneficial is that the apical extent of the filling material is usually assessed relative to the position of the radiographic apex. If your apex locator is giving you an apex reading at 2mm short of the radiographic apex, dry your canals, ensure that there are no interferences and accept that this is where your final fill should terminate if all available information is in line with this. The time to find out where you will be radiographically is not after the case is completed and you are uncertain if you lost length or folded a gutta percha cone. One of my attendings in my endodontic residency would frequently ask me: “Do you like surprises?” To this day, I still prefer to practice with no surprises. A case with no surprises is predictable, and predictable is what my referring doctors and their patients are looking for.

7. Variable Anatomy

The relationship of the radiographic apex to the canal terminus can be influenced by the variability of the position of the terminus. It can also be affected by the angle that the radiograph is taken from, as well as the relationship of the terminus to the greatest convexity of the root surface projected on the radiograph. As a general rule, a working length determination that is within 2mm of the radiographic apex is likely accurate if verified by another means. In my practice, I strive to have my root filling terminate in the same position where my file terminated in my working length radiograph (Figs. 5, 6 & 7).

8. Gutta Percha Size

Anyone who has performed endodontics has prepared a canal to a specific size only to discover that the corresponding gutta percha point does not go to length. In the days of hand preparation, a lack of coronal shaping would often cause this scenario. Nowadays, many systems have gutta percha that is supposed to match each file. A little-used device known as a gutta gauge is a very helpful adjunct (Fig. 8). This gauge allows us to verify the apical size of the cones by allowing us to trim the cones to fit. It is alarming when you see how often the number on the box doesn’t match the information you get from the gauge. Most of the cones I trim are smaller or larger than the number on the box. Trimming the cones takes a few minutes each week, but can save you a great deal of worry chairside.

Conclusion

The loss of working length is a common clinical problem. Once a working length has been determined early in the procedure and a glide path has been established, a predictable outcome is our goal. Good endodontic treatment and outcomes are a benefit to both specialist and generalist, regardless of who performs the treatment.

Author’s Bio

Dr. David Carter received his DMD from the University of Connecticut School of Dental Medicine. Upon graduation, he completed a general practice residency at Newark Beth Israel Medical Center. After eight years practicing all phases of general dentistry, Dr. Carter earned his endodontic certificate from Lutheran Medical Center in Brooklyn, New York. He currently owns and operates Precision Endodontics, Ltd., a private practice limited to surgical and non-surgical endodontics in Tempe, Arizona. He is a fellow in the Academy of General Dentistry, and is recognized as Board Eligible by the American Board of Endodontics. He can be reached at drc@endoltd.com.