We have heard the term “rules of engagement” used in the military to categorize a line of behavior that best fits the various situations that may arise. These rules are a product of experience, war college exercises and think tanks. They are critical because war is not a game and what starts off as an orderly process can rapidly degenerate in the fog of war.

While not as all-consuming as war, we need rules of engagement in endodontics. The American Association of Endodontists has established guidelines for determining degrees of case difficulty, implying beyond a certain degree of complexity, the cases should be referred to a specialist. While case assessment is a worthy goal, it is unrealistic to determine when a case should actually be sent to a specialist because of the wide range of endodontic skills that individual dentists bring to the tasks.

Rather than impose generalized rules, I think it is more productive to apply rules of engagement on the basis of sound mechanical principles, principles that apply to both the design and implementation of the instruments designated for endodontic procedures. Once dentists understand basic mechanical principles, it will become readily apparent what anatomical situations will impose greater burdens on the instruments and the dentists employing them. I don’t completely agree with an opinion that I have read in various venues stating that it is not the instrument, but the dentist employing it that matters. In fact, there is a continuous interaction between any instrument and the dentist using it and a well-designed instrument used in the most efficacious manner can reduce the challenges when encountering complex anatomy.

The best way to utilize the rules of engagement is to apply the logic that support these rules, one rule at a time and then observe how they interact with other rules having a neutral, positive or negative effect on the overall procedure. Let’s start with initial canal access. The goal is to gain access to the entire canal system while minimizing the amount of tooth structure that we must remove.

The more calcified the case, the greater the amount of overlying secondary dentin obscuring our access to the canal orifices. To discover these canals, we are most likely going to have to go deeper and wider since canals diverge from the chamber as they travel apically. Calcified chambers represent a line of division for some dentists who may then decide to refer out. For them, they have confronted the first rule of engagement, namely encountering a situation where they are uncomfortable in proceeding, and have correctly decided to withdraw. I say correctly because deferring to those with greater skills and experience is never a bad decision, although this is not what this article is about.
Typically, dentists will use either a No. 4 or 6 round bur to gain access into the pulp chamber and then straighten the walls with either barrel-type diamonds or carbide burs. Whether or not the canals are calcified the pulp chamber is approximately 7 mm apical to the cusp tip unless the cusp tip has been severely worn down (Fig. 1). Having a clearly defined 7 mm mark along the length of a surgical length high-speed bur makes aligning the appropriate depth easier (Fig. 2). With the roof completely removed either by pulling up with the round bur or the use of the barrel diamonds or stainless-steel carbide burs, we may be staring at a floor that gives little hint that it was once occupied by a soft gelatinous pulp tissue. What takes its place are pulp stones that grow from the floor coronally, are often somewhat translucent and take on a yellowish tint. At times these stones may actually cleave off the floor and walls of the canal while at other times they hold on quite tenaciously and must be removed with drills or ultrasonics.

Because these stones grow coronally from the floor, their presence is often denoted by a groove between the walls and the centrally placed stone (Fig. 3). The best place to concentrate on removing the stones while searching for canal orifices is along these grooves. I prefer the use of drills to explore the depth of these grooves rather than ultrasonics. Drills leave a smooth floor, while ultrasonics leave the floors scoured. It is easier to find any tissue inclusions when they represent interruptions in an otherwise smooth floor (Fig. 4). For the past several years I have been using Munce burs (CJM Engineering) that are a series of round burs from 0.25 to 4 on 34 mm shafts (Fig. 5). Recently, I have been experimenting with EndoGuide burs (SS White) (Figs. 6a, 6b) that for the most part are triangular in shape with rounded tips sizes that are smaller than Munce burs. Both readily cut the dentin in a very controlled fashion. I believe the EndoGuide burs are able to trough the grooves somewhat easier because of their triangular design. Working under a microscope using either one of these micro-bur systems gives the dentist the ability to find not only the main canals, but also mb2s, middle mesials and any other aberrant canals that may be present. The depth of the groove represents the limit on how deep you explore. Once a smooth floor is encountered, we now will only go deeper where tissue inclusion bodies appear.

We could say that the rules for further engagement when encountering highly calcified canals would include the need of a microscope or at least fairly powerful loupes with illumination as well as some form of Munce bur or EndoGuide bur. Without these extra tools, referring out becomes a time honored and wise decision.

Once the canals are recognized, we want to confirm their presence by being able to negotiate an instrument through them to the apex. It is quite logical that some of the calcifications encountered in the chamber will also have affected the patency of the canal. When first negotiating through a canal orifice, it is helpful to make sure the chamber is well lubricated with either NaOCl or aqueous EDTA. If vital tissue is present I prefer the use of aqueous EDTA first, because unlike NaOCl it will not congeal the tissue prior to digesting it, making it easier to negotiate through the length of the canal. When resistance is encountered with the first instrument attempting to negotiate into the canal orifice, there are those who suggest the use of stiffer files that can press heavily into what is believed to be the canal opening. I would suggest an opposite approach only using the most flexible reamers that have minimal engagement along length to first attempt to enter into a tight canal. I am against stiff instruments because if you are wrong in your estimate of where patency resides, a stiff instrument is far more likely to produce an indentation into the dentin making it more difficult.
to find the canal. It’s far better to use an instrument with minimal engagement that will find the smallest patent entry into the canal. If such an instrument does not find a patent pathway, it is likely one is still not present at the depth so far attained, and deeper probing with either the Munce burs or the EndoGuide burs is required.

Eventually, the dentist will reach a point where patency exists and he will find it earlier with an O6 reamer than he will with a K-file of the same tip size. By staying within the grooves that were troughed particularly at the apices of what may be a triangular, square or rhomboid floor of the chamber, the dentist is unlikely to perforate through the floor. There are ample landmarks available, and as long as we remain closely attached to them we are unlikely to perforate either through the floor or laterally.

An additional rule of engagement is to use reamers as well as relieved reamers, as I will soon show. Reamers both unrelieved and relieved are compatible in design and utilization with attaining the results you want. First you want to negotiate through the length of the canal as efficiently as possible. K-files, like every true file, have a high number of horizontally oriented flutes on a shaft that is watch-wound into the canal. In the process of applying a horizontal motion (that is what watch winding is) to horizontally oriented flutes, the flutes will engage and disengage without shaving dentin away from the length of the canal walls until the pull stroke is employed. Because watch winding is the predominant motion, it is all wasted energy that does not make for efficient shaping. The pull stroke will shave dentin away from the canal walls, but an instrument designed to shave dentin from the canal walls only on the pull stroke will distort curved canals to the outer wall as the tip size of the instruments increase. On the in-stroke, these same instruments will tend to impact debris apically with a resultant loss of length and further distortions when an attempt is made to regain that length.

Using reamers (SafeSiders, Essential Dental Systems), both unrelieved and relieved, eliminates the problems of K-files, even though they are used in the same exact manner. Reamers, unlike K-files, have flutes that are vertically oriented, immediately shaving dentin away rather than unproductively engaging it (Figs. 7, 8). The best analogy I can think of is a comparison to shaving one’s face with a razor. Please note that effectiveness of the blades on a razor is a result of their orientation being at right angles to the plane of motion. That is why it is on a T. Relieved reamers are more flexible, less engaging and more efficient at shaving dentin away from the canal walls, giving the dentist a superior tactile perception of what the tip of the instrument is encountering.

Superior tactile perception gives the dentist the ability to differentiate between the tip of the instrument hitting a wall or being in a tight canal. The former situation produces no tugback, while the latter produces immediate tugback. If no tugback exists, the dentist removes the instrument, pre-bends it at the tip and manually attempts to negotiate around the impediment. If tugback exists, the dentist uses a twist and pull motion to negotiate to the apex. It is far more difficult to achieve these efficiencies with K-files. Their design is not consistent with the

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Fig. 5. Photograph of a Munce Bur.

Figs. 6a, 6b. Photograph of SS White E65 and E67 burs.
function demanded of them while the reamers both unrelieved and relieved are. All it takes is to try them to confirm these differences.

Let's expand our rules of engagement. Now let us include the use of reamers as our initial instruments particularly when the canals are most calcified and tortuous in their pathway. Of course, if they are so much more effective in the most difficult situations, why would they not be used in all situations? They should be.

Today's paradigm is to create a glide path using K-files to a 20 and then switch to some rotary NiTi system. We have just discussed a much more productive alternative to K-files. Rotary instruments may now be used, but I believe we are all aware that the introduction of rotary NiTi does not come without a burden, acceptable to many and not to others. As you may have already surmised, I am referring to the potential for instrument separation, a result of the torsional stress and cyclic fatigue that is intimately associated with rotary NiTi. The NiTi instruments are shaped just like reamers with the exclusion of the flat. They are correctly designed in that regard, but rotation is not the way they should be used. Far better to use reamer designed instruments in a reciprocating handpiece, producing a small arc of motion that severely limits the amount of torsional stress and cyclic fatigue generated. In fact, that is precisely the way we use the relieved reamers, in a reciprocating handpiece (when not used manually with a tight watch-winding stroke) confined to a 30-degree arc of motion. Because the arc of motion is confined, we are not limited in its oscillating speed. Unlike rotary NiTi that is generally used at 150-300 rpm, the reciprocating handpiece operates between 3,000 and 4,000 cycles per minute (Fig. 8).

What the dentist experiences at this frequency is an instrument that literally negotiates through the length of the canal often like a hot knife through butter. While this is certainly a welcome condition, perhaps it is more important for the dentist to know immediately when the canal hits an obstruction. This capability tells the dentist exactly when he should stop using the reamer (either manually or engine-driven) remove it from the canal, pre-bend the tip of the instrument, negotiate manually around the obstacle and, once around, reattach the head to the reciprocating handpiece at the newly negotiated length followed by rapid negotiation to the apex. The reamers, both relieved and unrelieved, are the same instruments used both manually and engine-driven, providing a flexibility that neither K-files nor rotary NiTi can duplicate.

The rules of engagement are now expanded to the use of a reciprocating handpiece over a rotary engine. It is safer and more adaptable to complex anatomy. In fact, there must be much truth to the benefits of reciprocation over rotary NiTi when you see major rotary NiTi companies introducing reciprocating systems. Belatedly, they are recognizing the vulnerabilities of rotary NiTi and substituting a safer approach even though they are likely to cannibalize their own sales of rotary NiTi. While they are making progress in the reduction of instrument separation, they are reducing the cost of these instruments by coming up with techniques that shape canals far less adequately than recommended in the literature. A good deal of research has gone into establishing minimum apical preparations of 35. The manufacturers of these new oscillating systems are essentially telling dentists that an apical preparation of 25 is sufficient and, where major resistance is encountered, an even smaller apical preparation is acceptable. This is technique divorced from research and the increasingly detailed concept of what we know pulpal anatomy to be. How does a preparation to 25 conical throughout its length comport with anatomy that we know is often highly oval at times in the configuration of sheaths of tissue that are quite thin mesio-distally, but often four to eight times wider bucco-lingually?

Taking this one step further, in those cases where a 25/08 instrument goes to length fairly easily, is it not likely that the ease of negotiation results from a good deal of lateral space within the length of the canal that is not engaging the instrument? If this is the case, is it also not likely that those walls that were not engaged are also not well cleansed? Reciprocating NiTi instruments as they are presently being sold is a solution to a marketing problem that does not
address the requirements for sound biological principles. The rules of engagement tell us that we cannot compromise on canal preparations. They have an immediate impact on irrigation and the obturation that is shortly to follow.

We can round out this discussion by mentioning some recent research that makes all the sense in the world even though we may not have heard about it until recently. Recent research now tells us that the use of rotary NiTi instruments in curved canals results in micro-fractures in the apical third. Micro-fractures in the canals are the mirror image of the micro-fractures in the NiTi instruments that have been reported over the years. The only difference is that while the evolution of NiTi can make it less vulnerable to such micro-fractures, the tooth structure remains the same. Yet another reason for using NiTi in whatever form it is in the most conservative ways, safer for the instruments, but compromised biologic results for the patient.

One last point: Rotary NiTi is noted for the retention of the smear layer, particularly in the apical third. This is counterproductive for a well-sealed canal. Reciprocation, on the other hand, has been shown to completely remove the smear layer throughout the length of the canal.

Pictured are some recent routine results we attain using the relieved reamers in conjunction with the 30-degree reciprocating handpiece (Figs. 9–11).

References


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