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Alternative Endodontic Instrumentation Techniques That Eliminate Separated Instruments and Inadequate Three-Dimensional Debridement

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Abstract

Rotary endodontic instrumentation has reached a stage where detailed critical thinking can be applied to more accurately assess its value compared to other forms of instrumentation. At the time of its introduction, the competing techniques were pretty much limited to the manual use of K-files negotiating to the apex aided by peeso reamers and gates gladden burs to straighten the coronal portions of the canal that in turn made apical negotiation easier as the size of the K-files increased. Hand fatigue routinely resulted given that the bulk of the canal was prepared manually. Procedurally, manual instrumentation takes a great deal of time particularly as the canal anatomy becomes more complex. K-files with their predominantly horizontal flute configuration tend to impact debris as the file is directed apically [1]. In short, it is not unusual for dentists to lose length via apical blockages as the instrumentation proceeded with larger files. Certainly, this technique leaves much to be desired.

Rotary NiTi, an engine-driven system, employed after the glide path has been manually prepared with conventional K-files, limited the use of these instruments to a 15/02 or 20/02 dimension eliminating their extended use reducing that portion of the canal preparation that entails hand fatigue. It also reduced the procedural time requirements. Once the rotary NiTi instruments were used, patency was always checked using a file no thicker than a 10/02 minimizing the chances of impacted debris with loss of length. Engine-driven rotary NiTi eliminates hand fatigue as soon as it is employed. NiTi has the added advantage of being super flexible with heat treated NiTi being significantly more resistant to separation [2].

Flexibility conforming to curved anatomy without inducing distortions proved superior to K-files used essentially with a twist and pull motion in maintaining the original canal anatomy in larger form. Less hand fatigue, quicker procedures, reduced loss of length, minimal distortions are all benefits that are attained when switching from manual K-files to rotary NiTi. [3]

Despite these advantages research has confirmed what every dentist who uses rotary NiTi has experienced to one degree or another; they can unpredictably separate due to unpredictable amounts of torsional stress and/or cyclic fatigue. [4] Instrument separation, an iatrogenic event, is so obvious on x-ray and so detrimental to success rates in non-vital cases that a whole series of precautionary steps are recommended to reduce its incidence. Among these precautions is to utilize these instruments in the most centered position with minimal deviation from that path. [5] That particular precaution has no downsides when the canal being instrumented is conical. As the canals become more oval and isthmuses are present their centered positioning increasingly compromises three-dimensional debridement, a direct consequence of aligning the technique to assure the greatest safety for the instruments. [6]

Thorough debridement is now a secondary goal, one that practitioners accept, to reduce as much as possible the chances of breakage. Indeed, in recent years the rotary technique has become more conservative using fewer and thinner NiTi instruments for the final canal preparation. Conservative preparations save time and money while lowering the incidence of breakage. These steps, however, further decrease the debridement of the canal in three dimensions. [7]

Most dentists today having graduated from a dental school that limited their endodontic education to one or another rotary system have been taught that rotary despite the precautions needed for their safer use is the most advanced way to perform endodontic instrumentation, that the only other way is the long abandoned manual use of K-files involving hand fatigue, excessive time requirements, distortions and a high incidence of canal blockages. Give these two choices, most dentists will side with what they have been taught to use in their 2 years of clinical experience in the dental schools.

The real story of this article is that the dentists are not limited to two choices, that the shortcomings of both the manual use of K-files and the rotary use of NiTi can be overcome without introducing any new problems to contend with.

The first and most compelling problem is associated with rotary NiTi-instrument separation

Instrument separation in the canal due to excessive amounts of torsional stress and/or cyclic fatigue: Both conditions are more likely to be met when an instrument is locked apically, but keeps rotating coronally. Under these conditions the instrument will snap very quickly. The apical locking does not have to be absolute. Significantly more resistance apically than coronally can also lead to instrument separation. [8]

Cyclic fatigue occurs when a rotating instrument is negotiating through a curved canal. Every 180º the inner surface of the instrument becomes the outer surface. The inner surface is in compression, the outer surface in tension. Going from compression to tension every 180º subjects the instruments to cyclic fatigue, the degree of cyclic fatigue generated dependent on the amount of canal curvature and the radius of that curvature. The shorter the radius the sharper the curve and the greater the amount of cyclic fatigue generated. This entire dynamic is eliminated when the arc of motion is confined to 30º or 1/12 of a full rotation, a degree of rotation so small that the torsional stresses and cyclic fatigue generated does not exceed the elastic limit of the stainless steel instruments. [9]

The second problem of rotary NiTi derives from the first problem, instrument separation, resulting in inadequate cleansing of oval canals and any thin isthmuses that are present due to the necessary precaution of the instruments requirement to stay centered.

The 30º arc of motion employed, eliminating instrument separation gives the dentists the freedom to apply the instruments vigorously against all the canal walls. They are used in a 30º handpiece oscillating at 3000-4000 cycles per minute activating the irrigants that should always be present. The combination of the rapidly churned irrigants and the direct instrument contact with the canal walls assures effective debridement of the entire length and breathe of the canal be they oval canals and penetrable thin isthmuses. [10]

The hand fatigue and extended time requirements from the manual use of K-files:

Both of these shortcomings are practically entirely eliminated by employing the 30º oscillating handpiece at 3000-4000 cycles per minute from the beginning of instrumentation through 98% of the canal preparation. The process being engine-driven is rapid, far quicker than the manual preparation of canals.

The short arcs of motion used with a reamer-like action have clearly been shown to eliminate canal distortion when using stainless steel instruments.

It took the invention of NiTi to use instruments in rotation in curved canals. Stainless steel in rotation would lead to separation and distortions, but confined to short arcs of motion even at high frequencies they are virtually immune to both breakage and inducing distortions.11 The stainless steel instruments' adaptability are further enhanced by incorporating a relieved reamer design rather than a K-file configuration.

30º oscillating stainless steel relieved reamers have eliminated the problems associated with rotary systems, most specifically instrument separation and inadequate debridement. At the same time 30º oscillations employing these reamers have removed the problems associated with the traditional manual technique, hand fatigue, distortions and extended time requirements.

Other benefits resulting from the use of stainless steel relieved reamers in a 30º oscillating handpiece:

Instruments invulnerable to breakage can be used multiple times at great cost savings. The instruments confined to short arcs of motion impart far less stress to the canal walls that results in a lower potential to produce dentinal micro-cracks in the canal walls, something widely substantiated with the use of rotary instruments whether the rotations are continuous or interrupted. [12]

What is most difficult to understand is why a system designed to overcome the well-known deficiencies of both rotary NiTi and the traditional use of K-files is not more widely known. That is the subject of another post where a strong case can be made that information is dispersed based on the amount of money invested in marketing and not on critical analysis of the benefits of what is available. And all parts of the marketing structure starting with the dental schools coordinate that effort mostly motivated by the financial rewards each component of the marketing effort receives. Under these dollar-driven marketing efforts the most corporately funded approach becomes a self-fulfilling prophecy with critical analysis pretty much discarded.

Conclusion

The intent of this article is to first bring attention to the practical common sense alternatives that are available to overcome the shortcomings of the systems we are most familiar with. The final remarks are made to draw attention to the fact that we have not reached this state of enlightenment by accident, that it has been a well choreographed effort to direct our attention to expensive products that have introduced as many problems as they have solved and have obscured our learning about alternatives that would make our endodontic lives far less stressful.

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