Predictable Endodontic Success:
The Apical Control Zone

A collaborative article from the membership of ROOTS

> *"The "Apical Control Zone" is an area located in the apical one third of the root canal system that demonstrates an exaggerated taper from the clinician defined apical constriction. This greater rate of taper is needed as a control zone to provide resistance against the condensation pressures of obturation. This increases the retention/resistance form and insures against extrusion of the filling material. The ACZ can be created in a variety of manners, depending on the operator's preference."*

The pursuit of excellence in endodontics was compromised until recently by the incompatibility of biologic demands and technical limitations of the armamentarium available. The availability of increasingly innovative nickel titanium rotary instrumentation systems continues to reinforce the folly of the past that relied on a mathematical step-back approach in the shaping of the root canal space. Endodontics succeeds through the architectural rendering of the anatomy and geometry of the vagueries of the root canal system. Each portal of exit along the root face is biologically significant; this includes bifurcations, trifurcations, the base of infrabony pockets as well as the apical termini.

The root forms in a crown down manner and the root canal system calcifies coronal apically; therefore, to shape and clean a canal space in an "apex first" manner is illogical and inconsistent with morphogenesis. In addition, the "apex first" approach tended to oversize the coronal and middle third of the root thereby structurally weakening it, and causing zips, transportation, ledging and perforation in the crucial apical zone. In order to affect a thorough shaping and cleaning of the root canal system and seal it permanently with a biologically inert obturating material, the operator's focus must shift to the apical shape achieved that enables contained distortion of the obturation material and facilitates asymmetrical compaction into the perimeter of the foramen.

This has been a long and tortuous evolutionary process in the discipline of endodontics. A chronology of recent technical protocols: Serial Instrumentation Schilder 1974, Step-Back Mullaney 1979, Crown-Down Marshall 1980, Step-Down Goerig 1982, Balanced Force Roane, 1985. There is an imperative that has driven this evolution; the elastic memory of all metal instruments drives them to a single wall as they navigate curvature. In the pre-NiTi era, the self-centering characteristic of the instrument was not a component of the computer-modeled design. As a result, canal shapes were "larger" to compensate for the presence of the curve.

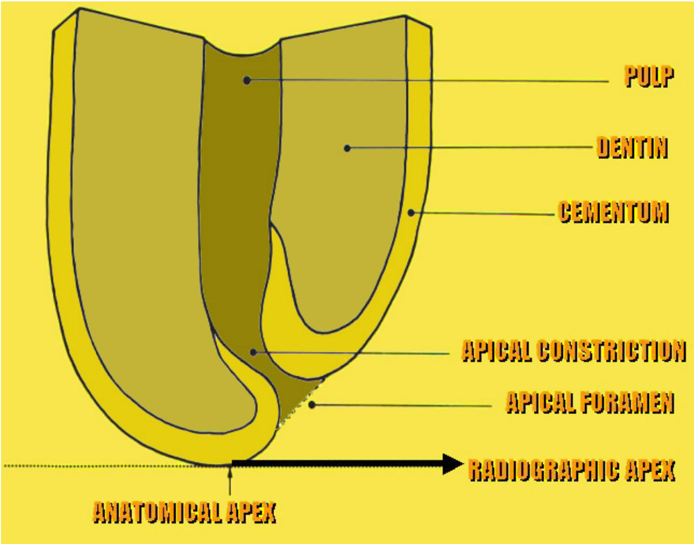
It should be evident in the NiTi era, that we are just now beginning to truly respect the pulp canal space as the defining parameter of cleaning and shaping; we are 'listening to its voice' for the first time. For much of the hand instrumentation era, the creation of resistance and retention morphology was the defining shape for obturation procedures. Unfortunately, in an era still dominated by lateral condensation, over-extension rather than the more biologically acceptable overfill was a potential result.

The creation of endodontic excellence especially in the era of nickel-titanium techniques demands strict adherence to preparation length, a more thorough understanding of cutting dynamics and awareness of the shape/design being achieved. The changing tapers in the instrument systems coming to market impart greater resistance to displacement in the apical third (the apical control zone) and enable the use of apical patency with minimal risk for the extrusion of thermolabile obturation materials.

The crown down approach eliminates constrictions in the coronal regions of the canal thereby reducing the effect of canal curvatures and providing better tactile awareness during apical cleaning and shaping. It allows irrigation to be effective to the complete depth that cleaning and shaping instruments reach. The majority of pulp and infecting microflora are removed before the apical third is reached thereby minimizing the risk of pushing pulpal and microbial irritants into the periapical regions. In addition, the working length is less likely to change during apical instrumentation because canal curvature has been reduced before working length is established.

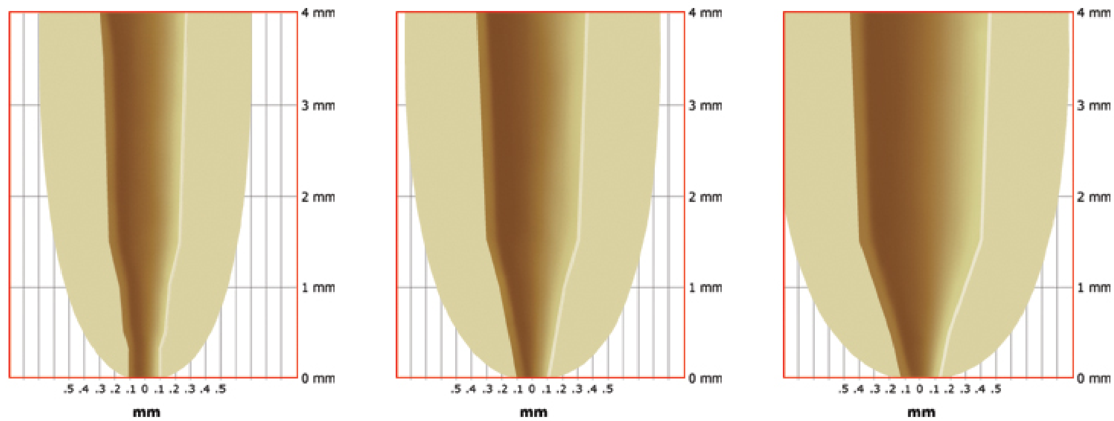
Apical Control Zone

The "Apical Control Zone" is the area that provides the resistance and retention form against the condensation pressures of obturation. This region can be anatomically complex, altered by pathologic resorption, or iatrogenic misadventure. It is essential that small file sizes be used to "survey" the glide path to the apical foramen (Fig 1).



Being redrawn

The vagueries of merging, curving, dilacerations, division et al must be "blueprinted" prior to the introduction of NiTi rotary systems. Properly done, a control zone predictably ensures a round and clean apical foramen for obturation



Roane Small ACZ | Roane Medium ACZ | Roane Large ACZ

Fig 2. Roane defined his small medium and large apical capture zones as #45, #60 and #80 preparations. The parameters he established were; small ACZ, #15 file to the radiographic terminus (RT), #45 file 1.5 mm back from the terminus, medium ACZ, #20 file to the RT, #60 file 1.5 mm back, large ACZ, #25 file to the RT, #80 file 1.5 mm back.

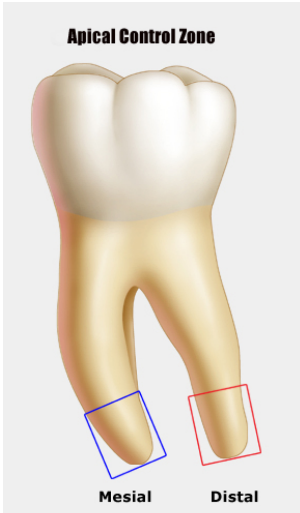
Members of the online endodontic discussion group roots@ls.rxdentistry.com (www.rxroots.com) were polled as to the nature of the instrumentation procedures. A number of trends were apparent as clinicians adopt and adapt rotary NiTi instrumentation into their shaping and cleaning protocols. A significant number are using hybrid rotary file protocols, most create tapered apical preparations ranging from .06 to .2 mm or more, thermolabile obturation techniques were ubiquitous, patency files were used in a majority of cases, all use apex locators, not all take working length radiographs and many use paper points as the primary indicator of length confirmation. The creation of an Apical Control Zone was dependent on operator's choice of instrumentation and obturation technique and was deemed to be crucial in obturating wide canals or those with open apices.

Systems

The goal of this article was to structure a standardized comparison between the Apical Control Zones created by the latest rotary NiTi instrumentation systems in the endodontic armamentarium; K3, Lightspeed, RaCe, Protaper and ProSystem GT.

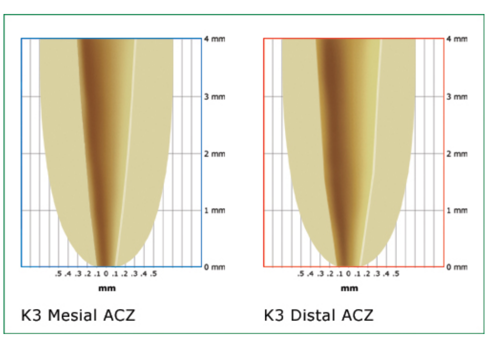
The operator created apical constriction (AC) was considered to be point zero and the instrument fitted to the AC of the mesial root of the mandibular molar chosen as the template was a #20 file, the instrument in the distal root, a #25 file. The apical control zone was created by looking at the instruments that negotiated the canal space in 0.5 mm increments back to the arbitary interface of apical and middle thirds of a typical molar root (Fig 3).

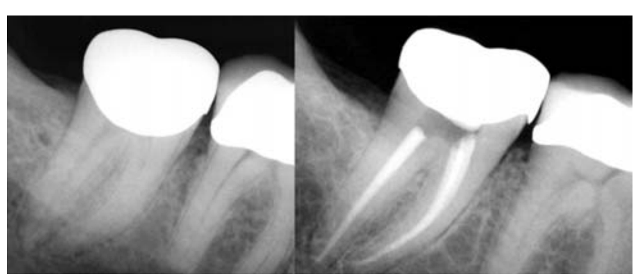
(Fig 3)



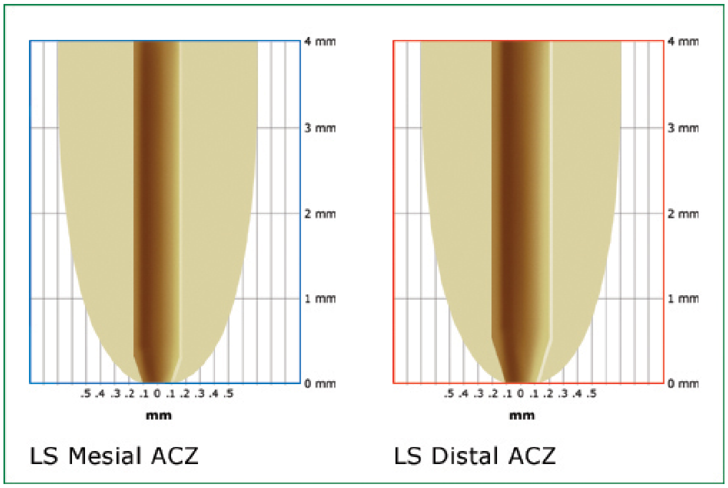
After coronal scouting, a typical K3 case will start with the #25/.10 and #25/.08 orifice openers or the #25/.06 file for smaller canals. These files are used to debride the bulk of coronal pulp tissue or necrotic debris and also to remove the cervical restrictive dentin from the root canal. A working length is then established with an apex locator. A variable taper/tip size sequence is then employed in a crown-down sequence to the working length.

Once the K3 files have reached the determined working length, the clinician will need to determine the appropriate degree of apical enlargement for each canal. Final apical gauging can now be accomplished with a series of stainless steel hand files. If, for example, the final apical gauging procedure allows for a size #35 hand file to be placed to the WL, it may be prudent to take the #35/.06 K3 rotary file to length. This will create a continuous taper from orifice to constriction. If the root is thin and/or if the canal is moderately to severely curved, a K3 #35/.04 rotary file taken to length may be more appropriate. The Apical Control Zone is created by stepping-back in 0.5mm increments with either the .04 or .06 tapered K3 files.





K3 Figure Legends: 0 mm 20, 1 mm 35, 2 mm 41, 3 mm 47, 4 mm 53



The LightSpeed ACZ Technique

Make a straight line access and prepare the coronal third of the canal.

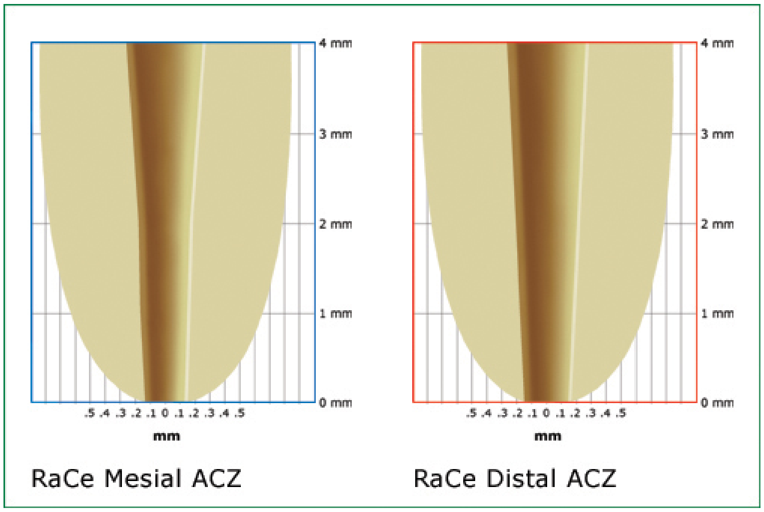
Locate the foramen with an apex locator and establish working length (WL) 0.25 mm to 1.00 mm short of the foramen (dentists choice). Note that for the ACZ graph we are using a WL that is 0.25 mm from point zero for the size 40 LS and a WL that is 0.50 mm from point zero for the size 50 LS.

Ensure canal patency to WL with at least a size 15 K-file. Start rotary instrumentation with the smallest LS size that binds on the canal walls before it gets to WL. when advanced apically by hand. Instrument to WL with that first binding instrument and continue mechanical preparation to WL with sequentially larger LS sizes. The final apical preparation size is determined using the "12 pecks" rule (see our technique guide). This rule ensures the canal is instrumented to a large enough size to ensure canal cleanliness.

The ACZ for LS is based on an apical stop preparation, (also called a dentinal matrix). For your graph you chose the "operator created apical constriction (AC) or point zero to be a #20 file for the mesial canals and a size 25 for the distal."

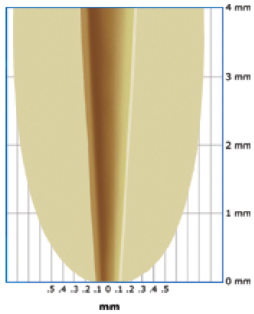
As given in our Technique Guide the apical preparation size for the **mesial** canals is usually a size 40. Therefore, on the graph, point zero would be a size 20 and 0.25 mm from point zero the preparation would be a size 40. It remains parallel (size 40) to the end of the graph (4 mm).

Our guide shows that the apical preparation size for the **distal** canal is usually a size 50. Therefore, on the graph, point zero would be a size 25 and 0.50 mm from point zero the preparation would be a size 50. It would remain parallel (size 50) to the end of the graph (4 mm).

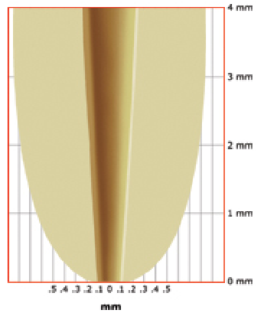


A typical RaCe case will start with the 25/.06 to open the orifice and remove the bulk of the coronal pulp tissue. This also allows the clinician to feel any coronal or midroot curvature that might exist. Working length is then established with an apex locator and followed by the 40/.10 to remove more coronal dentin, if there was minimal coronal curvature detected. Next a a 25/.02 is taken to length if possible. With the 25/.02 instrument to length a 25/.08 is used to advance as far as possible. Now the 25/.04 is generally taken to length followed by the 25/.06 to length. If the 25/.06 will not go to length the 25/.08 or 40/.10 is used to remove more coronal dentin. With a 25/.06 to length the majority of cases have the apical capture zone desired for obturation. On distal or palatal roots it may be possible to take the 25/.08 to length.

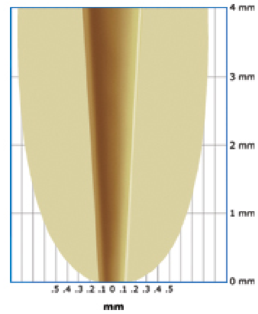
Plus others…..



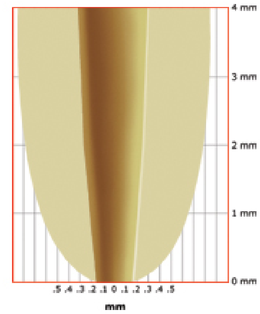
Protaper Mesial ACZ



Protaper Distal ACZ



Prosystem GT Mesial ACZ



Prosystem GT Distal ACZ

Ending with GT.06 - .08 - .10
Using K3 .06
no 20 to working length (WL)
no 25 WL – 0.25 mm
no 30 WL – 0.50 mm
no 35 WL – 0.75 mm
no 40 WL – 1.00 mm

O mm 20 1 mm 27 2 mm 34 3 mm 41 4 mm 46

Nahmias and Serota to complete and include images….