Predictable Endodontic Success: The Hybrid Approach — Part I

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The crown-down approach for root canal space preparation has been optimized through the past decade by advances in rotary nickel-titanium (NiTi) instrumentation.[1] The improved canal architecture produced by these instruments in conjunction with enhanced thermosoftened obturation techniques has demonstrably increased the predictability of endodontic success. However; regardless of the iterations in file design, the myriad complexity of root canal system morphology makes it is increasingly apparent that the "one system fits all" paradigm is no longer applicable.

In addition, as the concepts of deep shaping, apical patency and apical gauging[2-4] have become more and more mainstream, a greater appreciation of the need to fashion an apical control zone has taken hold.[5,6] The 'Apical Control Zone' is a matrix-like region created in the apical third of the root canal space. This zone demonstrates an exaggerated taper from the clinician defined apical preparation terminus regardless of whether this is spatially a linear or point determination. The enhanced taper in the apical control zone provides resistance form against the condensation pressures of obturation and acts to prevent the extrusion of the filling material during obturation.[7] Its formation is a function of the geometries incorporated into the design of NiTi instruments as well as the stainless steel (SS) hand file sequence used (Fig. 1).

This article addresses the synergy potential possible by combining the disparate design features of two rotary NiTi instrumentation systems currently available; Protaper™ files (Fig. 2a) and ProSystem GT® files (Figs. 2b & c). The geometries of each produce an excellent shaping definition to the root canal space. Used in concert, with appropriate irrigation protocols,[8] the shaping achieved enables debridement, disinfection and three-dimensional obturation in an unprecedented manner.

GLIDE PATH

Straight-line access to the apical region is essential

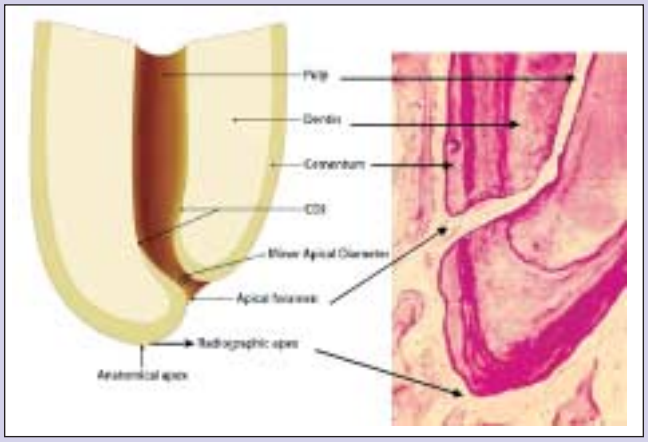

FIGURE 1—The lexicon of the apical region must be unequivocal in the same way that its histologic composition is immutable. The creation of the Apical Control Zone requires an appreciation of the anatomy in no less a manner than a planned procedure in a surgical site.

FIGURE 2A—The Protaper files were designed by Drs. Pierre Machtou, Cliff Ruddle and John West. Their unique geometries and multiple tapered configurations on each file provide for unprecedented cutting efficiency.

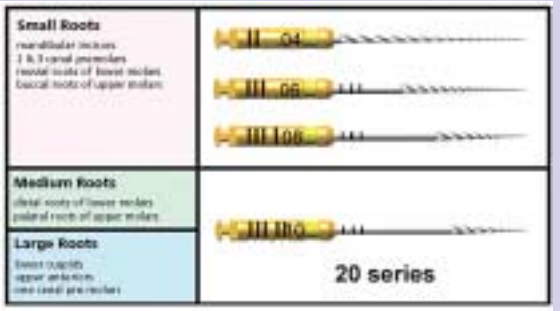

FIGURE 2B—The ProSystemGT files demonstrate a common tip size and variable taper array throughout their each of their size sequences. Accessory files are available in tip sizes 35, 50, 70, and 90 with a .12 taper for large diameter canals.

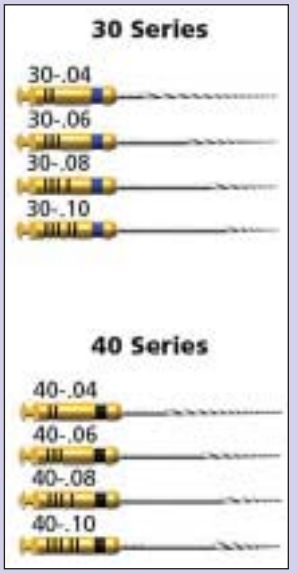

FIGURE 2C

in order to retain the natural flow of the root canal space during preparation in x, y and z axes. An ideal access entails the creation of a Class I inlay preparation to deroof the pulp chamber and align the axial walls of the preparation in a divergent orientation without undermining the peripheral coronal tooth structure. In the coronal segment, this orientation initiates the Glide Path (Fig. 3). Spatial alignment of the cusp tip, the pulp horn, the canal orifice and the interface of the middle and apical one-third intersection enables retention of the apical foramen in its original anatomical position during shaping.

The Glide Path is then further extended to the apical terminus by blueprinting a straight-line access pathway with smaller sized hand files; with this surveyed pathway, rotary NiTi instruments with their self-centering ability and their superelastic capacity can readily negotiate even the most complex system. However, if the irregularities in the glide path cannot be recontoured, then the apical architecture is best shaped with SS hand files. The elasticity of NiTi files does not compensate for their propensity to fracture in aberrant canal anatomy.

Furthermore, the creation of the Class I inlay style preparation defines the intra-chamber preparation for the coronal restorative component that will be placed after root canal treatment has been completed. The seamless integration of root canal space and restoration minimizes interface steps capable of producing stress vectors in the tooth that could lead to fracture during function (Fig. 4).

INITIAL PREPARATION

The chamber is accessed, pulp tissue and dys-

FIGURE 3—Multiplanar geometries define root canal system architecture. The most effective means of altering extreme curvature angulations is to initiate instrumentation in a standardized format. A Class I inlay design negates coronal and coronal/radicular interferences thereby minimizing torque irregularities that can cause fracture of rotary NiTi instruments.

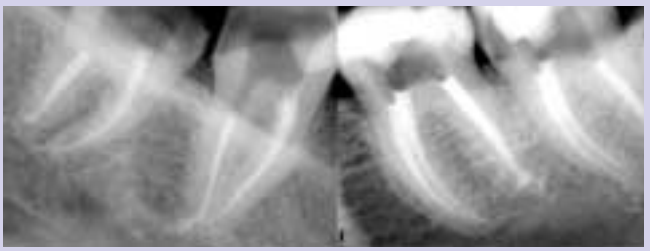

FIGURE 4—The geometries of the Protaper and ProsystemGT files mirror the natural anatomy of the root canal space when first formed. Their conservative shape in the coronal aspect obviates the needless overpreparation and structural weakening of the root integrity characteristic of the use gates glidden drills.

FIGURE 5—Blueprinting the pathway of any NiTi rotary file is a prerequisite for success. Regardless of their efficacy, they are for all intents and purposes "dumb and blind" in the absence of a surveyed Glide Path.

FIGURE 6—The S1 Protaper length must not exceed the maximum length of penetration of the scouting SS hand files. The Sx Protaper is designed with a sequencing of variable tapers consistent with the diametral widths of the 1, 2, 3, and 4 gates glidden drills.

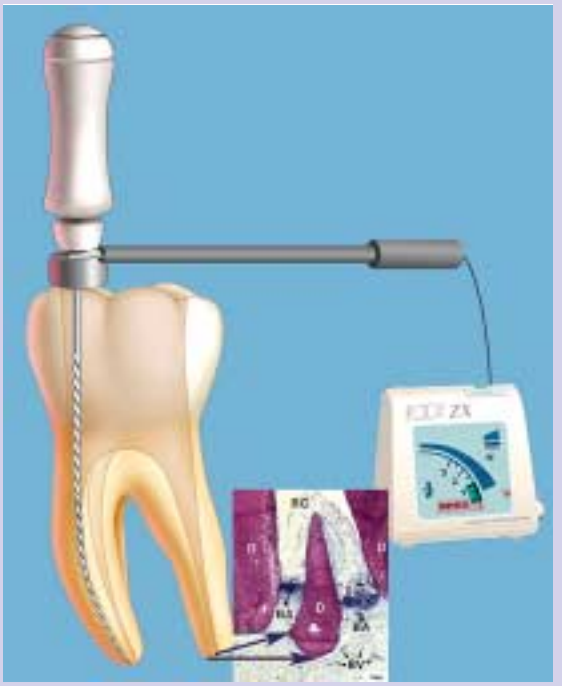

FIGURE 7—Determination of working length can be verified spatially in an arbitrary manner with a radiograph (lower arrow), however, exact determination of the physiologic change from pulpal tissue to that of the periodontal attachment apparatus can only be determined with an electric apex locator (upper arrow). The use of paper points to determine the precise location of the bleeding point of the severed pulp stump is also of significant advantage. RC – root canal, D – dentin, BA – bacteria, BV – blood vessel.

trophic calcification removal completed; warmed 5.25% sodium hypochlorite is left to soak in the chamber for 10 minutes. The chamber is then flushed and a caries detection agent used to landmark all orifices.

Preliminary debridement and passive exploration of the canal confines is made with ISO standard .02 taper SS files, #'s 08 through #20 in sequence (Fig. 5). Negotiation of the root canal system with hand files orients the operator as to the x, y, and z direction of the root canal space and identifies anatomic anomalies that may prevent the NiTi instruments from reaching the apical terminus. If the SS files can initially traverse the root canal space and negotiate to the EAL determined working length at this juncture, all the better, however; in the more typically calcified root canals this is neither expected, nor is it the intention of this initial phase of the shaping procedure. The "apex last approach" will eventually enable determination of an accurate working length without forcing instruments to place regardless of the degree of anatomic challenge presented by the canal.[9]

All hand files are used in a "watchwinding" motion; quarter turn clockwise followed by a quarter turn counterclockwise. This feeds the file into the canal until it first binds. At the initiation of treatment, instruments bind in the coronal aspect of an unflared canal, not in the apical region. Once engaged, the file is retrieved coronally away from the furcal wall along a linear path of no more than 2mm to ensure that the path of penetration is retained.

The depth of insertion of the #20 file is measured and this length transferred to the Protaper Shaping File No. 1 (purple ring) / S1 and auxiliary Shaping file/SX (no ring). The Sx relocates the coronal aspect of canals away from external concavities and will produce more shape, as desired, within any canal. Without pressure, and in one or more passes, the S1 and Sx are allowed to passively cut into the canal until their apical travel slows. They may be used like a brush to laterally cut dentin on the outstroke until the coronal to middle ⅓ of the canal are optimally prepared (Fig. 6). Applicable axioms; never push, exert only light pressure, avoid in and out pecking motion, repeat-

There are three principal means of acquiring knowledge… observation of nature, reflection, and experimentation. Observation collects facts; reflection combines them; experimentation verifies the result of that combination.

Denis Diderot (1713 – 1784)

FIGURE 8—Examination of the S1, S2, and F1 Protapers as they go to working length will reveal the location of the dentin removal from the canal – S1 – coronal third, S2 – middle third, F1 – apical third. This proves to be an invaluable marker for ensuring the flow characteristics of the shaping procedure.

edly clean flutes in order to minimize compaction stress creation.

At this point, except in the most extremely calcified cases, it is reasonable to assume that a #08 or #10 file can be negotiated to the apical foramen and an electrometric length determination (EAL – ROOT ZX®, J. Morita, Irvine CA) reading taken. Retaining the distance between reproducible occlusal and apical reference points is a function of apical patency.[10] A combination of the EAL determined working length (WL) and paper points, in distinct contrast to the traditional use of the radiographic terminus is the most accurate means by which to determine the true canal preparation termination point[11] (Fig. 7).The EAL will be used throughout the procedure to reconfirm WL as a more direct path to the terminus is established during shaping procedures which invariably shortens the WL to a degree.

The reproducible Glide Path to the apical terminus is checked and then the Protaper sequence S1, S2 (white ring) and F1 [yellow ring] (D0 diameter/taper of .20/.07) is carried to the full established working length. Depending on the length, diameter and curvature of the canal, the F1 will generally achieve length in one pass, a function of its reverse taper design.[12] The finishing criterion is to remove the F1, inspect its apical flutes and, if they are loaded with dentin, the shape is cut (Fig. 8).

APICAL GAUGING

Apical gauging is the technique where the apical diameter of the canal is measured after the shaping objective file (SOF), the file of suitable taper based on root morphology, has cut to working length. This is necessary to confirm that apical continuity of taper exists and that the tapered preparation extends all the way to the terminus of the canal. For the sake of example, if the SOF taken to length has a .20mm tip diameter, gauging is done with a #15 file passed through the canal terminus. A #20 K-file is taken to the terminus without pushing or cutting dentin. If it lightly binds at length and the #25 and #30 files bind shorter in the canal, there is apical continuity and the shape of the canal has been determined. If

FIGURE 9—In this typical small root case, the #15 K-file gauging instrument passively drops through the root canal. The #20 K-file gauging instrument binds at working length. The #25 K-file gauging instrument binds .25 mm short of the full working length and the #30 K-file gauging instrument binds 0.5 mm short of full length confirming there is an apical constricture and that there is shape coronal to that point.

FIGURE 10—Note the length of fluting on each file; the maximum diameter is 1.0 mm on each, but the number of cutting flutes varies. This is to ensure that cutting efficiency is optimized coronally and a true crown-down effect creates the apical control zone.

FIGURE 11—By using the gutta-percha cone as the template for blueprinting of the canal shape, the canal preparation tells you when it is done. In this way, the shape must accommodate the ideal cone, in contrast to adjusting the cone size or length to fit an inadequate shape.

FIGURE 12—Deep shaping is facilitated by recapitulation with the ProSystem GT files. It is desirable to have the 20/.08 file go to working length. The F1 Protaper is 20/.07 at its tip; the nominal alteration in taper created by the Hybrid Approach ensures a denser apical seal as the volume of gutta-percha sealing the terminus is enhanced.

FIGURE 13—The gutta-percha cone is refit and should now adapt exactly to the canal shape created.

the #20 K-file can still pass through the end of the root canal without meeting resistance, the K-file that binds at length is determined and the shape is adjusted by taking the same size tapered instrument into the canal with a larger tip size (Fig. 9).

HYBRID APPROACH

Deep shape is essential for ideal cone fit and enables penetration of obturation condensers to an optimum depth. The deep shape rendered by the Protaper files is now further augmented with the use of ProSystem GT files (Fig. 10). The geometries of the GT files were designed to mimic the natural anatomy of the root canal space when it first forms and therefore idealize the shape created. The 20/.10 GT file is used first regardless of root size and continues in a crown-down fashion until the first GT file gets to length (20/.10, 20/.08, 20/.06). As a general rule, **small roots** (mandibular incisors, 2 & 3 canal premolars, mesial roots of lower molars and buccal roots of upper molars) are shaped to a .06 or .08 taper;

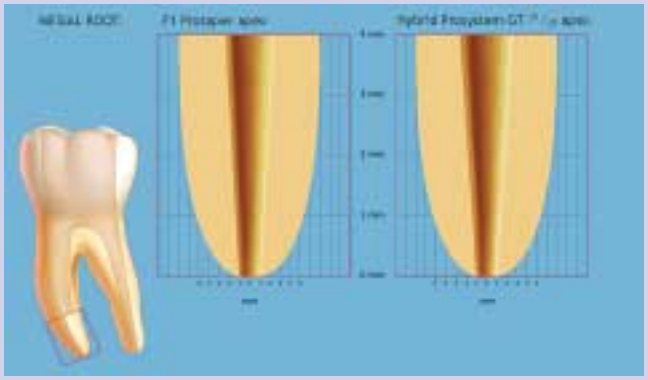

FIGURE 14—The apical control zone created by the Protaper files and augmented by the ProSystem GT files is demonstrated. The enhanced deep shape effect of the Hybrid Approach is readily apparent. The cutting efficiency of the Protaper files exceeds that of the ProSystem GT files, however the resultant shaping produced by the ProSystem GT files with their array of variable tapers results in the creation of a more substantial apical control zone enabling greater density in the apical region and thus preventing inadvertent overfills and overextensions.

canals with abrupt apical bends or multi-planer curves, an.06 taper exclusively is used. **Medium roots** are: distal roots of lower molars and palatal roots of upper molars, and usually have a .10 taper. **Large roots** are: lower cuspids, upper anteriors and one-canal pre-molars.[13]

The goal of the root canal space preparation is to enable a gutta-percha cone of suitable size and shape (ideally a non-standardized fine-medium or medium cone) to intimately fit the preparation. After the initial sequencing with the 20/GT file series, a fine-medium or medium gutta-percha cone is inserted and the degree of shaping achieved or required assessed (Fig. 11). If the cone comes up short of the terminus, the file sequence is repeated by recapitulation (Fig. 12) until the master cone to be used (fine-medium or medium) fits intimately and exactly (Fig. 13).

The difference in the exaggerated taper of the Apical Control Zone achieved with the Protaper files initially and then augmented by the ProSystem GT files is shown in figure 14. It remains to be seen whether we can ever achieve 100% predictable endodontic success; however, one thing is patently clear. Each innovation in canal debridement and disinfection, each iteration in irrigant formulation, and each successive evolution in obturation technology brings us that much closer to the day when apical periodontitis can be successfully eliminated and the possibility of its recrudescence negated. **OH**

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Oral Health welcomes this original article.

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