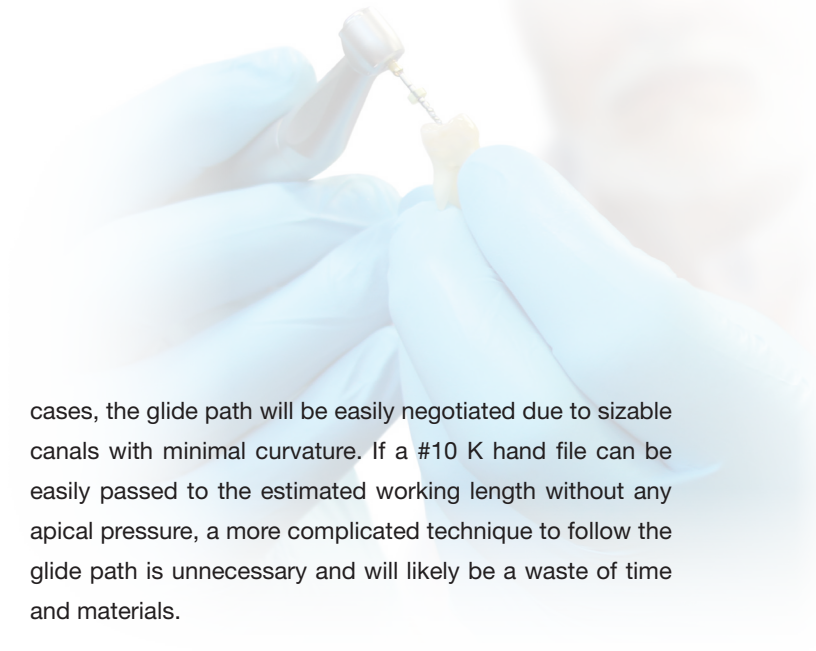


Proper Glide Path Technique

By David Landwehr, DDS, MS

Much has been written in the field of endodontics about the importance of coronal access and the establishment of a glide path from the orifice of the chamber to the full apical extent of the root canal[1,2,3,4]. Although the principle of straight-line access into the pulp chamber is generally accepted, the concepts surrounding glide path and straight-line access into the root have remained misunderstood.

A glide path does not need to be fabricated within the root canal - it's a pre-existing part of the original tooth anatomy within the root. The glide path is nothing more than the natural space occupied by the once healthy dental pulp. Due to anatomical variability - especially in the apical one third of the root - the glide path may be irregular in many teeth and great care must be taken to follow the natural path of the canal. In fact, to achieve a clean root canal system, the glide path needs to be followed, not made. A proper glide path will allow rotary nickel titanium instruments to shape to the apical terminus of the root canal and minimize the risk of instrument breakage[5]. Fabricating a "white line" to the root apex by channeling through the root structure and creating a canal without removing bacteria and tissue debris, will most certainly lead to post treatment disease.

A proper diagnosis, profound anesthesia, rubber dam isolation and straight-line access into the chamber are essential prior to enlarging the glide path. Coronal access needs to be large enough to allow entry into all canals, while preserving tooth structure for future restoration. In some cases, the glide path will be easily negotiated due to sizable canals with minimal curvature. If a #10 K hand file can be easily passed to the estimated working length without any apical pressure, a more complicated technique to follow the glide path is unnecessary and will likely be a waste of time and materials.

In complex anatomies with small, long and potentially multi-planar canals, it is not possible to immediately pass a #10 K-file initially to the root end. Subsequently, the clinician may try to force smaller files to the apex. However, #6 and #8 files are typically not needed to enlarge the glide path to the apex unless it is an extraordinarily difficult case. The apical foramen will always be larger than a #10 K-file; therefore any resistance met prior to the apex is likely due to curvature or irregularity in the canal[6]. As a result, opening up the canal with a #10 K-file in small increments can be an efficient way to follow a reproducible glide path, while minimizing the likelihood of creating a ledge or blockage in the canal. The tip of the file should never be forced apically because the risk of creating a ledge is greatly increased. If the tip of the file never binds into the canal wall, it is impossible to make a ledge.

Access and orifice opening for all teeth

Straight-line access into the chamber will not ensure straight line access into canals as a triangle of dentin will be present at the orifice, which continues for a few millimeters below the pulpal floor. This dentin triangle

1) Pasqualini D, Mollo L, Scotti N, Cantatore G, Castellucci A, Migliaretti G, Berutti E. Postoperative pain after manual and mechanical glide path: A randomized clinical trial. J. Endod. 2012; 38:32-6.

2) Lopes HP, Elias CN, et al. Mechanical behavior of pathfinding endodontic instruments. J. Endod. 2012; 38:1417-21.

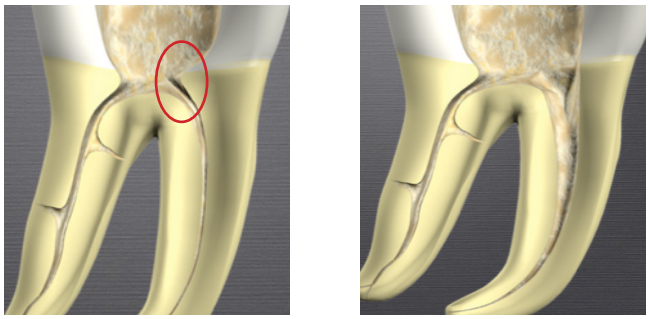
3) Pasqualini D, Bianchi CC, Paolino DS, et al. Computed micro-tomographic evaluation of glide path with nickel-titanium rotary pathFile in maxillary first molars curved canals. J. Endod. 2012; 38:389-93.

4) de Oliveira Alves V, da Silveira Bueno CE, Cunha RS, et al. Comparison among manual instruments and PathFile and Mtwo rotary instruments to create a glide path in the root canal preparation of curved canals. J. Endod. 2012; 38:117-20.

5) Patino PV, Biedma BM, Liebana CR, Cantatore G, Bahillo JG. The influence of a manual glide path on the separation rate of NiTi rotary instruments. J. Endod. 2005; 31:114–6.

6) Morfis A, Sylaras SN, Georgopoulou M, Kernani M, Prountzos F. Study of the apices of human permanent teeth with the use of a scanning electron microscope, Oral Surg. Oral Med. Oral Pathol. 1994; 77:172-6.

needs to be removed for straight-line access into the root canal. This step of ensuring straight line access into the canal should be accomplished for every tooth, even if the pre-operative anatomy seems straightforward. For example, when instrumenting the mesial-buccal canal of a mandibular molar, the initial path of insertion for the #10 K-file will almost always be from the distal and lingual. When using the initial #10 K-file, it should be directed to the mesial and buccal to start removing the dentin triangle while making no attempt to move the file apically. As mentioned previously, if the file tip is not allowed to hit the canal wall, it is impossible to make a ledge. The initial opening of the orifice should be done above any curve in the canal. Some teeth will require more hand filing at this level due to a more constricted canal, while other canals will require almost no manual instrumentation.



(L) With the dentin triangle at the orifice, straight-line access into the chamber has been achieved, but not into the canal.

(R) After removal of the dentin triangle, straight-line access has been achieved into both the chamber and the root.

After the #10 K-file has initiated removal of the dentin triangle two to three millimeters below the orifice, a rotary instrument can be used. A ProTaper Gold® or S1 rotary file can be used in a brushing motion to explore the canal and the active cutting action can complete the removal of the dentin triangle and ensure straight-line access into the root. ProTaper Gold was introduced in early 2014 and touts increased flexibility, greater resistance to cyclic fatigue and a shorter, 11 mm handle than that of ProTaper Universal. Again, no attempt should be made to take this rotary file to working length and this first rotary instrument should not be taken to any place in the canal that has not been opened by a hand file. A brushing motion is used to remove dentin at the orifice level while moving away from the furcation and centering the orifice over the canal.

Other options for removal of the dentin triangle would include Gates Glidden drills, orifice openers or a series of larger hand files. Gates Glidden drills have the potential to cut to the furcation side of the canal. Over enlargement may result in the thinning of the root wall or a root perforation. Hand files will require more time and are stiff, thereby increasing the risk of altering the natural canal anatomy, but hand instruments can be effective at this level of the canal.

Vortex® Orifice Openers

Vortex® Orifice Openers provide another very efficient way to remove the dentin triangle in premolar and molar teeth and they excel at centering the MB2 canal orifice over the body of the root in maxillary molars. Vortex Orifice Openers are active cutters and are best used in a brushing motion away from the furcation side much like the ProTaper Gold® SX or S1. These instruments are available in 16 and 19 mm lengths and have a short 11 mm handle to facilitate access to molar teeth in patients with limited opening. The active portion of the file is 12 mm and the apical region is tapered to provide access into the canal while the most coronal 4 mm portion of the file is parallel to prevent over enlargement of the canal. For example, the ProTaper Gold SX and S1 have a maximum dimension of approximately 1.2 mm while the 20/0.08 and 25/0.08 Vortex Orifice Openers have maximum dimensions of 0.92 and 0.99 respectively. These smaller maximum shapes preserve coronal tooth structure and provide an alternative means to ensure straight-line access into the root in smaller canal anatomies.

Instrumentation technique for standard canal anatomies

Because most molar teeth are going to have curvature in both the mesial-distal and buccal-lingual directions, a #10 K-file will likely encounter resistance on the way to apex in longer teeth even though the dentin triangle has been removed from just below the orifice. Because of this, the next step should be opening the canal with a #10 K-file below the first curve (usually this is the buccal-lingual curve), but coronal to the second curve (mesial-distal). This will usually correspond to a point between one-half and two-thirds of the way down the canal.

A safe distance into the canal can be determined with a #10-K file. The main goal at this point of glide path enlargement is to advance the file apically, but passively. As the file meets any resistance at the tip, the canal should be opened 1mm short of that length. Again, the canal is opened with a #10 K-file, without binding the tip or creating undue apical pressure prior to placement of a rotary instrument like a ProTaper Gold® S1. The ProTaper Gold S1 has a tip diameter of .185 mm and the maximum dimension is 1.2 mm, which is slightly larger than a #4 Gates Glidden drill. As a result, the largest part of the ProTaper Gold S1 should not be taken to any point in the canal that would not accommodate a #4 Gates Glidden drill. The 1.2 mm size of the ProTaper Gold is advantageous to the final instrumentation with WaveOne® reciprocating file because the maximum diameter of WaveOne is also 1.2 mm and this pre-enlargement allows for easier dentin removal in the coronal half of the root canal. This initial enlargement also lessens the likelihood for debris to block the canal during final instrumentation or be extruded through the apex.

After the dentin triangle has been removed and the canal has been opened below the buccal-lingual curve to the junction of the middle and apical thirds of the root, a #10 K-file should go around the mesial-distal curve and passively go to the canal apex because the apical foramen is larger than a #10-K (usually in the 20-25 range). The #10 K-file should be worked until loose at the estimated working length and canal patency has been achieved. After the natural canal path has been followed and slightly enlarged from the orifice to the apex, the final instrumentation can be completed to create the desired shape and cleanliness appropriate for that root. If the canal anatomy allows, spinning the ProTaper Gold S1 to working length will finalize the shape in the coronal two thirds of the root and final shaping will only be needed in the apical one third of the root.

Instrumentation techniques for the most complicated canal anatomies

Because the ProTaper Gold SX is a short instrument and the S1 has progressive taper, smaller, longer root canal systems may not be amenable to the previous technique. However, in spite of the fact that these are the most difficult cases, only small modifications to the previously described instrumentation sequence are needed to follow the natural glide path. With that in mind, the margin for error in these cases is very small and great care needs to be taken not to force the files apically or bind the file tip into the canal wall or a ledge will be formed.

Vortex Blue® Rotary Files

The quintessential glide path instrument would be small enough to negotiate tight anatomy with a guiding tip to follow the natural canal, yet it would be an active cutting instrument to efficiently remove dentin. Additionally, the perfect instrument would possess a high resistance to cyclic fatigue along with maximum flexibility to minimize the risk of file separation[7]. The ideal glide path instrument would also have reduced shape memory compared to standard nickel-titanium instruments. This feature would prevent the tendency of other NiTi instruments to pull to the furcation in the coronal half of the root and straighten the canal in the apical half of

7) Gao Y, Gutmann JL, Wilkinson K, et al. Evaluation of the impact of raw materials on the fatigue and mechanical properties of ProFile Vortex rotary instruments. J. Endod. 2012; 38:398–401.

the root. Lastly, a short handle would facilitate access into the smallest most curved canals. Although many practitioners are unaware of its existence, all of these design features are characteristics of a size 15/0.04 Vortex Blue® file.

Vortex Blue instruments have a unique "blue color" compared with traditional super-elastic NiTi instruments. The "blue color" is due to an oxide surface layer that is the result of a proprietary heat treatment manufacturing process. Vortex Blue instruments feature variable helical angles to provide a combination of flexibility and efficiency. There are more flutes per millimeter at the tip for increased flexibility while there are fewer flutes higher on the shank for increased efficiency and dentin removal. Although described in this context as a glide path instrument, this is a stand-alone instrumentation system that is available in 0.04 and 0.06 tapers and ISO sizes 15-50. Because of the taper choices and the available file sizes, these instruments can be used in almost any clinical situation to create the final root canal shape following the establishment of a repeatable glide path.

Vortex Blue® Technique

After opening the orifice, a Vortex Blue 0.04 taper size 15 can be used to open to the same level as hand files. As the canal is enlarged with a 15/0.04 Vortex Blue to the same depth as the #10 K-file, the natural tendency will be for the instrument to track deeper into the canal because the obstructive dentin has been removed. However, it is very important to avoid this temptation and only use the 15/0.04 Vortex Blue to the corresponding length of a previous glide path that has been confirmed with hand files. Doing so will minimize the risk of instrument breakage.

PreOp Vortex Blue® Technique PostOp

In these cases, it may be necessary to advance to the apex in several small 2-3 mm steps. Provided that the tip of the hand instruments are not bound at any level within the canal, this passive advancement of hand and rotary instruments will allow the natural glide path to be followed in all cases despite the length and curve.

PathFile® Rotary Files

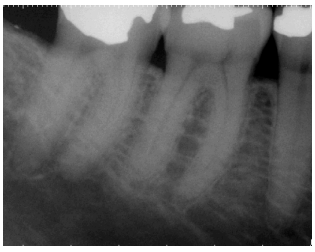
In the smallest most intricate canal systems, the 0.04 taper of the Vortex Blue may feel too large. In the smallest, longest and curved canal systems, a PathFile® series can be used to facilitate initial canal enlargement. PathFiles are 0.02 taper, the same taper as traditional hand files, but are used in a rotary motor at 300 rpm. They are manufactured in three tip sizes: 0.13, 0.16, and 0.19 mm and three lengths: 21, 25 and 31 mm. The PathFile tip is rounded rather than cutting to avoid procedural mishaps. PathFiles have a square cross section for added strength and four cutting blades for increased cutting efficiency.

PathFile® Technique

As described previously with Vortex Blue files, the PathFiles should not be taken to any level within the canal unless an open glide path has been confirmed with hand files. Therefore, after a #10 K-file opens to any given length, PathFiles can be used to the same length to safely enlarge the glide path[8]. Again, in these most challenging cases, it is critical to avoid binding the tip of the file at any level to avoid ledge formation with a hand file or instrument separation with a rotary file. The #10 K-file can be advanced apically in small increments without binding the tip and subsequent cycles of the PathFiles can then open the canal to a size that is more appropriate

8) Berutti E, Cantatore G, Castellucci A, et al. Use of nickel-titanium rotary PathFile to create the glide path: comparison with manual preflaring in simulated root canals. J. Endod. 2009; 35:408–12.

for final shaping. An obvious drawback of this technique is the time required and the number of instruments necessary to follow and enlarge these small canals. In some teeth, four or five cycles will be required to passively advance to the root end. This means a #10 K-file and three rotary PathFiles at each level within the canal. However, to treat complex canal anatomies in an effective and repeatable manner, an equally complex technique is required.



PreOp

PathFile® Technique PostOp

ProGlider™ Rotary Glide Path Files

Although the most difficult anatomies will require the use of multiple files to follow the natural canal path to the root apex, many teeth would be more efficiently treated with a single rotary instrument to create the glide path. ProGlider™ rotary glide path files provide this option. These files have a small tip diameter (0.160 mm) and 0.02 taper in the apical portion of the file to allow access into tight canal spaces. However, the increasing variable taper along the length of the file and cutting efficiency ensure an appropriately sized glide path can be established throughout the root canal system to facilitate final instrumentation with WaveOne®, ProTaper NEXT® or any other instrument series. ProGlider files are single use, pre-sterilized instruments with a square cross section that are manufactured from M-Wire® NiTi to ensure a high resistance to cyclic fatigue[9]. Added together, these design features, combined with the simplicity of a single file, provide a powerful new instrument to predictably follow and enlarge the natural glide path.

ProGlider™ Technique

Before spinning a ProGlider, the canal should be opened with a #10 K-file. If the file will passively go to estimated working length with little or no apical pressure, working length can be determined and the ProGlider can be used in one or more passes until working length is reached. The ProGlider is used in a rotary motion at 300 rpm. Very little or no apical pressure is needed and a brushing action is recommended to remove dentin triangles. If resistance is met prior to working length, the canal should be irrigated and canal patency confirmed. Additionally, the ProGlider flutes should be cleaned to ensure an efficient cutting action.

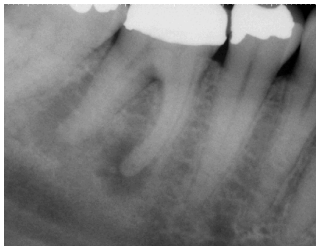
ProGlider tip size is 16.02.
Recommended motor settings:

- Speed: 300 rpm
- Torque: 2-5.2 Ncm
- Continuous rotation/rotary

When challenged with a root canal system, demonstrating a longer working length or significant curve, a #10 K-file and ProGlider can be incrementally advanced in the root canal system until working length is achieved. For example, if a #10 file can be passively inserted to a depth of 14 mm, but the estimated working length exceeds 21 mm, several options exist. Forcing the hand files apically in a watch winding motion would risk the formation of a ledge in the canal. To eliminate this risk, the canal should be opened with a #10-K file to 13 mm and the ProGlider file could then be used to

9) Johnson E, Lloyd A, Kuttler S, Namerow K. Comparison between a novel nickel- titanium alloy and 508 nitinol on the cyclic fatigue life of ProFile 25/.04 rotary instruments. J. Endod. 2008; 34:1406–9.

the same depth. Following initial glide path enhancement to 13 mm, the #10 K-file will passively track deeper into the root because the canal size is greater than the file size and the dentin triangle that was impeding the file has been removed. Several passes can be made with the #10 K-file and ProGlider™ until working length is achieved.



PreOp

ProGlider™ Technique PostOp

With each pass, the #10 K-file will passively advance further into the canal as the obstructive dentin is removed. It is critical that the tip of the file not bind the canal at any level to eliminate the possibility of creating a ledge in the canal. Copious sodium hypochlorite irrigation should be used to prevent blocking the canal with dentin debris.

Conclusion

Several new instrument systems to create the final root canal shape have come to market in the last few years. These instrumentation techniques are characterized by unique file designs, improvements in metal technology and new rotary motions. With so much emphasis placed on final instrumentation, it is important to remember that final shape doesn't matter without a glide path that follows the natural canal anatomy to the root apex.

Tips to remember

1) The glide path should be established in the presence of sodium hypochlorite to prevent blockage of the small canal with pulp or dentin debris and to initiate the disinfection of necrotic teeth.

2) Coronal access needs to be large enough to uncover anatomy and facilitate cleaning of the canals, but should also be as conservative as possible for restoration and resistance to fracture.

3) Inadequate radicular access and trying to force files apically are common causes for procedural mishaps. A #10 K-file should always be loose before going to a #15-K file or NiTi rotary instruments.

4) Canal anatomy at the apex is very irregular and great care must to be taken to follow the natural pre-existing glide path.

5) Pre-curved files will allow the clinician to more easily scout around small curved canals.

6) A #10 K-file will determine if multiple steps are needed to follow the glide path. If any resistance is met with a #10 K-file prior to reaching the estimated working length, the coronal region should be opened to the point of resistance with larger rotary glide path files prior to making any further attempt to move the #10 K-file apically.

David Landwehr, DDS, MS

Dr. Landwehr is Chief of Endodontics for the Meriter Hospital general practice residency program in Madison, WI. He has presented case studies in endodontics and oral pathology both nationally and internationally. In addition, he has published several articles in various peer reviewed journals and served as an evidence reviewer for the American Dental Association.

Dr. Landwehr earned his D.D.S. at the University of Minnesota; he also holds an M.S. degree and certificate in Oral and Maxillofacial Pathology from The Ohio State University and has completed specialty training in endodontics at the University of Michigan. Dr. Landwehr has maintained a private practice in his home state of Wisconsin since 1999.