Rotary negotiation as first file to length

Drs. L. Stephen Buchanan and Christophe L.M. Verbanck discuss a modern answer to an age-old issue

"If you obey all the rules, you miss all the fun" — Katharine Hepburn

The rotary file rule

Since the beginning of the nickel-titanium (NiTi) rotary file revolution, we have been nearsighted in our expectations of what is possible. For the 30-plus years we have had them in our arsenal (Haapasalo and Shen, 2013), our wonder over what mechanized instrumentation could do for us was limited by the instruments we had at the time, by our conceptual misunderstanding of what is really going on when we use hand files to negotiate small complex canal forms, and by our fear of damaging patient's teeth. This is completely understandable considering the hidden and tortuous canal paths we encounter when we thread the first file to length (Figure 1). For these reasons, endodontic educators and clinicians came to believe that rotary files should only be used for shaping after a glide path to the terminus has been secured with hand-operated K-files. The realistic concerns were that rotary files would break if used as first file to length; that rotary files used this way would block, ledge, or lacerate apical anatomy; and that rotary files would resist advancing through apical curvatures or beyond apical impediments.

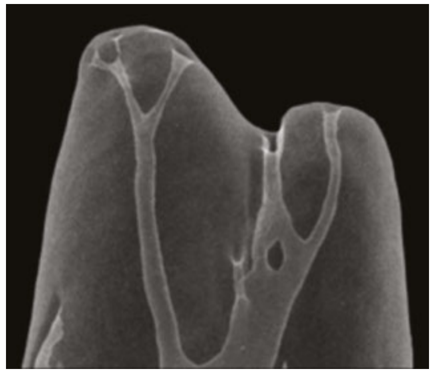

Figure 1: This CT reconstruction of the apical third of a premolar root shows the challenge we often encounter when negotiating root canals to their terminal lengths. In just these two canals, there are five potential impediments to passage of the first negotiating file to length

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Disclosures: Dr. L. Stephen Buchanan is a co-founder of PlanB Dental.

Functional characteristics of file geometry and metallurgy

At the advent of the rotary file revolution, before heat treatment was used to reduce the shape memory of NiTi alloy, file breakage was a serious problem that was mostly resolved by procedural workarounds such as crown-down shaping (using a big-to-small file order) to reduce torsional stresses delivered to the smallest files (Peters, 2004). This has changed radically as today's heat-treated rotary files have the ability to unravel and wind up backwards before coming apart under stress (Peters, et al., 2012; Santos, et al., 2013); so for the first time, they can be used as first file to length (FFL) before any coronal shape has been cut (Buchanan, 2019). Conversely, without heat-treated NiTi files, rotary negotiation as FFL is untenable.

The other technological advances in rotary file manufacturing have been achieved through improved flute angles, file tip geometry, and cross-sectional core strength (Figure 2). Typical tapered-file flute geometry has flute angles that are tighter at the shank end and more open near the file tip, which contributes to files threading into canals when their shank end flutes approach the orifice level. When that happens, file tips are propelled into the canal; and if they have lesser flute angles, they are more likely to hang an edge, a major cause of file separation. Files with consistent flute angles have greater tip flexibility and strength, while their shank end flutes resist threading and cut more effectively. This flute-angle geometry is imperative when using rotary instruments as FFL (Buchanan, 2019). Without it, breakage too easily occurs, even when using a light touch and a low-torque limit. Adequate core strength is also critical in these narrowest of files; miniKUT Rotary Files have different cross-sectional geometries, depending on their purpose — just two flutes for the larger shaping files to aid cutting function, and four flutes for the smaller EZP rotary negotiating files to add torsional strength (Oh, et al., 2010).

With these engineered solutions that minimize breakage, the only remaining concern about using rotary negotiation as FFL is the possibility of rotary file tips blocking, ledging, or perforating the often tortuous apical regions of canals. This is why file tips on these rotary negotiators are fully radiused. This extremely passive tip geometry not only prevents ledging and perforation, but also actually causes these rotary files to kind of "bump" around impediments that would absolutely be engaged by an unbent hand file. While blockage is always a concern when advancing a file into apical regions of vital canals during negotiation procedures, it turns out that the way hand files function when used in a watch-wind, push-pull manner is actually the cause of most apical blockage.

Deconstructing hand file negotiation, learning to love motor-driven negotiating files

Before we move on, it's important to thoroughly understand what happens in apical regions when hand K-files are used as first file to length during negotiation. It's not quite what you think. Hand K-files are used in many ways, including watch-wind, push-pull, 1/4 turn-pull, and the Balanced Force method.

Forty-seven years ago, 1/4 turn-pull was shown to ledge curved canals, so that's out (Weine, et al., 1975). The Balanced Force (Roane, et al., 1985) manner of cutting with K-files, while the most effective way to move a hand-operated K-file through dentin, is not a good technique when using files smaller than a No. 15 K-file. That leaves us with watch-wind, push-pull.

Watch-wind, Push-Pull (WWPP) filing action is accomplished by inserting the file into the canal (with a lubricant filling the access cavity) until it binds. Apical pressure is applied to the file and it is then rotated back and forth (watch-winding), limiting the movements to a 1/4 turn in either direction, wherein the file usually moves apically and tightens in the canal. The file is then used in three to four push-pull filing motions to loosen it at that position in the canal. After that, apical pressure is reapplied to the file; it is again watch-wound to advance it further in the canal, followed by push-pull filing to advance again. Rinse and repeat until the file does not advance during watch-winding with moderate apical pressure.

What actually happens near the canal terminus during apical advancement with this method? As the first file progresses to length in these small canals, it pierces and macerates pulp tissue, then leaves it in the apical third, risking compaction by the next larger file used. That is why we need to use lubricants and patency files during this procedure to avoid apical blockage by pulp remnants or, when it occurs, to pick a hole through the apically compacted debris, break it loose, irrigate it out of the canal, and then run another cutting cycle. Reciprocating motor-driven files cut and move even more debris in an apical direction in less time than a hand file when used with the WWPP technique, so it is too dangerous to use for rotary negotiation. In the authors' opinion, reciprocating handpieces are a step backward in apical function.

The only motion that won't work at all with hand K-files is continuous rotational cutting by hand. When small K-files are in use, continuous rotation in the same clockwise direction threads the file into the canal until its tip binds canal walls; whereafter, if CW rotation is continued, the file shank is literally twisted off the bound-up file tip. Constant rotary file rotation works because of a) the torsional strength of NiTi, and b) the centripetal force provided by the file spinning at 500 rpm (8 times a second), which bangs the flutes against the dentin, cutting it with a fraction of the torsional stresses delivered by hand files continuously rotating in a CW direction.

In fact, one of the greatest, but least appreciated, advantages of even the earliest rotary files was that for the first time, these rotary files removed the debris cut from the canal — carried in its flute spaces — instead of leaving cut debris in place to cause trouble. This functional characteristic of rotary files once again comes to play a major role when they are used as FFL.

During the development of rotary negotiation files, the overriding concern was preventing file breakage and avoiding apical blockage, ledging, and perforation (Plotino, et al., 2020). Surprisingly, the outcome was not a technique just as safe as hand-driven K-files. The outcome was a technique that is faster, easier, better, and safer than hand file manipulation.

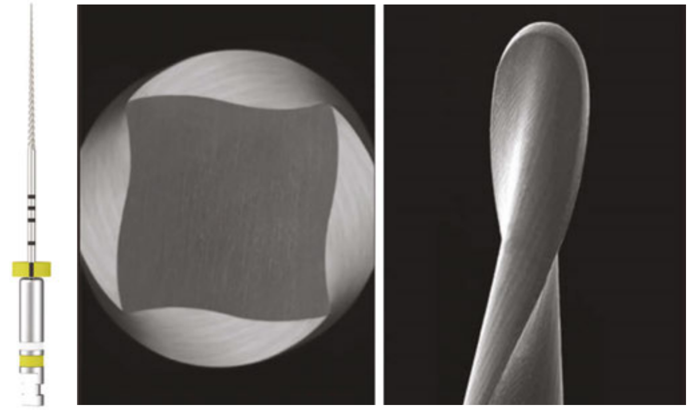

Figure 2: PlanB's 15-.03 miniKUT EZP Rotary Negotiation File. Note the square cross section and the aggressive rake angles of the four flutes, providing torsional strength with cutting efficiency (middle). The completely passive "duck-bill" file tip geometry eliminates the chance of ledging curved canals during rotary negotiation as FFL (right). The side view shows flute angles that are consistent from tip to shank, preventing file threading and tip breakage (left)

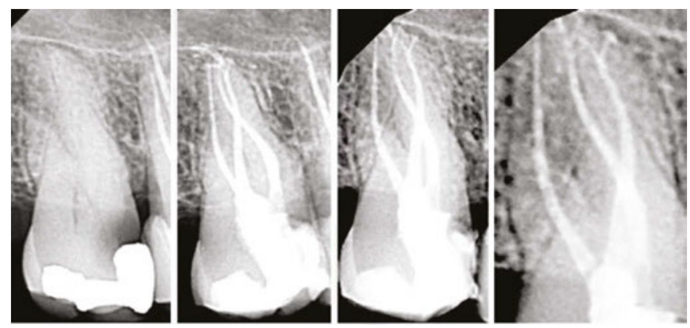

Figure 3: The canals in this case were negotiated with a 15-.05 miniKUT EZP Rotary Negotiation File (PlanB Dental) after multiple unsuccessful attempts to get through the DB canal beyond mid-root with prebent No. 06, No. 08, and No. 10 SS K-files. Case by Dr. L. Stephen Buchanan

With rotary negotiation, patency is not an issue because pulp tissue is broached out of the canal and augured into the pulp chamber by the constantly spinning file (Ha, et al., 2016). Conversely, hand K-files used with WWPP motions encourage apical blockage and tend to engage the smallest canalar impediments rather than glance by them as rotary negotiation files do.

The simple fact is that rotary negotiation as FFL is superior to hand file negotiation (Figures 3,4 and 6).

Handpiece + EAL = Smart
Handpiece + EAL + Rotary Negotiation = Genius

While having a heads-up display of handpiece and apex locator functions will likely be available in the future, we already have remarkably sophisticated functionality in the latest endo handpieces with electronic apex locators (EAL) inside (Figure 5). Motors with a resident EAL have a file lead conductor that runs through the handpiece attachment to its chuck where it contacts the latch-grip handle of the file, eliminating the need for a separate apex locator and file lead.

While these handpieces still require a ground lead be connected to the patient, eliminating the file lead and automating important handpiece functions is a game changer. Above all, the *Apical Stop* function of these handpieces improves clinicians' accuracy during instrumentation. This is chosen during initial programming as opposed to *Apical Slow,* or the worst, *Apical*

Reverse. *Apical Slow* isn't helpful as some files break more easily when used at speeds lower than the manufacturer's recommendation. *Apical Reverse* causes the file to back up when the preset apex locator position is reached, which dumps all the cut debris in tip flute spaces into the apical constriction, a perfect setup for apical blockage. *Apical Stop* is ideal: When the file stops spinning in the canal, it lightly binds at length, providing stability of the file as the stop is moved to position at the chosen reference point.

When positioning a hand file with a traditional EAL, besides the awkwardness of holding a hand file with an EAL clip hanging off of it, it requires rotating the file back and forth, so the helical flutes move the file in and out with vernier movements until the apex locator shows a steady bar at the position set on the EAL. Then the stop on the file shank is set to a reference point on the tooth, the file is removed, measured, and the next file to be used has its stop set at the referenced length. Rotary positioning of the file based on electronic signals is dead-on, immediate, and it cuts out at least four to five opportunities for error during length determinations with traditional methods.

First off, having the EAL inside provides Auto Start and Auto Stop functions. The Auto Start and Auto Stop functions not only significantly boost productivity during instrumentation, but also eliminate one of the most irritating aspects of using a cordless endo handpiece — having to hit the on/off button instead of actuating it by foot control. We use foot controls in a car (gas, brake, clutch) because we need to use our hands to steer, and humans are quite good at moving all of their limbs to control simultaneous but different functions. When we have to turn a cordless handpiece on and off, we momentarily lose our dexterity in directing the handpiece physically through space. With Auto Start, the moment the file tip touches irrigants or lubricants in the access cavity, the motor spools up. Auto Stop then happens as soon as the file clears the pulp chamber, allowing immediately cleaning and inspection of the file, thus shortening the time it takes to get the file back in the canal to do more work.

So what do we do when a rotary file doesn't want to progress to length, and we need to use a hand K-file? These handpieces all have a secondary file lead (plus the file lead running through the handpiece) if a hand file needs to be brought into service.

Single-file canal treatment

Great progress has been made over the past years in endodontic procedural concepts, tools, and techniques. For those who resist the idea of using rotary negotiating files as first file to length because they believe hand files provide the chance to shape complex apical anatomy, this is both wishful thinking and sophistry. Fortunately, there are increasing numbers of clinicians who understand that instrumentation is solely meant to cut enough space in canals (if it doesn't already exist) to allow adequate irrigation and obturation of the space in all of its natural complexity.

The benefit of this conceptual leap? Fewer files, less breakage, less time spent instrumenting before irrigation, and less loss of structural integrity. When you use three to five hand files before you meet the apex, that is not a Single-File Case. A Single-File Case is when a 15-.05 miniKUT EZP rotary negotiation file cuts to length without pause and the canal then gauges at a No. 15 K-file, indicating that shaping is complete. *That* is a true Single-File Case. Welcome to the 21st century.

Look for our next article on the broader topic of instrumentation in the spring edition of *Endodontic Practice US*. EP

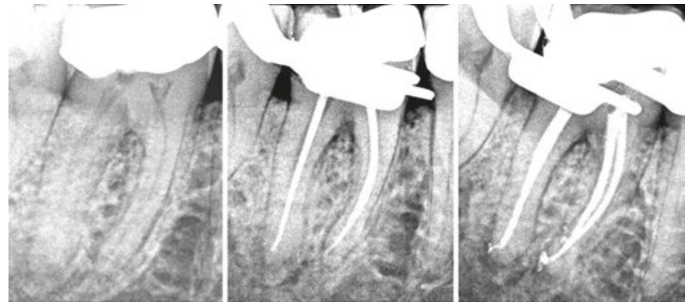

Figure 4: First full-rotary negotiation case. Rotary negotiation with a Hyflex EDM 10-.05 Glidepath File (Coltene) was the easy way to go because of the limited inter-occlusal distance. Case by Dr. Christophe Verbanck

Figure 5: PlanB cordless endodontic handpiece with an electronic apex locator inside, providing automatic on/off function as well as highly accurate apex location

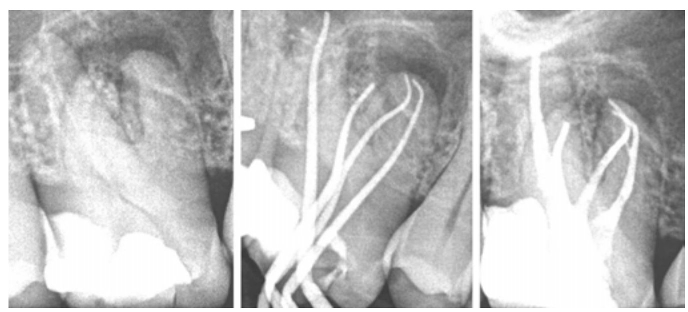

Figure 6: Rotary negotiation case done with miniKUT 15- .03 EZP Rotary Negotiating File (PlanB Dental), used with a cordless endo handpiece with built-in apex locator. Case by Dr. Christophe Verbanck

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