The Endodontic Glidepath: *"Secret to Rotary Safety"*

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INTRODUCTION

You will do it 5,000 times in your career.

Give or take a few...

The ADA estimates that most dentists treat an average of 2 endodontic teeth per week. If we assume there are at least 2 canals per tooth, 47 treatment weeks per year for 25 years, then most dentists will attempt approximately 5,000 Glidepaths in their career: 2 root canals per week x 2 canals per tooth x 47 weeks x 25 years = approximately 5,000 Glidepath attempts.

The amazing fact is that the subject of Glidepath has no formal training in the endodontic curricula of most dental schools. In fact, a PubMed Central search of Glidepath and endodontics reveals 300 references. However, none of them actually describe *how* to prepare a Glidepath. Most of the references say something like, "Of course you must first make a Glidepath." That's all. And so the purpose of this article is to serve as a reference guide for endodontic Glidepath preparation and answer the following questions: What is it? Why is it important? How do you predictably prepare the Glidepath?

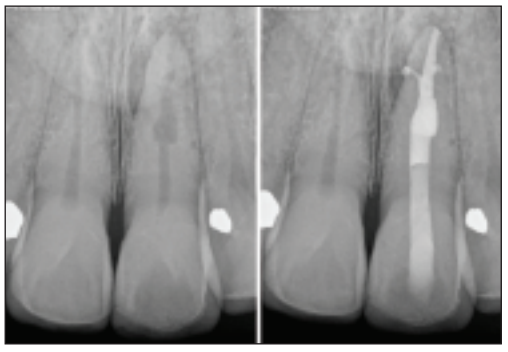

Figure 1. Glidepath is key to Rotary Shaping. Pretreatment image (left) shows apparent apical calcification. Post-treatment image (right) reveals proper apical shaping and obturation made possible by successful Glidepath preparation.

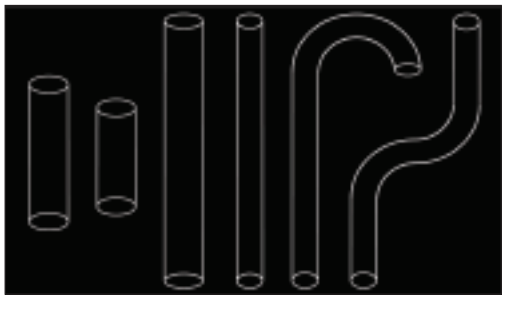

Figure 2. Glidepaths occur in multiple widths, lengths, and curvatures. They can be long or short, wide or narrow, curved or more curved. Root canal system anatomy is often tortuous and in multiple planes not observed in 2-dimensional images. Glidepaths must ultimately "follow" and replicate the original canal path in order to preserve the position of nature's portal of exit locations.

STARTING WITH THE ANSWER

The purpose of endodontics is to prevent or heal lesions of endodontic origin.[1] In order to achieve this purpose, the root canal system must be successfully obturated. In order to be obturated, the root canal system has to be successfully 3-dimensionally (3-D) cleaned and rotary shaped. In order to be 3-D cleaned and rotary shaped, a Glidepath has to be successfully prepared (Figure 1). And so the Glidepath is the answer. It is the starting point of radicular preparations. Without it, cleaning and shaping become unpredictable or impossible because there is no guide for endodontic mechanics.

1. What size hand file do you prefer for your Glide Path? (Choose one)

A. Size #10_____
B. Size #15_____
C. Size #20_____
D. Larger_____

2. Do you use straight manual files or do you curve them? (Choose one)

A. Straight_____
B. Curved_____

3. Do you "go to length immediately" if you can or do you "do early coronal enlargement" first?

A. Immediately if I can_____
B. Early coronal enlargement_____

4. When making the Glide Path, what is your preferred irrigation solution? (Choose one)

A. Sodium hypochlorite_____
B. EDTA_____
C. Viscous chelator such as ProLube, Glide, or RC Prep_____
D. Combination of the above_____

5. How do you determine your Glide Path length? (Choose one)

A. Apex locator_____
B. Radiographic terminus_____
C. Both of the above_____

6. When making the Glide Path, what hand motion(s) do you use? i.e.: "watch/wind," "push/pull," or other.

7. When blocked, what do you do next?

8. When you first notice a shelf starting, what do you do next?

9. If you were to design the ideal Glide Path file(S), what would you want as your most desired features or characteristics? Please be specific. (Optional)

Figure 3. Sample of Glidepath survey letter to endodontists. Answers to Nos. 1 through 6 are presented in Figures 4 to 9.

WHAT IS A GLIDEPATH?

The endodontic Glidepath is a smooth radicular tunnel from canal orifice to physiologic terminus (foraminal constriction). Its minimal size should be a "super loose No. 10" endondontic file. The Glidepath must be *discovered* if already present in the endodontic anatomy or *prepared* if it is not present. The Glidepath can be short or long, narrow or wide, essentially straight or curved (Figure 2).

WHY IS THE ENDODONTIC GLIDEPATH IMPORTANT?

First, without the endodontic Glidepath, the rationale of endodontics cannot be achieved. The rationale states that "any endodontically diseased tooth can be predictably saved if the root canal system can be nonsurgically or surgically sealed, the tooth is periodontally sound or can be made so, and the tooth is restorable."[1] A nonsurgical seal requires first the creation of a radicular path that can be cleaned of viable and nonviable bacteria, vital and nonvital pulp tissue, biofilm, and smear layer; then shaped to a continuously tapering funnel that can be predictably and easily obturated.

Second, the Glidepath is necessary for quality control. Sustainable excellent endodontic obturations are not possible without it.

HOW DOES THE DENTIST PREDICTABLY PREPARE THE GLIDEPATH?

In order to answer this question, I first surveyed the American Association of Endodontists (AAE) and reported my findings at the AAE annual scientific meeting in San Diego on April 16, 2010.[2] The title of my presentation was "The Magic of Mastering the Glidepath: *What Every Endodontist*

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Should Know." I asked the following 6 questions (Figure 3). The survey results speak for themselves.

1. What size hand file do you prefer for your Glidepath (Figure 4)?

2. Do you use straight manual files or do you curve them (Figure 5)?

3. Do you "go to length immediately" or do you do "early coronal enlargement" (Figure 6)?

4. When making the Glidepath, what is your preferred irrigating solution (Figure 7)?

5. How do you determine your Glidepath length (Figure 8)?

6. When making the Glidepath, what hand motion do you use (ie, "watch/wind," "push/pull," or other) (Figure 9)?

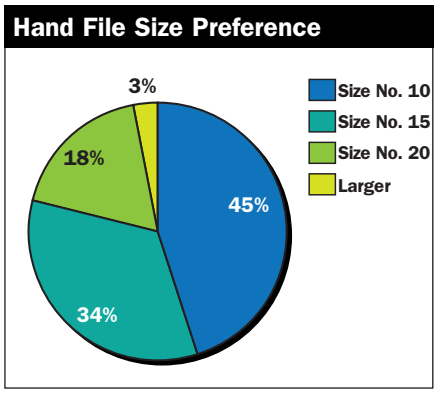

Figure 4. *Hand File Size Preference.* More than one-half of endodontists prefer a rotary Glidepath file size No. 15 or larger. As described in this article, the author prefers, instead, a "super loose No. 10."

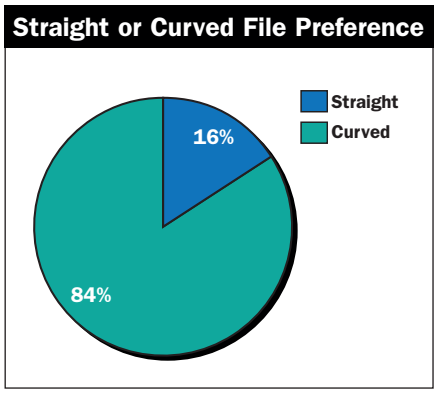

Figure 5. *Straight or Curved File Preference.* The only valid time to use a straight file is sliding into the orifice where the angle of incidence is greater than the angle of access.

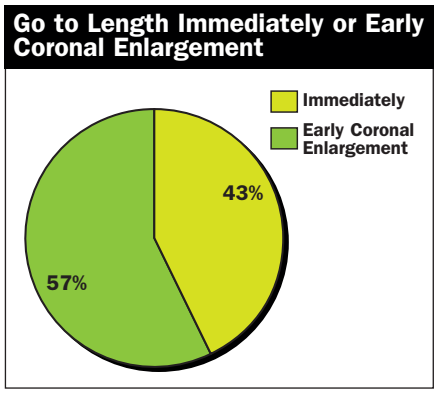

Figure 6. *Go to Length Immediately or Early Coronal Enlargement.* Slightly more endodontists prefer early coronal enlargement, primarily due to the presence of restrictive dentin which restricts finesse and mastery of the first Glidepath file.

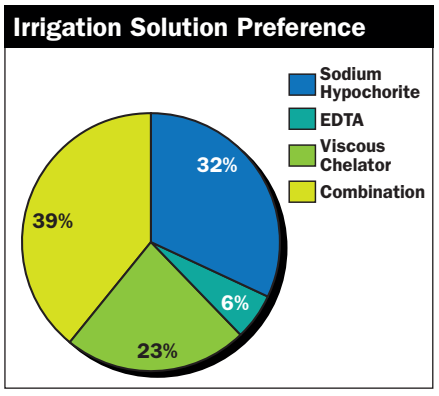

Figure 7. *Irrigation Solution Preference.* Sodium hypochlorite and a viscous chelator (or a combination of the 2) enable digestion of necrotic pulp and the ability to emulsify vital pulp.

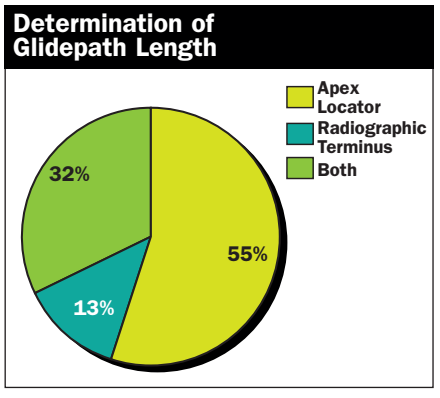

Figure 8. *Determination of Glidepath Length.* The apex locator, or a combination of apex locator and radiographic terminus, is the clinician's choice. Canal length accuracy is excellent when both methods of length determination validate each other. The important thing to remember is that the length is dynamic and becomes shorter, especially in the early stages of rotary shaping, due to canal shortening.

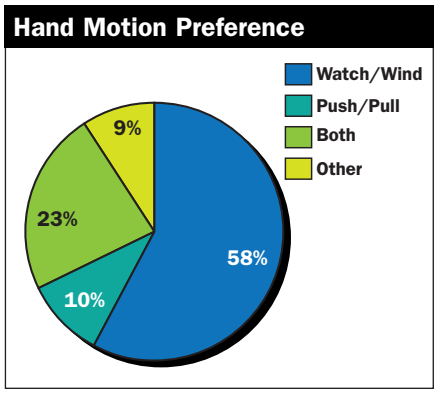

Figure 9. *Hand Motion Preference.* Most endodontists prefer "watch/wind." Only 9% chose "other." This article describes the critical distinctions of the manual motions of Glidepath preparation. These 4 motions make endodontic files efficient when the dentist learns how, when, and why to use what motion. Glidepath demands that the dentist "thinks" and is "deeply present," resisting all distractions.

GLIDEPATH TECHNIQUE

There are 4 skills that you need to know in order to produce consistent Glidepaths for safe rotary. First, find the canal. When beginning an endodontic procedure, it is useful to know the number of canals typical to a particular tooth.[1] It is also useful to know the typical anatomic variations of the specific tooth you have scheduled to treat (ehuman.com/products/3d-tooth-atlas-6). When reviewing ToothAtlas teeth, the first realization is the typical root canal system anatomy of a specific tooth is *not typical* at all. *None* are the same and that is the lesson: *always expect the unexpected*; no 2 root canal systems are the same—root canal systems are literally like "banners in the breeze." They are complicated and curved, their canal walls vary from smooth to rough, from wide to narrow, or from patent to clogged with pulp, necrotic debris, or calcifications. Once you know the typical number of canals for a particular tooth and you understand some of the anatomical possibilities, then magnification and illumination are essential to finding canals. Any dentist serious about endodontic treatment should be trained in the use of the operating microscope. With an aging population and therefore aging teeth with their root canal systems, normal calcific degeneration occurs and when these pulps become nonvital, the canals are smaller and more difficult to find without magnification and illumination (Figure 10).

Second, "*follow*" the canal to its radiographic terminus (RT). While the RT is always some distance past the physiologic terminus, the RT is the best default or home base position (Figure 11). By "following" to the RT, the clinician guarantees foraminal patency, which is prerequisite for a successful Glidepath. The technique is to clean *to* the RT and then shape *inside* using a wide variety of physiologic terminus location methods such as apex locator, paper point determination, different angle radiographs or digital images, and, finally, patient response to an endodontic file passing through the foraminal constriction where a lesion of endodontic origin exists and anesthesia is not being used or wearing off at the end of a visit.

Rather than think "the canal goes left," or "the canal is coming toward me," instead simply allow *the file to "follow" to the RT with little or no concern which direction it curves apically.*

Third, understand the 4 possible reasons (or a combination of these 4 reasons) why you may not be able to easily follow to the RT (Figure 12).[3,4]

1. *The canal is clogged or seemingly blocked by dense collagen or necrotic debris.* This is the fatal flaw of Glidepath preparation. *Solution*: irrigate thoroughly with sodium hypochlorite, make an abrupt apical curve on smallest file in your armamentarium (typically a size No. 6 or No. 8 file), imagine successfully reaching the RT (actually imagine seeing the file at the RT while examining the pretreatment radiograph or digital image), "follow" gently to and touch the blockage, remove the file, irrigate, re-curve the last millimeter of the file and repeat until the file moves deeper into the canal (Figure 13). Extreme restraint is required here and, at the same time, extreme intention. If you are patient and delicate enough, and if you do not put a time limit on this essential skill, I promise you that you will eventually "follow" successfully to the RT!

2. *The angle of access and the angle of incidence are not the same.* In other words, the file curvature and the canal curvature do not mimic each other. *Solution*: The key here is randomization. Rather than think "the canal goes left," or "the canal is coming toward me," instead simply *allow* the file to "follow" to the RT with little or no concern which direction it curves apically. Your only concern or outcome is to reach the RT. So, if you do not reach the RT with the first apical curve that you make, make a different curve and "follow" with that file. Then, if you do not reach the RT, make another different curve, and so on. Maybe multiple apical curves will be the answer. The guideline again is patience, restraint, and gentleness. *NEVER FORCE OR PUSH! NEVER, EVER!* Forcing is a natural response and must be resisted for Glidepath success. Being aware of the tendency and immediate normal reaction to push when you encounter resistance is the first step to overcoming making the "fatal flaw" worse. Relax; take your time. Once you successfully reach the RT, the rest is easy; simple mechanics. How you manage this moment in

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Glidepath preparation is the difference that makes the difference.

3. *The diameter of the file is too wide for the canal that it is following.* In other words, the file does not fit. *Solution*: Easy. Choose a smaller file. At no time do you know what solution will be the answer. You use all the solutions 1, 2, and 3 all at once. Be delicate. Change the curve. Go to a smaller file. You do not care what the solution is; you only care that you reach the RT.

4. *The shaft of the file is too wide for the canal.* In other words, the file cannot "follow" deeper into the canal because restrictive coronal dentin will not allow it. Remember, pulps not only inflame and necrose coronal-apically, they also calcify coronal-apically. *Solution*: Sometimes changing to a smaller file with a narrower coronal diameter will allow the file to "follow" deeper. A second method to remove restrictive dentin is to mechanically remove the restrictive dentin using Gates Glidden drills or nickel titanium rotary files short of the depth followed by the manual file. Historically, this approach has been referred to as early coronal enlargement. Progresssively tapered files (such as ProTaper Universal [DENTSLPY Tulsa Specialties]), used in a brushing motion, are particularly effective and efficient for restrictive dentin removal through the technique.[5] A third method for restrictive dentin removal is the "envelope of motion" manual motion which is described below.

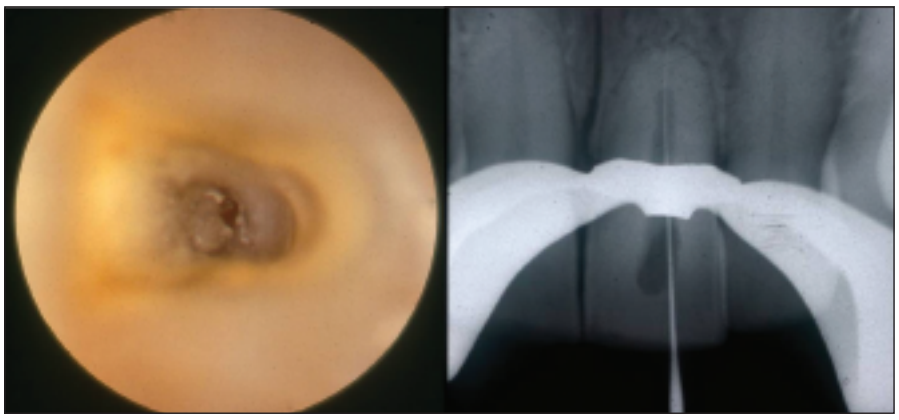

Figure 10. Severely calcified canal (left) can be successfully "followed" using microscope and color differentiations. Note canal patency (right) did not occur until a few millimeters from the canal terminus and yet the procedure was entirely safe and minimal tooth structure was removed.

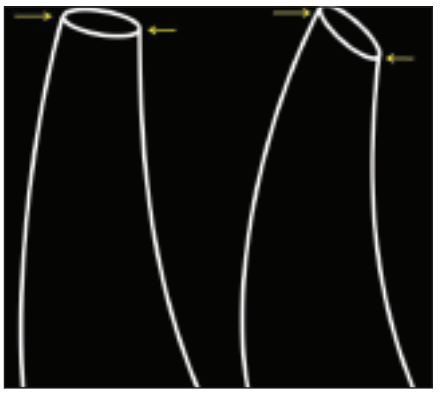

Figure 11. Physiologic Terminus may actually have different lengths. The walls of the canal on the left are the same, while the walls of the canal on the right have a longer one and a shorter one. Canal length determination is not an exact science; it is an art form. What the rationale of endodontics requires is the *entire* length of the root canal system be cleaned and shaped. Glidepath is perquisite to this mechanical objective.

Figure 12. Four reasons a file will not "follow" to its terminus: (1) Canal is blocked (2) File curvature does not replicate canal curvature (3) Diameter of file is too wide at its tip (4) Diameter of file is too wide in its shaft. (Often, a combination of reasons one to 4, or all 4 are the situation.)

Seemingly, while all 4 Glidepath "following" skills are separate, *they are not.* Often combinations of the 4 conditions exist, requiring a combination of solutions. For example, a canal might be packed apically with necrotic debris, have restrictive dentin, and you may choose a file that is too wide. Without being delicate, removing restrictive dentin and choosing a narrower file all at the same time is a recipe for failure to follow to the RT, which is the critically essential step of a successful Glidepath.

The fourth skill for consistent Glidepath preparation is to understand and master the 4 manual motions to prepare the rotary Glidepath.

1. "Follow." Identify the entrance to the canal and remove any dentin or enamel triangles that are preventing straight-line access. Irrigate thoroughly with sodium hypochlorite before *gently* "slipping and sliding" down the

canal (Figure 14). If a plug of dentin covers the orifices that have been identified using ultasonics, high-speed burs, or Mueller burs, first agitate chamber sodium hypochlorite using EndoActivator (DENTSPLY Tulsa Specialties). Then dense orifice dentin will be removed or softened, and small files can penetrate easily and the "following" motion can begin. Take the smallest file that fits the canal easily, and slightly precurve the apical a few millimeters using metal cotton pliers. If you are using a microscope, hold the handle of file with cotton pliers so your fingers do not block the line of sight to the orifice. Once the file can stand upright in the canal on its own, "follow" the file down the canal. Allow it to go whatever direction it wants. Be intentional about reaching the RT but stop attempting to "follow" short of maximum resistance and implement the No. 3 motion called "Envelope" (described below). When following to the RT, use watchwords such as gentle, caress, slip and slide, stroke, trail, and restraint. If RT is reached easily with the first "follow," identified with apex locator and validated with radiographic or digital image, then proceed with manual motion No. 2: "Smooth."

Four manual motions have been distinguished that, if used properly, will produce a safe rotary result....

2. "Smooth." Once RT file position has been validated, make short amplitude vertical stokes until the file is *loose*. This may mean a half a dozen strokes or it may mean 100 strokes. Whatever it takes, do it. If the file is at first too tight to easily make short strokes, ie, the file is apparently binding against 2 or more walls, then wiggle the handle left and right without any up or

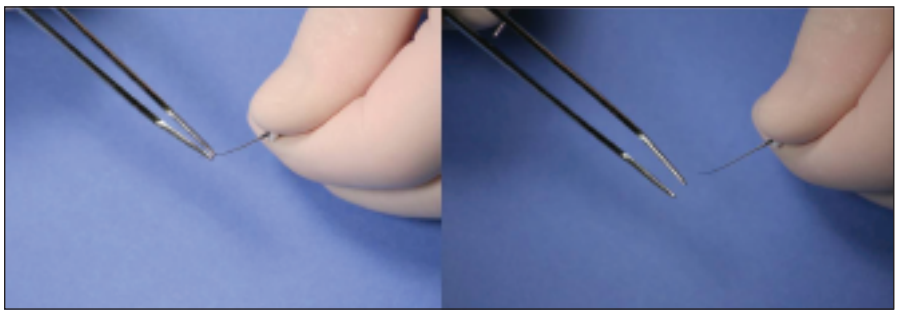

Figure 13. "Follow" files are more effective when curved. First squeeze cotton pliers against file shaft at right angles and sweep the cotton pliers toward the tip (left). The resulting file (right) has a gentle and continuous curve to and through its tip.

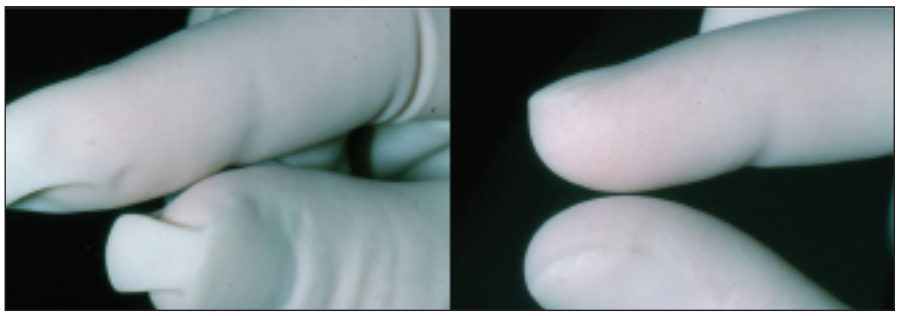

Figure 14. Glidepath "following" requires optimum tactile sense. Loose gloves do not enable the dentist to feel the file handle (left). Gloves must fit tight so that the balls of the fingers together allow the finest possible touch and delicacy (right).

down motion. This simple, safe nuance will wear away the small amount of restrictive dentin and free the file for the smoothing motion. The minimal Glidepath file size for safe rotary shaping is a loose No. 10 file. While many endodontists prefer a larger file (55%, as noted in my spring AAE 2010 survey), every increase in size while making a theoretically bigger pilot hole for rotary, also risks creating a shelf in the radicular dentin wall. Rotary files rarely glance over shelves or ledges and must be meticulously removed before proceeding.[4] An excellent series of manual files for smooth and progressive Glidepath enlargement are the ProFile Series 29 invented by Schilder (DENTSPLY Tulsa Specialties) (Figure 15).

3. "Envelope." If the file does not easily "follow" to the RT, stop short of maximum resistance. You now have 2 choices: force or remove. If you force, you may block or ledge. So, *DO NOT FORCE* or *PUSH*. The proper next step is to remove the file using the "envelope of motion." The envelope will wear away restrictive dentin by withdrawing and carving to the right, or clockwise, direction. Envelope is the only motion of the 4 manual motions that removes dentin on the outstroke. The other 3 motions require that the file is moving in an apical motion in order to execute. This is a subtle motion and gives the impression that you are wasting your time because nothing is happening. But remember, endodontics is not a big job, it is a little job. The amount of tooth structure that is removed compared to coronal enamel and dentin preparations is minuscule. Endodontics is, however, a smart job. The "envelope motion" is a smart and efficient motion. Test it out yourself and experience that suddenly, effortlessly, and even miraculously the previous file "follows" deeper. You will experience a newfound freedom and control of the evolving radicular shape which, unfortunately, cannot be observed directly like all other restorative. Your unimpeded files are your eyes in endodontics. Now "follow" to the RT with your smallest file, smooth, and finish Glidepath. If you cannot "follow" to RT, you will almost always at least "follow" closer toward the RT. Envelope again and repeat until you reach RT, smooth, and finish the Glidepath.

4. "Balance." Sometimes a file size larger than a super loose No. 10 is desired. The dentist may feel safer with a larger size or the walls may not feel as smooth as possible. If you want to have a smooth No. 15 as your Glidepath size, for example, then use balance motion. It is safe and predictable. Originally this motion was referred to as Balanced Force or the Roane Technique, named after Dr. James Roane, the first person to describe this manual motion.[6] Simply put, turn the handle of the file clockwise, and then turn it counterclockwise using slight apical pressure so that the file will not "unscrew" its way out of the canal. During the clockwise motion, the file blades cut into the dentin; during the apical counterclockwise motion, the dentin is collected into the file's flutes. This can be repeat-

Figure 15. ProFile Series 29 files (DENTSPLY Tulsa Specialties). These files offer the finest manual transition between Glidepath files because of their constant and appropriate size increases.

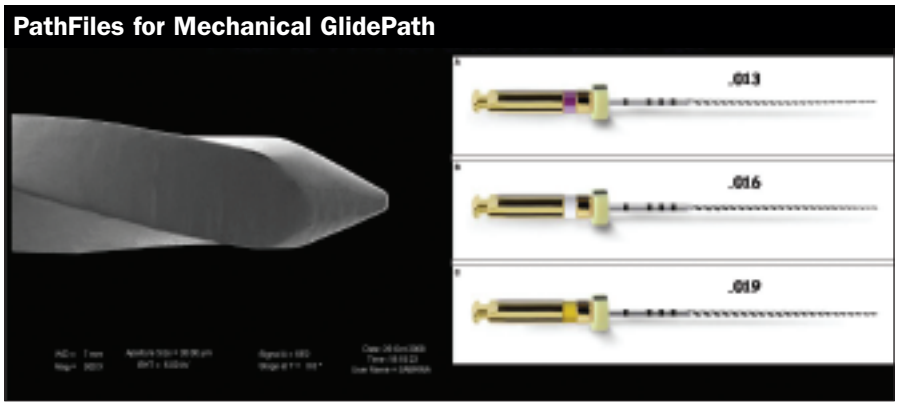

Figure 16. New PathFile rotary Glidepath files (DENTSPLY Tulsa Specialties). These robust files, when used properly, can prepare a Glidepath that is safe and precise. While a manual Glidepath is still recommended, the PathFile is an excellent way to increase rotary shaping safety.

ed several times as the file is "balanced" apically. The file is then turned clockwise and removed having carved a wider Glidepath. That same file is then used in a "smoothing" motion and the Glidepath is once again finished and ready for rotary shaping.

A new approach to increasing Glidepath size is mechanically vs. manually. One recent and successful method is the introduction of 3 PathFiles (DENTSPLY Tulsa Specialties) (Figure 16). When properly used, these robust and efficient rotary Glidepath files can take even further risk out of rotary shaping. As with every dental instrument, the dentist must precisely follow the manufacturer's directions for use.

SUMMARY

The endodontic Glidepath is the secret to radicular rotary safety. This article has offered a definition of Glidepath, explained why it is important in producing optimum endodontic mechanics, and described how to prepare a Glidepath for radicular shaping. Four obstacles to Glidepath preparation have been identified along with the solution for each one. Four manual motions have been distinguished that, if used properly, will produce a safe rotary result and an endodontic experience that you truly control.✦

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Watch for 2 more articles on the topic of Glidepath by Dr. West in future issues of *Dentistry Today*: "Manual Versus Mechanical Glidepath: *When and How Do You Do What?"* and "Implementing the Endodontic Glidepath: *What Are Your Action Steps?"*