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Real World Endo Sequence File

Kenneth A. Koch, DMD[a,*], Dennis G. Brave, DDS[b]

[a]*Real World Endo, The Barba Plaza, 2nd Floor, 2114 Silverside Road, Wilmington, DE 19810-4448, USA*
[b]*The Johns Hopkins Hospital, Baltimore, MD, USA*

The past 10 years has been witness to many changes in endodontics, and this trend will continue in the foreseeable future. The introduction of new technologies has resulted in endodontics becoming easier, faster, and most important, better. Paramount among these changes has been the introduction of nickel–titanium (NiTi) rotary instrumentation that results in consistent, predictable, and reproducible shaping. This predictability of shaping has not only influenced instrumentation but also obturation results. Primary cone fit no longer needs to be a struggle. Machined, predictable shaping now makes a primary cone fit easy and precise. These changes are certainly welcomed, but are there more advances on the horizon?

As previously mentioned, the authors are confident that significant change will continue to come to endodontics. The anticipated changes range from the idea of disposable endodontic products to the concept of a true hermetic seal when obturating the canal. Certainly not the least among the changes is the issue of making endodontics not only better but also simpler. The authors firmly believe that the more sophisticated a concept, the simpler it should be.

As a result of this quest for a better, simpler technique, Real World Endo in partnership with Brasseler USA has developed a new endodontic file and sequence. It is hoped that this file and sequence will satisfy many of the current demands of modern root canal therapy, while at the same time, be user friendly. Before the specifics of this new "sequence file" are discussed, however, the benefits of a fully tapered preparation must be reviewed.

When clinicians understand the rationale of a continuously tapered 0.06 preparation and perform it in a consistent manner, they will be stunned by how quickly endodontics can become simpler and more predictable.

Real World Endo has been and continues to be a strong proponent of a fully tapered 0.06 preparation. There are multiple benefits to be gained

* Corresponding author. 23 Misty Meadow, Irvine, CA 92612.
E-mail address: HK5DENT@aol.com (K.A. Koch).

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from such a preparation. Before the authors evaluate the potential benefits, however, the issue of taper must be addressed.

A question that clinicians often ask is "How am I going to place a 0.06 taper file into a space that I have had problems using a 0.02 taper? Isn't a 0.06 taper file three times the width of a 0.02 taper?"

The answer to the above question is no. A 0.06 taper is not just three times the width of a 0.02 taper. The proof is in the arithmetic. Consider the following example:

A size 20, 0.02 taper file (20/0.02) is 0.20 mm at a distance (D) of 1 mm from the tip (D-1), and at D-10, the diameter is 0.40 mm. This number is calculated by multiplying the taper (0.02) by the length (10 mm). The apical tip size at D-1 (0.20) is added to the previously calculated number to get 0.40 mm. When the taper is increased from 0.02 to 0.04, it can be determined that the width at D-10 for the new file is 0.60 mm. Interestingly, the taper increased 100% (from 0.02 to 0.04), but the width at D-10 only increased 50% (from 0.40 to 0.60 mm).

If the apical size of the file at D-1 is increased to a size 40 (0.40 mm), the diameter at D-10 for this file can be calculated to be 0.60 mm. Again, if the taper is increased from 0.02 to 0.04, the diameter at D-10 for the 40/0.04 can be determined to be 0.80 mm. So, although the taper increased 100% (from 0.02 to 0.04), the width at D-10 only increased 33.33%. This finding is even more interesting. But what does this really mean?

It means that the effect of taper is inversely proportional to the apical tip size; that is, as the size of the file increases, the effect of taper decreases. This is very significant because this is why a 0.06 taper rotary file can be used with minimal problems. In addition, this is why a fully tapered 0.06 preparation can be performed and still have a conservative preparation.

The knowledge of taper also allows the clinician to understand that there are basically two ways to perform a root canal. The clinician can use a sequence of files that employs a common tip size but has varying tapers (eg, a 20/0.10 file followed successively by a 20/0.08, a 20/0.06, and eventually a 20/0.04 file). The ProSystem GT employs such a variable taper sequence, as do a number of other file systems such as Quantec and RaCe (Brasseler USA, Savannah, Georgia).

A second option is to use a constant-taper file system, with variable tip sizes (eg, a 35/0.04 followed by a 30/0.04, a 25/0.04, and finally a 20/0.04). Two file systems that employ a constant taper are the Profile and the K^3 (SybronEndo, Orange, California).

The authors agree with others who, in effect, have said that the biggest obstacle to endodontic success is the step back preparation. The authors could not agree more, and for the past 2 years, Real World Endo has been trying to get this point across at lectures and in print. The authors, however, would like to take this point one step further.

The authors strongly believe in using a constant-taper file sequence such as a 0.04 or 0.06 taper to shape the root canal preparation. A variable-taper concept, in the authors' opinion, does not work nearly as well clinically as it does on paper. When one thinks about it, a variable-taper sequence is nothing more than a step back preparation from the opposite end of the tooth. As a result of better-quality manufacturing, clinicians now have the ability, with a series of constant-taper files, to create predictable, reproducible shapes. The variable-taper sequence results in a different shape each time a root canal is done. The result is a lack of reproducibility that will make obturation more challenging.

A total comprehension of taper is absolutely critical to clinicians' interest in increasing the quality of their endodontics; however, the question remains, "Why do endodontists prefer a continuously tapered 0.06 preparation?"

There are a number of reasons for this preference. Two of the major benefits of the 0.06-tapered preparation are a dramatic reduction in postoperative sensitivity for patients and the ability to have a precise cone fit. This combination leads to predictability, along with increased patient satisfaction; however, there are other benefits associated with a 0.06 preparation.

When performing a continuously tapered 0.06 preparation, the larger taper removes the tooth structure in the coronal part of the canal that has a tendency to bind instruments. Consequently, the removal of this tooth structure results in a dramatic increase in proprioceptive ability. Therefore, one benefit of this technique is more tactile awareness. In addition, the continuous 0.06 taper allows the irrigation agent to work in a more efficient manner. How effective is the irrigation agent when a size 20 hand file can hardly screw to length? It is not very effective; however, with a 0.06 preparation (performed in a crown down manner), the irrigation agent is getting into the root canal system right from the start. The root canal should be thought of as a three-dimensional system, with webs, fins, and anastomoses. The only way these areas can be effectively cleaned is through the use of an irrigation agent. The irrigation agent has the ability to work much more effectively in a tapered 0.06 preparation compared with a 0.02 or 0.04 preparation. Canals that are preflared with Gates–Glidden burs (and a 0.02 or 0.04 taper) do not do as effective a job with irrigation as a 0.06 preparation. In fact, Gates–Glidden burs make a parallel preparation in the coronal part of the canal. A continuous taper, on the other hand, has superior hydraulics when it comes to irrigation. Furthermore, ultrasonics are particularly effective in a 0.06 taper preparation due to the continuous taper.

Another aspect of the 0.06 preparation that contributes to patient satisfaction is the reduction in extruded debris. Quite often when performing a root canal with hand files, debris is pushed out past the end of the tooth. In a sense, this inoculates the periapical tissues. The sequelae of this is increased postoperative sensitivity, if not pain and swelling. By using rotary files that, by design, pull debris coronally rather than push it in an apical direction, however, the amount of extruded material can be further reduced.

The authors firmly believe that endodontics can be accomplished in a truly painless manner. The 0.06 preparation is a significant key to achieving this goal.

Additional benefits of this technique come after a fully tapered 0.06 preparation has been created: primary cone fit and ease of obturation. Instead of guessing, estimating, or becoming frustrated with bent cones, the 0.06 preparation makes the primary cone fit a "no-brainer." Naturally, this becomes even easier when the main cone matches the preparation.

When live demonstrations at Real World Endo courses are performed, the participants are always stunned at the ease of the cone fit. It is not magic but a result of the 0.06 preparation and having a precisely sized cone. The news about performing a fully tapered 0.06 preparation, however, gets even better.

The authors can confidently state that whatever obturation method is used, they all work better with a 0.06 preparation. Even the solid core obturator systems such as Thermafil work better with a 0.06 preparation because the size no longer has to be "verified."

Even though the authors have performed thousands of 0.06 cases, they previously have been frustrated by one aspect. The authors have not been able to successfully teach (to their satisfaction) this technique to the majority of general dentists. This inability is because the previous 0.06 tapered files had a tendency to be sucked down into the canal or were quite stiff. Consequently, the general practitioner has had a tendency to use 0.04 taper files or files with variable taper. (It is the authors' belief that a 0.04 taper preparation should be performed only when the situation does not allow a fully tapered 0.06 preparation.) The authors hope to change this tendency with the introduction of the Real World Endo Sequence File. True appreciation of this file is gained when its design features are fully understood and it is actually used clinically.

All endodontic companies are trying to produce files that will work more efficiently and safely; however, there remains tremendous variability between the different files. In fact, as more rotary files enter the marketplace, there seem to be greater differences and less in common between the files. Some of the areas where file design differs is in blank design, metal treatment (or lack of), quality of NiTi manufacturing, taper, tip design, cutting efficiency, resistance, flexibility, pitch, helical angles, and speed requirements.

General rotary file design

Blank design

NiTi rotary files are ground, not twisted, during the manufacturing process. Consequently, there are fairly significant differences between the various files. Most files are symmetric in their blank design, although some have an asymmetric design such as the K^3 by SybronEndo. Although the majority of rotary files have blanks that create significant engagement against the dentinal walls, there are other files such as the RaCe that have an alternating spiral design and, therefore, reduced engagement. The blank design of a file is very important because it will influence the flexibility of the file and the lateral resistance. The greater the resistance, the more torque is required to work the files properly. This concept is important because it must be remembered that excessive torque is one of the key factors in instrument separation.

Metal treatment

Metal treatment has been greatly underused in the manufacture of NiTi rotary files. Currently, there are very few companies doing metal treatment of any nature to their rotary files. Surely, most companies know the benefits of metal treatment procedures such as cryogenics or electropolishing. The concept behind the metal treatment of rotary files is that such procedures can extend the life of a rotary file, making it a better file.

For example, electropolishing will dramatically reduce the potential for crack propagation in NiTi files. This process is very significant because it has been repeatedly shown that crack nucleation and propagation is a leading cause of unexplained instrument separation.

Quality of manufacturing

The adage "you get what you pay for" can be applied to endodontics. In fact, there are different quality NiTi blanks that are available for commercial purposes. Some manufacturers use NiTi blanks that exhibit extreme flexibility and excellent shape memory. Other manufacturers employ NiTi blanks that are stiff and actually seem to hold a curve. The quality of the NiTi blank is a little-known factor of file design but one that has serious consequences.

Additional aspects of the quality of manufacturing can be seen if the handle of the file being used comes off during engagement. A good test of the quality of a file is to turn the file around and look straight down on the file as it is rotating in the handpiece. Is the file running true (tight concentric revolutions) or is there a wobble? A wobble signifies a less than ideal manufacturing process.

Taper

The majority of manufacturers produce rotary files that come in a variety of tapers. Depending on the blank design, however, certain rotary files can become extremely stiff in tapers greater than 0.04. In addition, some companies are also producing rotary files in a 0.02 taper, which is the same International Standards Organization taper size as a hand file. Although a 0.02 taper may work well in the hands of certain specialists, the authors believe that using 0.02 taper rotary files is a serious mistake for most clinicians. A 0.02 taper rotary file is so small and flexible that it can easily get pulled into the small radius curvatures present in the apical third of many teeth. Small radius curvatures are a common cause of instrument breakage. If a clinician needs to use a 0.02 taper file, the authors' recommendation is to use a hand file. Real World Endo feels very strongly about this issue because their goal is to not only make instrumentation more efficient for the clinician but also maintain safety at all times.

Tip design

Tips have been described as either cutting tips or noncutting tips. Some files claim to have "modified cutting tips" or "partially active tips." Others have "guiding tips." These claims are all a bit of semantics because a tip can actually be noncutting at the true tip but may become active before D-1 on the shank. Nonetheless, the greatest safety cushion is afforded with noncutting tips.

Is there a place for a cutting tip on a rotary file? The answer is yes; however, cutting tips have a limited indication in endodontics and should be used only in the hands of an experienced clinician. As previously mentioned, Real World Endo believes that most dentists are best served using a rotary file with a noncutting tip. The authors are very confident about that statement. Although some experienced clinicians may be able to use cutting tips, the authors believe that they are too aggressive for most practitioners.

There are two serious concerns with a cutting tip. The first is if the clinician accidentally "goes long" (past the end of the tooth). Going long with a noncutting tip will create a concentric circle at the end of the root. These spaces are easily filled with a nonstandardized or tapered cone; however, if the clinician goes long with a cutting tip, when the file is retracted, an elliptical tear is generally created. This tear is very difficult to repair and obturate, even for a specialist. Furthermore, a cutting tip on a nonlanded file, or a file that does not have a self-centering ability, has the very real possibility of transportation.

Cutting efficiency

Cutting efficiency of rotary files is an area that has received much attention in the past few years. The more efficient a rotary file, the less torque is required. Most manufacturers are attempting to address this challenge. Rotary files with full radial lands and a neutral rake angle have modest cutting efficiency. Rotary files with a positive rake angle and recessed radial lands may have seemingly better cutting efficiency. Depending on where a rotary file is sectioned, however, the rake angle can, in fact, be different. The entire issue of rake angles continues to be one of controversy in endodontics.

Alternately, files that employ a modified triangular bade design and progressive taper (such as the ProTaper [Dentsply Tulsa Dental, Tulsa, Oklahoma]) exhibit increased cutting efficiency. Another aspect, often overlooked, is the sharpness of the cutting edge. A sharper edge can be achieved with a triangular blank design (without radial lands), along with the process of electropolishing. Electropolishing will greatly enhance the cutting efficiency of an edge (Fig. 1).

Resistance

Increased resistance will result in increased torque requirements, which as previously mentioned, is not a good thing for rotary files. Radial lands on rotary files (either full or recessed) will increase lateral resistance (torque) as opposed to a triangular blade design without radial lands. In addition, the more spirals present on a blank (such as a hand K file), the more resistance generated. A reamer design (triangular), on the other hand, will have up to 50% less resistance than a true K-file design. The less resistance created, the smoother and safer a file will perform.

Radial lands were a tremendous help with the first generations of rotary files. They helped keep the files centered and they reduced, to a lesser extent, the tendency for the file to get sucked into the tooth. This was because many of the earlier designs of rotary files were based on hand files or screws. To accomplish this task of not getting sucked down into the canal, however,

Fig. 1. Precision tip after electropolishing.

radial lands sacrificed cutting efficiency along with creating increased resistance (torque).

Flexibility

Flexibility is a design feature that received a lot of attention when rotary files first entered the marketplace. Throughout the years, the flexibility of NiTi files has become a given; however, this is not truly the case. There is tremendous variation in flexibility among the various rotary files. Although it is true that design features can effect how well a file performs, flexibility still remains a critical factor for rotary files.

Many things can effect flexibility, such as the manufacturing process, blank design, and the presence and width of radial lands. The authors strongly believe that if clinicians are treating difficult endodontic cases in their practices, then they need a file with excellent flexibility. It is as simple as that. Flexibility is not as critical in straight canals or teeth with very modest curvatures.

Pitch/helical angles

Pitch is the number of spirals or flutes per unit length. Pitch is very important because a constant pitch will work much like a wood screw and pull you into the tooth. A variable pitch, on the other hand, will significantly decrease the tendency of the file to get sucked down into the tooth. This is especially significant when using tapers of 0.06 or greater. Interestingly, it does not matter how the pitch is varied, so long as it is variable.

Variable helical angles are also an important aid to moving debris up and out of the canal. One can actually see debris moving up along the shank of the file that has variable helical angles. A constant helical angle file is more prone to debris accumulation. This debris accumulation can lead to the need for increased torque, which can lead to potential separation.

Speed

Concerning speed and its influence in rotary instrumentation, the authors would like to propose a formula. E = S & T, where *E*, the energy required to remove dentin, is a function of both speed (*S*) and torque (*T*). As you decrease the torque requirements, one may increase the speed. Basically, this concept means that a file will run better at a higher rate of speed (within reason) than at a lower rate. Although the higher rate of speed may be beneficial, it also decreases the cycles to failure (ie, the file cannot run as long before the onset of cyclic fatigue). It has been the authors' experience to observe that clinicians usually run rotary files at too slow an rpm, not at too fast a rate.

Having discussed the design features of rotary files, in a general sense, the features of the new Real World Endo Sequence File are specifically examined.

Real World Endo Sequence File design

Blank design

The blank design of the Sequence File is absolutely revolutionary. It is designed in such a way that there are alternate contact points (ACPs) along the shank of the instrument. This innovative design not only keeps the file centered in the canal but the ACPs also greatly reduce the torque requirements of the file. This is because ACPs greatly reduce the resistance of the file (Fig. 2).

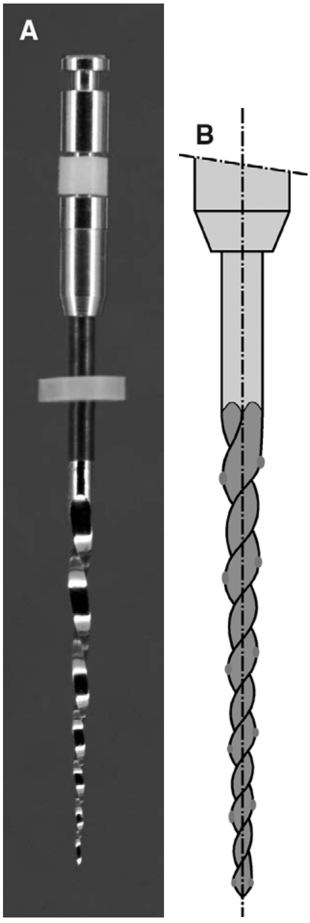

Fig. 2. (*A*) Sequence File with ACPs. (*B*) Diagrammatic representation of ACPs.

There are other significant features to the ACP design. Because the ACPs, in combination with a precision tip, keep the file centered in the canal, there is no need for radial lands. This design change is profound because the lack of radial lands allows the instrument to be sharper and, consequently, more efficient. In addition, the lack of radial lands results in a decreased thickness of metal. The result of less metal is a dramatic increase in flexibility. Clinicians will be amazed at how flexible a fully tapered 0.06 rotary file can be when not burdened by the excessive metal that is needed for radial lands.

Metal treatment

Another admirable feature of the Sequence File is that it has been subjected to the process of electropolishing, which is very significant because of the benefits gained from such a treatment.

Electropolishing removes many of the imperfections in the NiTi that can have catastrophic consequences. For example, electropolishing is very effective at inhibiting crack propagation in NiTi blanks. These cracks have been shown repeatedly to be a major cause of instrument separation. In addition, the creation of a superior finish will keep the edge of the NiTi instrument sharper, cleaner, and more durable. The result of these benefits is a rotary file with more cutting efficiency, less lateral resistance, and increased resistance to wear. Electropolishing can extend the life of a rotary file, but the Sequence File has been designed to be part of a single-use system. Simply put, electropolishing makes any rotary file safer and better (Fig. 3).

It also must be noted that at the current time, the Real World Endo Sequence File is the only constant-taper rotary file system that is subjected to an enhancement procedure such as electropolishing. The authors believe that this is a significant advance in the manufacturing of constant-taper files.

Quality of manufacturing

It is not sufficient to say that just because something is ''Swiss-made,'' it means that it is excellent; however, there is a certain connotation to Swiss-made and the authors believe that the ''proof is in the pudding.'' Real World Endo is committed to the concept of ''Precision-Based Endodontics,'' and this precision is a function of the quality of manufacturing.

On thorough inspection of a Sequence File, by rotating it slowly and checking the consistency of rotation, one should see a shadow consistently climbing up the helical angles from the tip to the handle. After inspecting the edges, one can confirm the sharpness: when the file is pulled across the fingernail (cuticle to tip), it will bite and engage. The sharp edges are a function of its manufacturing process.

On inspection, one can also confirm the flexibility of the Sequence File and, more important, the shape memory of its NiTi blank. The shape memory is superb. It is next to impossible to separate the handle from the shank.

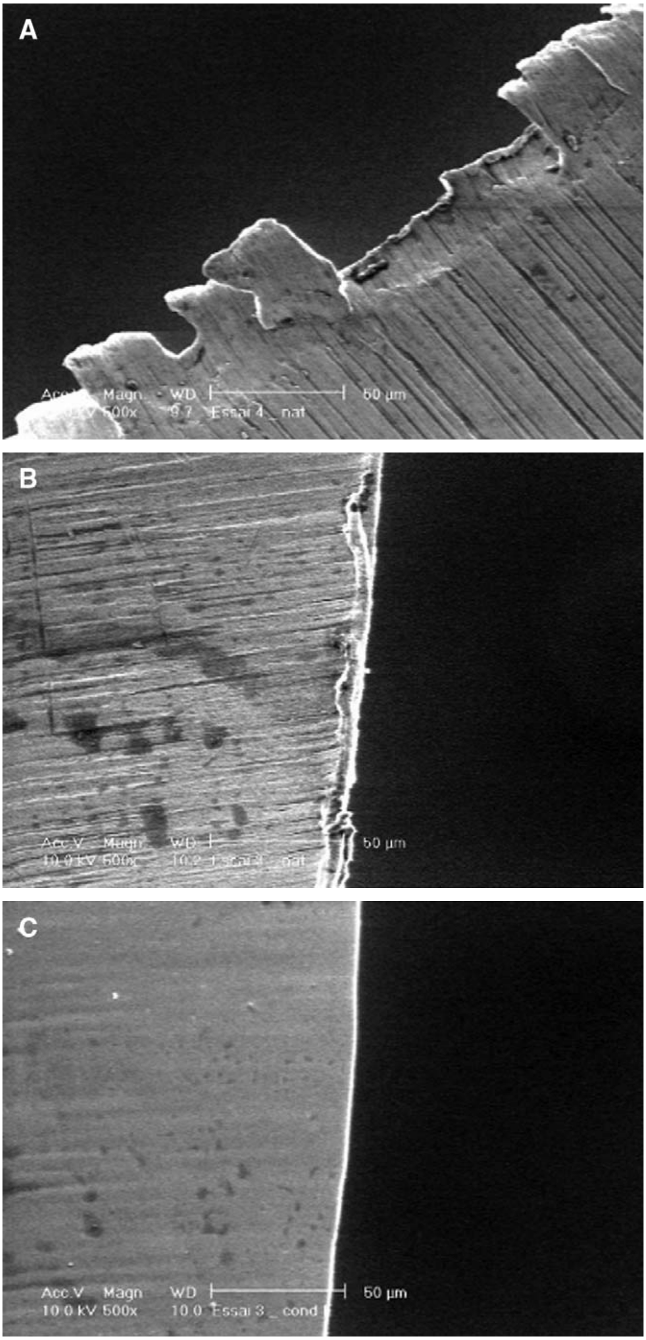

Fig. 3. (*A*) Pretreatment view. (*B*) After traditional polishing. (*C*) After electropolishing.

It is with supreme confidence that the authors can say that the Sequence File has been manufactured to the highest possible standards. The authors challenge any other manufacturer to meet these simple yet rigorous standards.

Taper

The Real World Endo Sequence File is available in both 0.04 and 0.06 tapers. Most important, these are fully tapered files, which means that the working shank is 16 mm, not a reduced 9 or 10 mm. A full working shank is significant because it will allow the practitioner to ‘‘machine’’ a preparation in a precise, crown down fashion. Not only will this technique contribute to painless endodontics but it also will make the primary cone fit an easy match. Obturation becomes much easier when you have a fully tapered machined preparation.

Tip design

It is a goal of Real World Endo to have clinicians perform not only efficient endodontics but also safe endodontic procedures. Consequently, the Sequence File uses a precision tip. A precision tip, by definition, is a nocuutting tip that becomes active right at D-1. The result is safety (nonperforating) combined with efficiency. This is exactly what we want to have in a tip design (see Fig. 1) It is truly amazing how such an effective cutting file can remain centered in the canal. This ability to remain centered is the result of a precision tip combined with ACPs of the blank design. This concept is a new and revolutionary one.

Cutting efficiency

The Sequence File has superb cutting efficiency. The only other file that the authors have seen with a similar efficiency is the ProTaper. Although the ProTaper also employs a triangular bank design, it is somewhat modified. What gives the Sequence File extra cutting efficiency is the electropolishing that results in its characteristically sharp edges. Furthermore, the ACP design allows the portion of the instrument that is engaged to really work in an efficient manner because the full shank is not totally engaged and there is no encumbrance of radial lands.

Experience has shown that the Sequence File cuts so effectively that the operator must be aware to wipe clean or change the file after three pecks (or engagements) of the file. After a brief period of time (3 to 5 seconds), the operator can actually see the flutes (which are a reamer design) begin to accumulate debris. This accumulation is a result of the file’s superb cutting efficiency. Consequently, the operator and the assistant need to be conscientious about cleaning the file. The file should be in the canal only for 3 to 5 seconds before cleaning.

Another wonderful aspect of its cutting efficiency is how well and how fast the Sequence File can enlarge a canal preparation. For example, many times a clinician may be able to reach the working length of a mesial buccal canal (in a lower molar) with only a size 15 file. The following attempt to enlarge this preparation to a size 20, 25, or 30 may be extremely difficult and frustrating. It is astonishing how the Sequence File is quickly able to enlarge the preparation to a size 25 or 30. Best of all, there is no transportation. This ability of the Sequence File to withstand transportation is a function of its ACPs, precision tip, and excellent flexibility. Clinicians will immediately notice the difference when comparing the ability of the Sequence File with any other fully tapered landed file to withstand transportation.

Resistance

The Sequence File, without question, generates the least lateral resistance of any constant-tapered rotary file system, which is a result of its triangular reamer-like design, extremely sharp edges, electropolishing, and lack of radial lands. The manufacturer has combined all these features into a single file, with the result being the lowest torque requirements of any constant-tapered rotary file system.

Flexibility

As previously mentioned, the flexibility of this file is outstanding. The ability to create a file that stays centered, without the need for radial lands, results in greater flexibility of the file. Flexibility becomes a tremendous asset in rotary endodontics as the clinician begins to tackle more difficult cases. In fact, endodontists will always continue to be challenged by more difficult cases. Consequently, the need to have a flexible file becomes paramount to perform quality endodontics.

The key point to remember concerning flexibility is this: flexibility is not the same among the various rotary files and it most certainly should not be taken for granted.

Pitch/helical angles

The Sequence File has both variable pitch and variable helical angles. The result is less of a tendency to pull down into the canal, which is further enhanced by its blank design (ACPs) and the lack of radial lands. The net result of these features is greater control. Control over the file means control over the procedure.

To consistently achieve Precision-Based Endodontics, manufacturing excellence must be combined with clinical control. Although the Sequence File is very efficient at cutting, it nonetheless has excellent debris removal as a result of its variable helical angles.

Speed

The Sequence File has been shown, through test cases (both clinically and bench top), to work best in a range of 450 to 600 rpm. The ideal speed may vary a little according to clinician preference and engine. Every engine the authors have worked with seems to have an optimal rpm for specific files. This concept is analogous to marine engines in which a boat will plane and perform smoothly at a certain rpm, but at other rpm, the boat will experience some noise and vibration.

The authors' personal preference is 600 rpm, which they have found to work well in multiple engines. The authors particularly like the way this file performs in a portable engine (Fig. 4).

Historically, portable engines have been challenged when running fully tapered 0.06 rotary files because the radial lands on the previous generations of rotary files produced excessive lateral resistance. Due to the ACP design (no lands) and its lack of torque requirements, however, the Sequence File runs superbly in a portable handpiece.

It also is a goal of Real World Endo to remove as many rheostats as possible from the treatment room. The day is coming when clinicians will be able to perform rheostat-free endodontics.

It must also be pointed out that the Sequence File has a tendency to click in the canal. In the past, this clicking might have been cause for alarm; however, it is not unusual for a triangular-shaped blank. If the clicking becomes a clacking (or clearly noisy), however, then it means that you are pushing too hard on the file. The clacking will disappear when the file is not pushed as hard. The rpm should not be reduced because the clacking is a result of excessive force, not rpm.

Fig. 4. Brasseler Sequence File portable handpiece.

In the authors' experience, rotary files that are run at too low a speed (150–175 rpm) result in increased breakage. This breakage takes place because the file is going so slowly that there is a tendency for the clinician to force the file. A file should never be forced. By running the handpiece at the proper rpm (450–600 rpm), the clinician can let the file do the work.

Now that the design features of the Sequence File have been discussed, the following section addresses clinical technique.

Real World Endo Sequence File technique

The Real World Endo Sequence File comes in packages of four files each. The selection of Sequence Files includes an Expeditor file (four to a pack) and 0.06 taper rotary files in sizes extrasmall/small, medium, and large. In addition, there are 0.04 taper Sequence Files available in sizes extrasmall/small and medium.

All root canal preparations are begun by confirming coronal patency. This confirmation is achieved with a size 10 stainless steel hand file that is taken down half way into the canal. Coronal patency is important because if the coronal half of the canal is open (patent), then it will be open all the way to the apex. After reaching the halfway point in the canal, the size 10 file is "worked" in a back and forth motion to ensure a glide path. If the canal is extremely tight, then the clinician may also wish to use a size 15 hand file.

After coronal patency has been confirmed, an Expeditor file is the first rotary file placed into the canal. The use of an Expeditor is a new concept, using a totally different file. The Expeditor is a size 27, 0.04 taper rotary file that incorporates a working shank of 16 mm and an overall length of 21 mm (Fig. 5). The purpose of the Expeditor is to determine the approximate size of the canal and which package of files should be opened. The authors have given the Expeditor an overall length of only 21 mm so that the clinician does not get tempted to "bury" the file deep into the canal (ie, efficiency combined with safety).

After entering the canal with the Expeditor, this file is taken down into the canal until significant resistance is encountered. Significant resistance is when the file no longer progresses in an easy manner. Having met resistance with the Expeditor, this file is now removed from the canal, and the operator chooses which package of files to open. This decision is based on information gleaned from the preoperative radiograph, the resistance of the size 10 hand file, and the depth of penetration of the Expeditor.

When the Expeditor goes down halfway into the canal, it signifies a small canal; however, when the Expeditor goes down more than halfway, it means the canal is medium sized. A totally loose Expeditor that goes to its entire length signifies a large canal. After the canal size is determined, the operator simply picks the appropriate pack of files.

Fig. 5. Sequence Expeditor file.

For example, in a narrow canal, the package of extrasmall/small files may be chosen. After choosing the appropriate Sequence File, a crown down technique is performed in the recommended manner. For example, in a small canal, beginning with a size 30, 0.06 taper (30/0.06) file, the author takes that to resistance. Following the initial file, a 25/0.06 Sequence File and then a 20/0.06 file are taken to resistance. Quite often, the 20/0.06 Sequence File will take the author to the working length. The question remains, however, "How do you know when you are finished?" The crown down preparation is complete after the first rotary file that reached the working length with resistance has been used.

There will be times, however, when the 20/0.06 Sequence File falls short of reaching the working length with resistance. In this case, crown down should be continued to a 15/0.06 file, and generally, this file should take the clinician to the final working length. If the canal is narrow and the clinician must crown down all the way to the 15/0.06 file, the authors suggest that the preparation should not be finished with this size instrument. It is better to simply go back into the canal with a 20/0.06 Sequence File, which will readily go to the working length. This procedure is easily accomplished because the Sequence file is extremely efficient at enlarging a previously created glide path.

The aforementioned technique works very well for the overwhelming majority of cases; however, in extremely difficult, narrow canals, the authors slightly modify the technique to reduce stress on the file.

Real World Endo Sequence File technique for extrasmall canals

As always, the clinician begins by confirming coronal patency with a size 10 stainless steel hand file. This step is extremely important when treating narrow canals. It is also suggested to take a size 15 hand file into the canal and create a glide path. This procedure will facilitate the rotary instrumentation in such canals. Following the use of the hand file, the Expeditor is introduced into the canal. The Expeditor is worked down into the canal until significant resistance is met. Following the use of the Expeditor, the clinician should open the package of files labeled extrasmall/small.

The crown down procedure can begin, but with one modification. A modified crown down sequence will be substituted for a straight crown down.

The modified crown down preparation begins with a size 25, 0.06 taper (25/0.06) Sequence File, taken to resistance. Generally, this file goes down the canal about 15 mm and should be followed with a 30/0.06 Sequence File. This file will generally go 1 to 2 mm less. After two files, the coronal half of the canal has been successfully preflared. The final working length may now be determined with a size 10 stainless steel file and an apex locator. The clinician may chose to create a glide path to the apex with a size 10 or size 15 hand file. Following length determination, the clinician returns to the original 25/0.06 file and works this file to resistance. Instead of just going to 15 mm, however, it now tracks down to about 18 mm. This increased length is what is so effective about this technique. Following this step, the clinician takes the 20/0.06 file to resistance. Often, the size 20 will reach the final working length. If not, the crown down should be continued with a 15/0.06 file, which will generally reach final working length. As previously mentioned, when crown down must go all the way to size 15, the authors recommend looping back with a 20/0.06 Sequence File and taking this to length. The authors do not advocate finishing the preparation with a size less than 20. This applies to both 0.04 and 0.06 fully tapered preparations.

Although the modified crown down works extremely well in difficult cases, one further change can make the technique easier: performing this technique with 0.04 taper rotary files instead of 0.06 taper instruments.

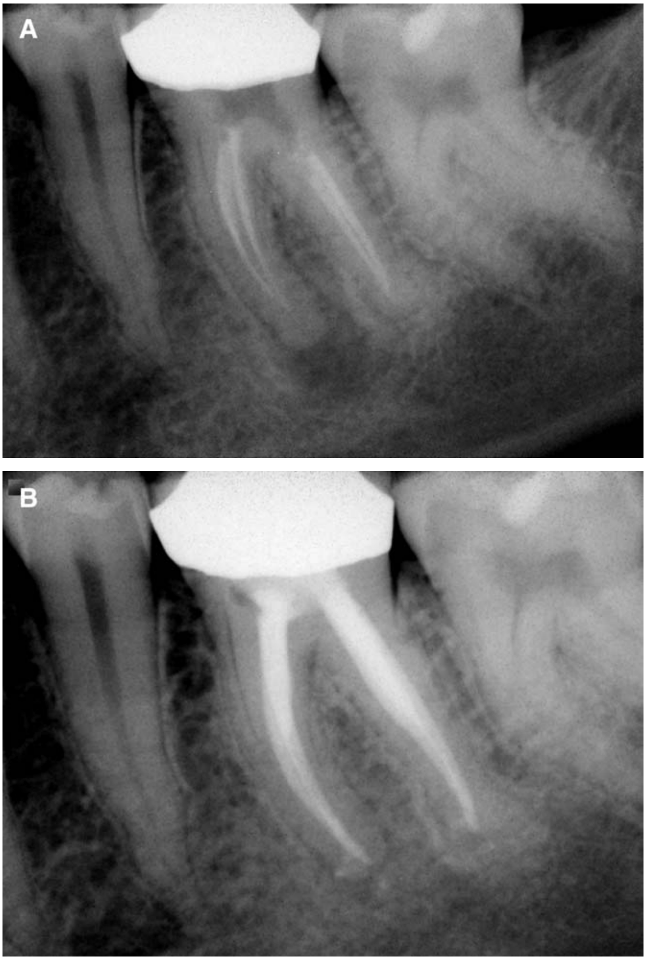

Fig. 6. Case 1. (*A*) Failed 0.02 taper hand filing case. (*B*) Successful retreatment with 0.06 taper rotary files.

Often, this change is exactly what is needed to instrument these challenging cases (ie, it is all a function of taper).

Summary

In review, the entire Real Word Endo Sequence File technique is based on the concept of using an Expeditor file and then choosing the size of the canal. The canal size is either small, medium, or large, and each corresponding package contains the four files necessary to properly shape the

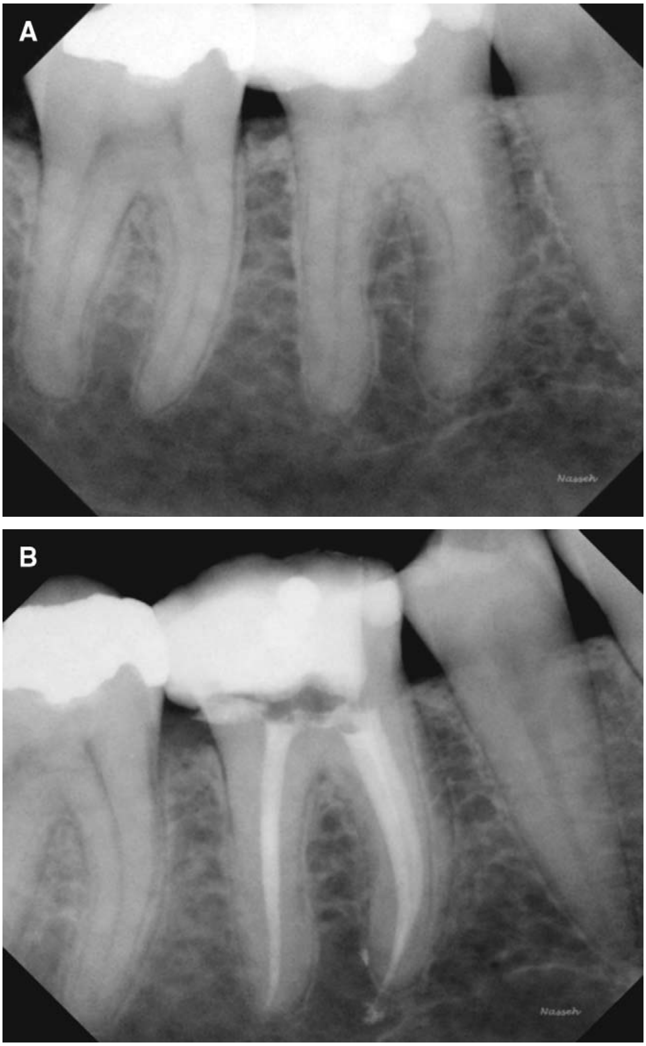

Fig. 7. Case 2. (*A*) Preoperative radiograph of mandibular molar. (*B*) Postoperative radiograph showing machined preparations. (Courtesy of Dr. Ali Nasseh.)

canal. Generally, the canal preparation will require only three files, but a fourth file has been included for challenging cases (Figs. 6–10).

Although the Sequence File is unique in being both procedural and precision based, it is also different in terms of its handling ability. It is a rotary file, and like all rotary files, it should not be forced. As previously mentioned, if this file is ‘‘muscled,’’ then a clacking of the instrument is heard. This is a ‘‘heads-up’’ to reduce the pressure on the file. When the proper technique associated with this file is learned, however, the clinician

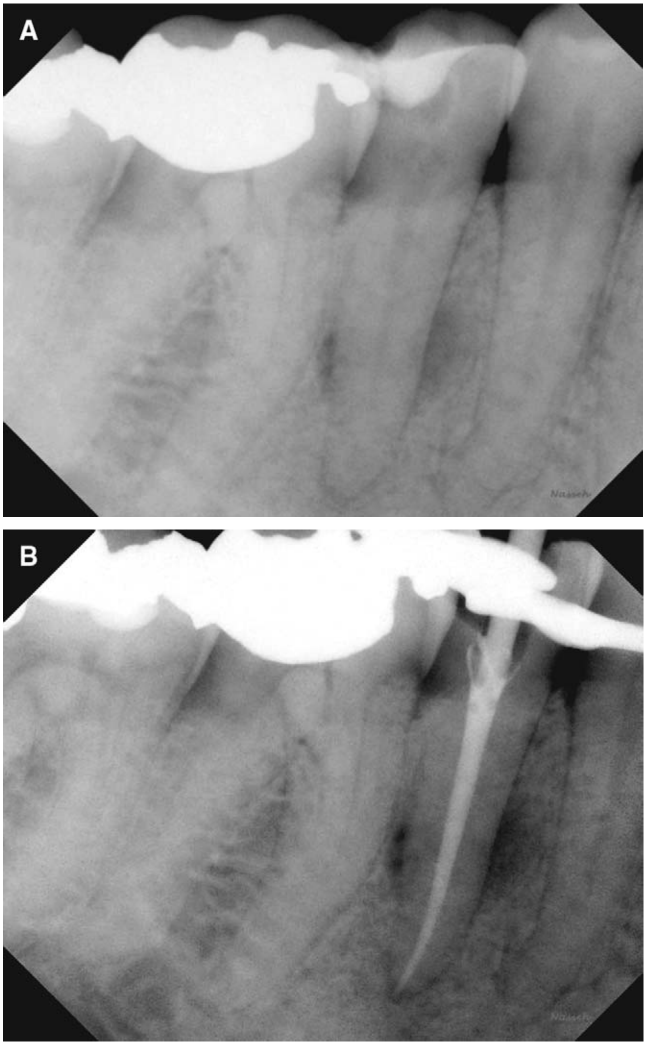

Fig. 8. Case 3. (*A*) Midroot "area" on mandibular premolar. (*B*) Working film displays precision of preparation. (*C*) Postoperative radiograph. (Courtesy of Dr. Ali Nasseh.)

will realize that it is merely a matter of guiding the instrument. This is a result of its superb cutting ability. In addition, the unique ACPs gives this file an unbelievable "feel." The canal can actually be felt with the Sequence File. This change from some of the previous rotary files that were stiff and lacking in sensitivity is a welcome one.

The clinician needs to establish a firm finger rest when using rotary files. This concept also is important with the Sequence File; the entire procedure can be made very comfortable when combined with a portable handpiece.

Fig. 8 (*continued*)

The Sequence File is not used like previous rotary files that had radial lands; that is, the file is not taken to resistance and back, to resistance and back, and so forth. The Sequence File also is not used with short staccato-like pecks. Instead, it is used in a single "1-2-3" motion. The file is taken to engagement (1) and back, to engagement (2) and back, and finally to a third engagement (3), and out of the canal. The clinician will very quickly learn this rhythm. It is the rhythm of precision endodontics.

Always clean the file after three engagements. It is recommended that the clinician perform two series of three engagements each before going to the next file. Each series of engagements should take approximately no more than 3 to 5 seconds.

What is meant by engagement? When performing this technique, the clinician can actually feel the Sequence File engage the walls of the canal and begin to work. As soon as the clinician feels the file engage, the file should be slightly retracted (1–2 mm) and then reinserted for another engagement. By using this technique, the clinician is instrumenting the canal millimeter by millimeter.

The portable handpiece allows clinicians to work strictly with their fingers (thumb to middle finger). So, instead of controlling the file from the wrist area (as is done with thicker, landed files), we now have, for the first time, a rotary file that is controlled by finger tip pressure. This adds greatly to the overall control of the procedure and will more easily allow the clinician to achieve Precision Based Endodontics.

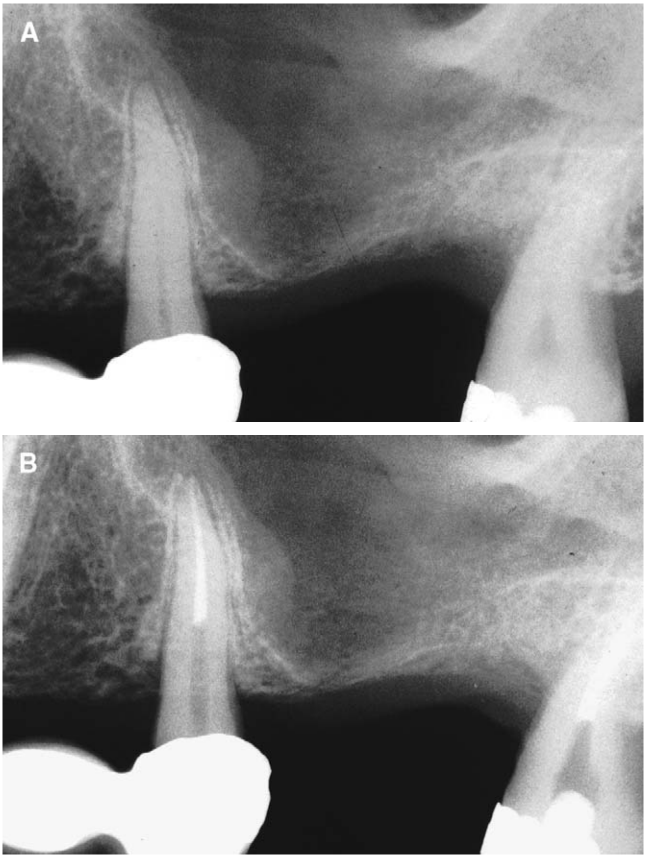

Fig. 9. Case 4. (*A*) Preoperative radiograph of maxillary bicuspid. (*B*) Completed case showing conservative aspect of machined preparations. (Courtesy of Dr. Emanuel Alvaro.)

The following list reviews the basic Real World Endo Sequence File technique:

1. Confirm coronal patency.
2. Use Expeditor to determine canal size.
3. Begin crown down.
4. Establish working length after second file from Sequence File package.
5. Complete crown down.
6. Obturate the canal.

The following list reviews the basic Real World Endo Sequence File technique (straight crown down):

1. Confirm coronal patency with a size 10 stainless steel hand file. The file only needs to go to approximately one half of the projected working length. If a canal is patent in the coronal third, then it usually will be

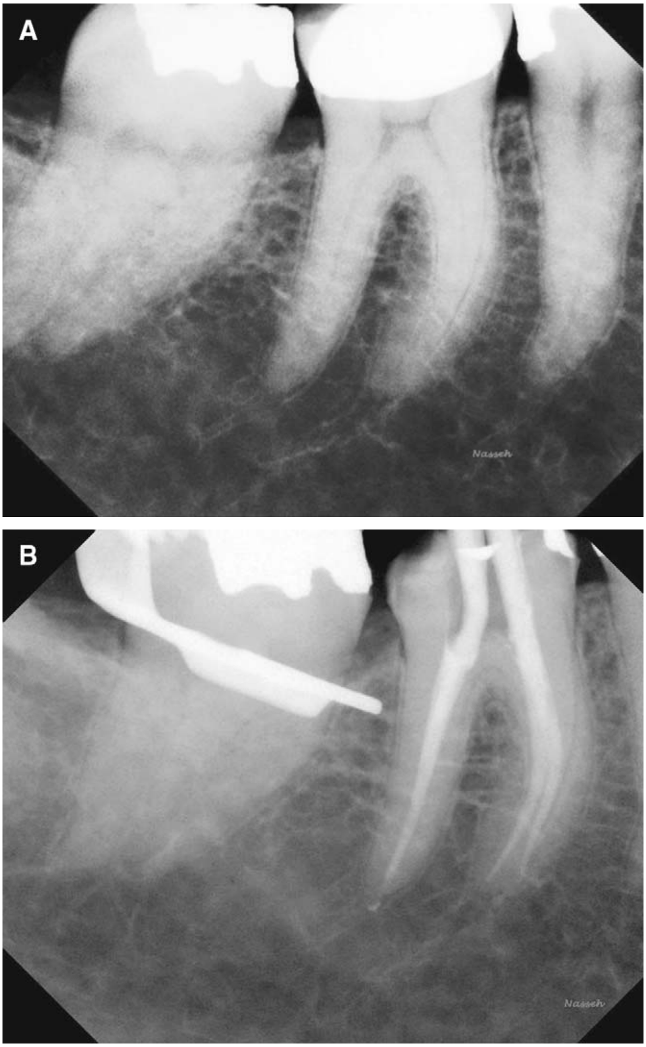

Fig. 10. Case 5. (*A*) Preoperative radiograph of molar. (*B*,*C*) Working film displaying precision of Sequence File cone fit. (Courtesy of Dr. Ali Nasseh.)

open to the apex. Too many dentists make the mistake of trying to force a hand file to length before coronal flaring.

2. Determine canal size based on the preoperative radiograph, the fit of the size 10 stainless steel hand file, and the depth of penetration of the Expeditor. Canal size is generally small, medium, or large.
3. Begin crown down with a file from the appropriate file-size package.
4. Establish working length with a size10 hand file and an apex locator after using the second rotary file from the package. Determine working length after the second rotary file to take advantage of the crown down.

Fig. 10 (*continued*)

5. Complete rotary preparation in a straight crown down fashion. The first Sequence File to length, with resistance, completes the preparation.
6. Obturate the canal with the technique of your choice.