As a practicing endodontist and manufacturer of endodontic instrumentation systems, it is fascinating to me to observe the initial evaluation of greater tapered rotary NiTi instrumentation as a paradigm improvement over traditional manual techniques morph into a far more cautious view where more and more evidence documenting its deleterious effects on the dentin is becoming increasingly evident.

To support that observation, research has found a correlation between the use of greater tapered rotating NiTi and the production of dentinal micro-cracks.1–4 Research has also found a decrease in resistance to vertical fracture; as the taper of the preparations increase, a clear gap between the actual pulpal anatomy that exists and the tools used to cleanse and shape them for obturation. It was noted by the last president of the AAE that he has seen a greater number of vertical fractures over the past 20 years, a time consistent with the introduction of greater tapered rotary NiTi instrumentation. His observations were supported by a large number of endodontists present at this meeting.

It is difficult to dismiss the reality that rotation of instruments within curved canals leads to torsional stress and cyclic fatigue, the two factors responsible for instrument separation. To reduce instrument separation, dentists have learned to do the following:

1. Establish straight-line access in the mesio-distal plane.
2. Use a crown-down technique that minimizes instrument engagement along length.
3. Employ heat-treated NiTi that are more resistant to cyclic fatigue.
4. Employ the instruments only once.
5. Create a more instrumented glide path prior to the use of rotary NiTi.
6. Remain centred when negotiating to length.
7. Use the instruments in interrupted rotation rather than continuous rotation.
8. Reduce the dimensions of the final canal preparation.

The above techniques and strategies are employed to reduce the stresses that occur in the instruments as they rotate within the confines of the canal. The emphasis is placed on maintaining the integrity of the instrument with minimal thought given to the impact they have on the integrity of the remaining root structure.

Straight-line access is purchased at the expense of removing additional amounts of coronal tooth structure. Crown-down preparations significantly increase the amount of coronal dentin removed so the instruments will contact a reduced amount of canal length at any one time. Heat treatment is a technique that increases the life span of the instrument without a comparable increase in the life span of the dentin, a tissue that is not amenable to technological improvements at present.

The instruments may be used once, but the impact of stress on dentin is cumulative whether new instruments are employed or not. A single instrument will simply work longer in a canal to achieve its goals of cleansing and shaping than any one instrument used with a multiple sequence technique.
Keeping instruments centred in canals that are highly oval, anatomy that is more the rule than the exception, keeps the instruments intact at the expense of compromised cleansing most often in the bucco-lingual plane. The new single file interrupted rotary systems are prone to instrument separation because they are still generating a minimum of 200 full rotations per minute, as a single instrument they are now doing the complete shaping after glide path creation and suffer from the same need to remain centered within the confines of the canal despite the presence of significant buccal and lingual extensions of pulpal tissue.

By instrumenting the canal to smaller tapers, the rotary systems either continuous or interrupted remove less tooth structure and are less prone to breakage. However, they are still confined to centred preparations with little lateral brushing occurring leaving untouched buccal and lingual extensions of tissue.

If we go back to an earlier time prior to the introduction of greater tapered rotary systems, we basically relied on the use of K-files to shape the canals. From the start, these instruments are poorly designed to shape and cleanse canals. Their main defect in design is the incorporation of 30 predominantly horizontal flutes aligned along the 16 mm of working length.

Horizontal flutes can only shave dentin away with the pull stroke because it is only then that the cutting edges of the flutes are more or less at right angles to the plane of motion, a requirement for the removal of dentin. This same flute alignment unfortunately is designed to impact dentin at the tip of the instrument when it is directed apically.

Losing length when using K-files is familiar to most dentists, especially when curves exist in the apical third. Rather than employing instruments with predominantly horizontal flute orientations as our initial tools, we should be using instruments with predominantly vertical flute orientations, similar to the designs incorporated into most rotary systems.

A predominantly vertical flute orientation will shave dentin from the canal walls with the first clockwise stroke. When the instrument is removed and reintroduced into the canal, the vertically oriented flutes will tend to glide past any debris present rather than impacting it apically. These instruments are defined as reamers.

Essentially, we are using a watch-winding motion, similar to that used with K-files, but with far greater efficiencies and far less likelihood for apical blockage. We further improve the mechanics by incorporating a flat along the length of the reamers further reducing engagement and creating an instrument that now has two columns of cutting chisels that work in both the clockwise and counter clockwise motion.

A watch-winding motion eliminates the full rotations that lead to excessive torsional stress and cyclic fatigue that produce the instrument separations we want to avoid. The hand fatigue associated with the use of K-files is completely eliminated when generating the watch-winding motion in a 30- to 45-degree reciprocating handpiece. The speed of the procedure is significantly increased because the reciprocating handpiece has the added advantage of oscillating at 3,000 to 4,000 cycles per minute.5

For those dentists using greater tapered rotary NiTi systems, the goal of the K-files was limited to creating a glide path producing an 02 tapered centred space up to at most a 20. The relieved reamers also have that function, but with the power of a reciprocating handpiece generating oscillations of 3,000-4,000 cycles per minute, the instruments have the added ability to vigorously work the buccal and lingual extensions of highly oval, sheath-like pulpal anatomy.

One need not be concerned about the reduced flexibility of stainless steel relieved reamers. In their smaller dimensions they are easily flexible enough to negotiate complex curved canals. As the thinner, highly flexible instruments faithfully enlarge the original canal anatomy free of distortions, they are defining a pathway that the somewhat larger and less flexible relieved reamers will then faithfully follow. The goal in most situations is to produce an apical preparation of 30 applied to all the walls of the canals, be they round or not. Please realize that this goal will ultimately produce a larger version of the original canal anatomy rather than the imposition of a large conical shape that bears little relationship to the original anatomy.

For the most part, we do not want to exceed a taper of 04. Such a conservative preparation preserves coronal dentin and in combination with the relieved reamers allows us to remove tissue from those thin extensions that are off limits to rotary NiTi instrumentation.6 The system we are defining is based primarily on 02 tapered stainless steel relieved reamers (Fig. 1). After the glide path creation using the relieved reamers (SafeSiders), crown-down preparations are no longer necessary. Rather the final preparation is a simple extension of instrumentation that widens the canal from a 20/02 preparation to a maximum of 30/04 in most situations (Tango Endo, Fig. 2), a final result that requires only two more instruments after the 20/02 preparation has been achieved.
Given our clinical experience, along with the insights that are being documented from recent research, we can make the following conclusions regarding the use of this approach to endodontic instrumentation:

1. Instrument separation is virtually eliminated, producing a much more favourable mind-set for the dentist.
2. Dentinal micro-cracks associated with rotary NiTi are not associated with the short amplitudes of motion produced by the 30- to 45-degree reciprocating handpieces.1–4
3. Lesser tapered preparations reduce the amount of coronal dentin being removed increasing the resistance of the tooth to the forces that produce vertical fractures.1–4
4. The thin 02 tapered stainless steel relieved reamers are capable of removing tissue from the often thin buccal and lingual extensions that are not touched by the greater tapered systems and where canal blockages occur when using K-files.5
5. The recommended relieved reamers will negotiate to the apex with far less resistance than the traditional use of K-files.
6. Due to their limited exposure to torsional stress and cyclic fatigue, a result of the 30- to 45-degree reciprocating handpieces, the instruments may be used several times before replacement, yielding dramatic savings.5

In our endodontic practice, the feeling of security is most important. We seek out ways to produce highly effective predictable results. For us, that means no instrument separation as a cause of concern with the full appreciation that our procedures must primarily maintain the original integrity of the remaining tooth structure as much as possible.

References