52. Can a division of the canal into zones of preparation be beneficial?

If all of the parameters listed above are to be followed, dividing the canal into two zones can simplify and expedite canal preparation, with each zone having a different technique approach. These zones are most effectively differentiated by the location of curvatures or constrictions, which result in peaks of increased torsion or pressure during advancement into the canal. Two methods are very useful in identifying a restriction: (1) If a file that is smaller than the canal meets resistance as it is passively advanced into the canal, the depth at which the resistance is met also denotes the terminus of the **coronal zone**. (2) To advance a .06 tapered, .25 mm diameter file the first 1 mm into a canal after it becomes engaged, a specific pressure needs to be applied. If a depth is reached in a canal short of the working length that the determined specific pressure needs to be exceeded in order for additional advancement to occur while using 1 mm increments of insertions, that depth of penetration denotes the coronal zone. The .25 tip is used to detect a constriction and the .06 taper has the rigidity that will resist a curvature. The most reliable files for following this procedure include the K-3, Quantec and the RaCe files. This second technique for determining the **coronal zone** requires a learning curve and should be employed only after sufficient experience.

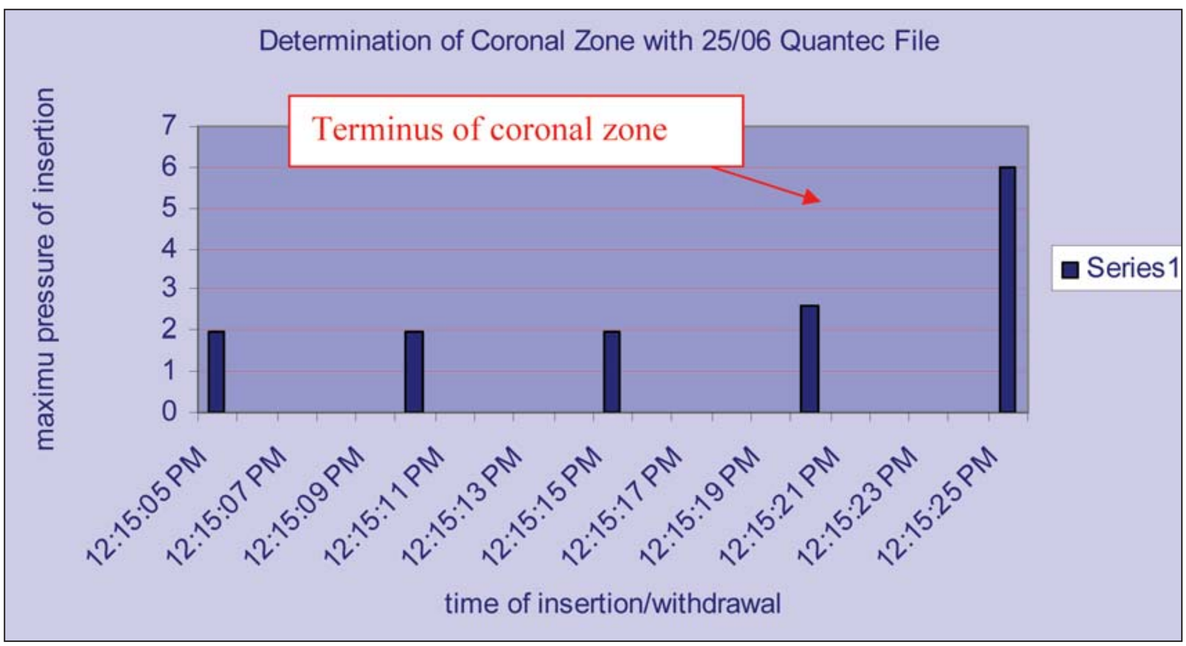

Table 122 A Quantec 25/06 file was inserted and withdrawn at a rate of ½ mm/s. It was inserted 2 mm and withdrawn 1 mm with each cycle. The peak pressure in pounds per square inch was recorded with each cycle. The pressure for the 5th insertion (5th mm depth of insertion after engagement) was substantially higher than any previous insertion. This level indicated the terminus of the coronal zone.

Fig. 123

The red arrow indicates the type of anatomical restriction or curvature represented in the chart above that would require an increase in pressure to advance to a greater depth in the canal. Assuming that this is at the 5mm depth after the file became engaged as in the chart above, this level would represent the terminus of the coronal zone. Stress on the files is minimized of the apical zone beyond the curvature is prepared with a technique that considers the file diameter as it transgresses the curvature.

The Zone Technique for canal preparation

The zone technique was designed with two objectives for minimizing file stress for any type of NiTi rotary file: One, the canal diameter should be large enough coronal to a curvature to prevent any engagement in that portion of the canal when any file is being used apical to the curvature. Two, the file diameter is not too large to rotate safely in a curvature.

The first step is to determine if there is a curvature of any significance and how far the curvature is from the apex. Withdrawing the file used to establish the working length, and passively re-inserting will indicate a curvature if it meets any resistance short of the working length since the canal is now larger than the file. The canal portion short of the resistance defines the **coronal zone** and the portion beyond the resistance defines the **apical zone** (Fig. 124). The length of the canal to the curvature, the coronal zone, is measured and recorded with the same importance as determining the working length. The working length minus the coronal zone length provides the distance the curvature is from the apex, the apical zone length.

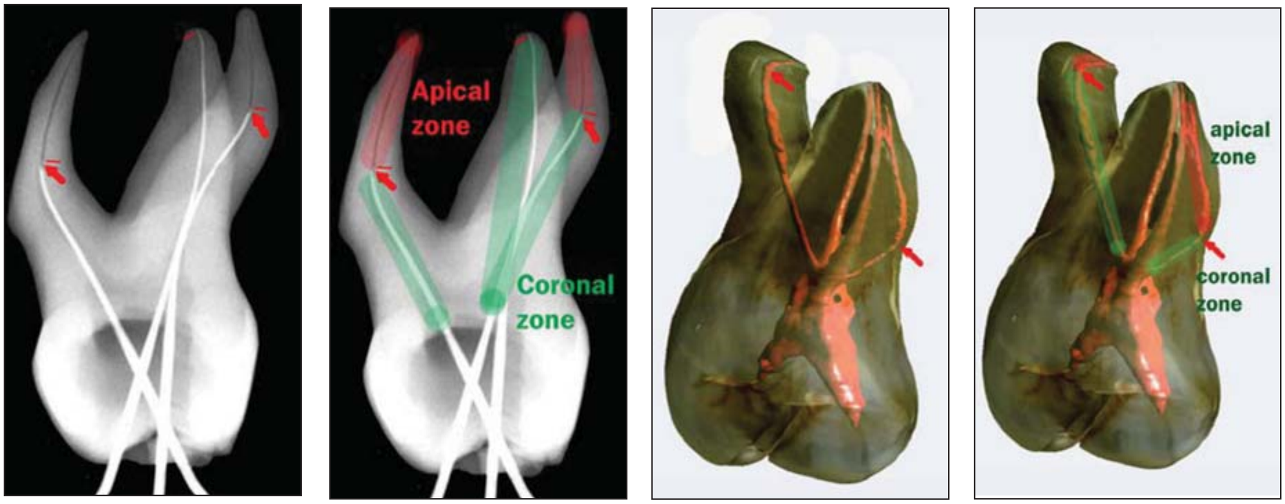

Fig. 124 The points of resistance files encounter, indicated by the arrows, when passively being inserted into canals having a larger diameter, divides the canals into coronal and apical zones. The zones require different preparation approaches.

The second step is to determine the distance each of the files having different sizes and tapers can safely be advanced around the curvatures and which size file will need to be used in the coronal zone to prevent any subsequent file from binding in the apical zone. By using the parameters suggested above for diameter limitations ***(.60mm for a .02 taper, .55mm for .04 taper, .50mm for .06 taper, and .35mm for a .08 taper)***, we can calculate if the diameter of a selected file would exceed our limitations.That determination can be calculated by using the following formula:

Diameter limitation* (-) tip size (÷) taper (=) the length the file can be projected around a moderate curvature.
**no more than .60mm for a .02 taper, .55mm for .04 taper, .50mm for .06 taper, and .35mm for a .08 taper*

Example 1: If we select a size .25/.04 taper file to negotiate the canal illustrated in **Fig.125**, the diameter limitation suggested in the parameter is .55 mm.The .55 mm diameter limitation minus the tip size, .25 mm, is .30.The difference, .30, is divided by .04, the taper, which equals 7. The number of millimeters a .25/.04 file can be advanced beyond a moderate curvature is 7 mm and therefore, can be used to the working length in this situation. A size .50/.04 or larger would be required to enlarge the coronal zone to prevent any engagement in that portion of the canal while using a .25/.04 file to the working length.

Example 2: If we select a size .25/.06 taper file to negotiate the canal illustrated in **Fig. 125**, the diameter limitation suggested in the parameter for a .06 taper is .50mm. The diameter limitation, .50mm, minus the tip size, .25mm, is .25. The difference, .25 divided by .06, the taper, is 4 and is the number of millimeters a .25/.06 file can be advanced beyond a moderate curvature or into the apical zone and, therefore, should be advanced no closer than 2mm from the working length in this situation.A size .50/ 06 or larger would be required to enlarge the coronal zone to prevent any engagement in that portion of the canal while using a .25/.06 file to the working length.

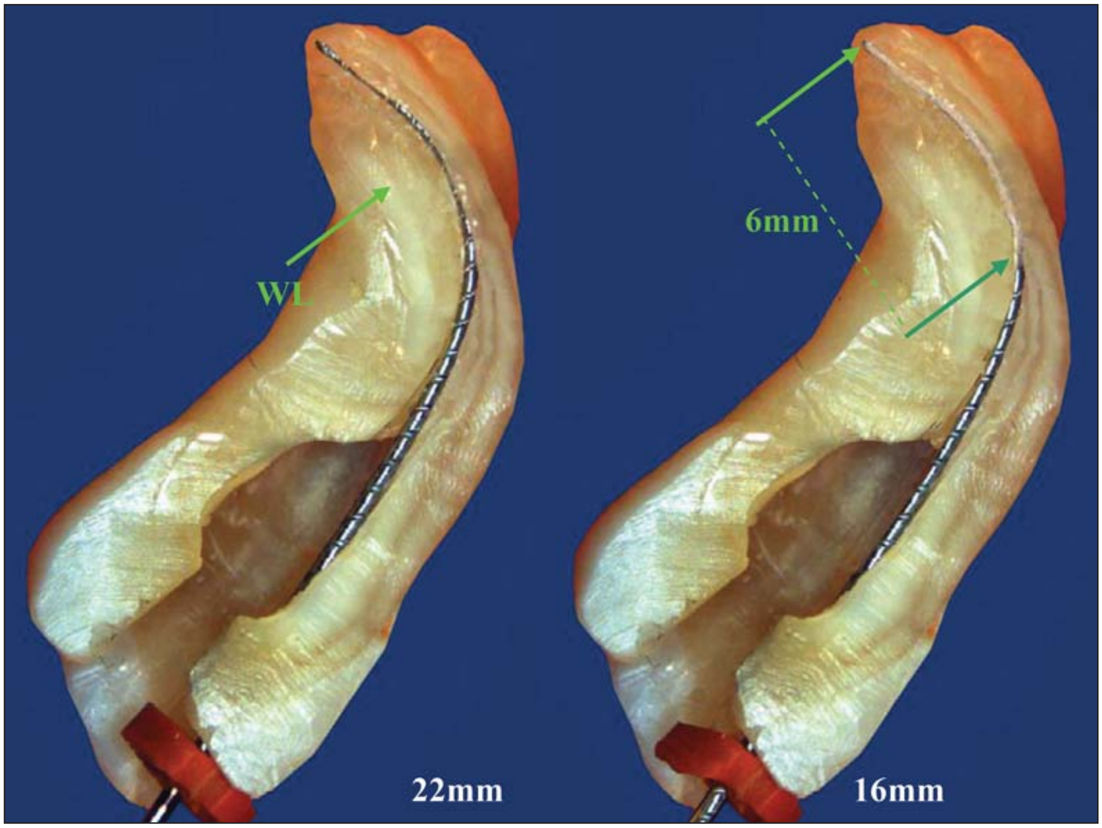

Fig. 125 The recorded length at which the smaller file encounters resistance in a larger canal canbe subtracted from the working length to obtain the distance the curvature is from the working length.

Once this procedure is followed, the terminus of the canal can easily be enlarged by using .02 tapered files. For more severe curvatures, the file sizes need to be reduced accordingly. Although the zone technique does require some mental exercise, hopefully within the capacity of any dentist doing root canals, its advantages can result in major reductions in preparation time and file stress.

53. How do I prepare the coronal zone?

The coronal zone presents no particular problems as long as it can be defined and its terminus is not violated. Essentially, the coronal zone is a straight canal and the considerations for preventing file breakage can easily be applied. The selection of the first file for preparing the coronal zone should meet two objectives. The file tip should be small enough to negotiate the entire coronal zone yet rigid enough to tactilely detect any point of curvature or a restriction that requires an increase in applied pressure for apical advancement. The final preparation of the coronal zone should be large enough to avoid or minimize engagement of any subsequent file and provide adequate access for obturation. A frequent mistake is to use tip diameters at the terminus of the coronal zone that are smaller at that point than the diameters for files used in the apical zone. For instance, if a 25/.08 file is carried to the terminus of the coronal zone and a 25/.02 file is carried 5 mm apical to that point, the 25/.02 will be engaged in the coronal zone, since its diameter will be .35mm at the terminus of the coronal zone.

When encountering a canal anatomy that cannot be instrumented with conventional techniques while following the parameters listed above, closely following an exercise for designing a technique modification that will conform is an excellent mechanism for learning efficiency and avoidance of file failure. Examples for technique procedures that conform to the instrumentation rationale presented thus far are as follows:

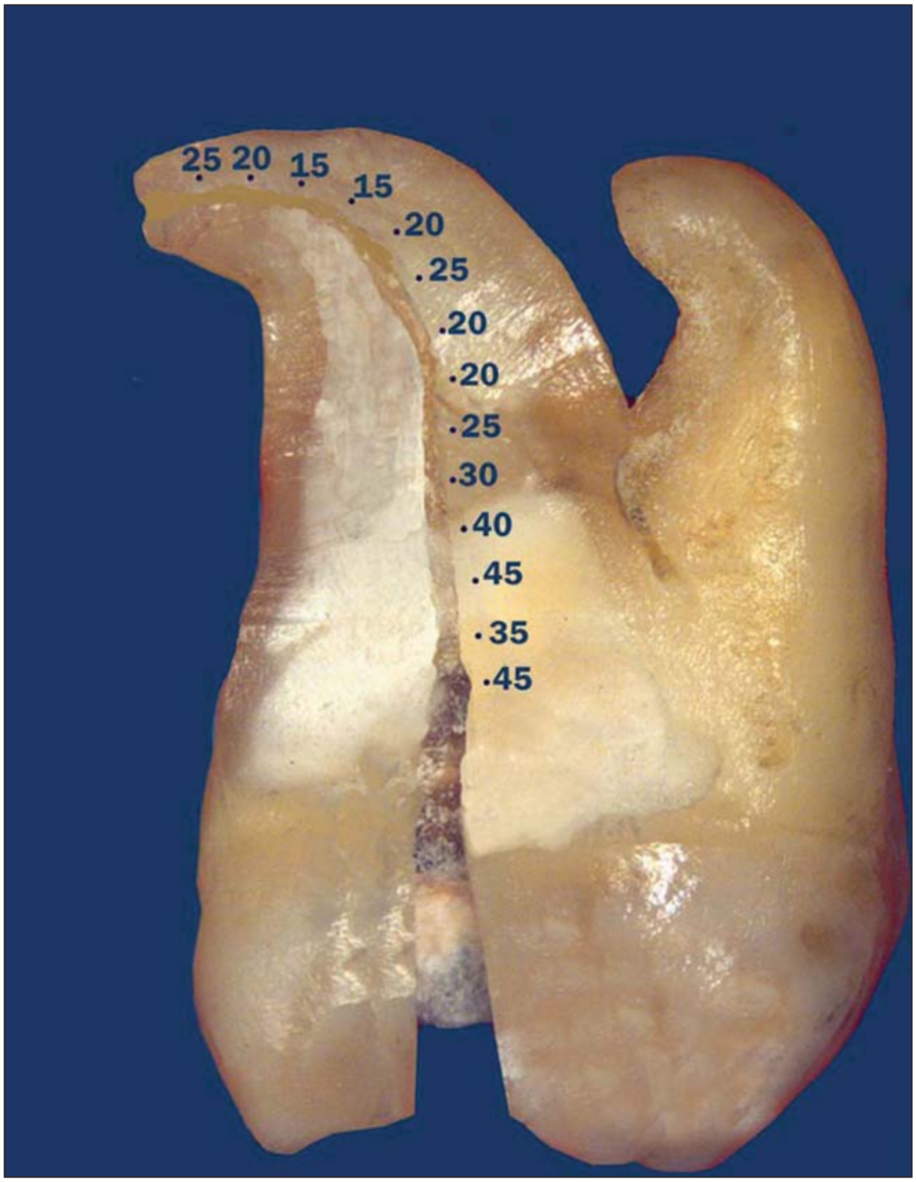

Fig. 126 The tooth illustrated has been sectioned to expose the mesio-buccal canal. The curvature begins 6 mm from the apical foramen and its radius is slightly less than 8 mm. Adjacent to the canal are the canal diameters prior to instrumentation from the foramen to the canal orifice.

Step 1. Determine the terminus of the coronal zone.

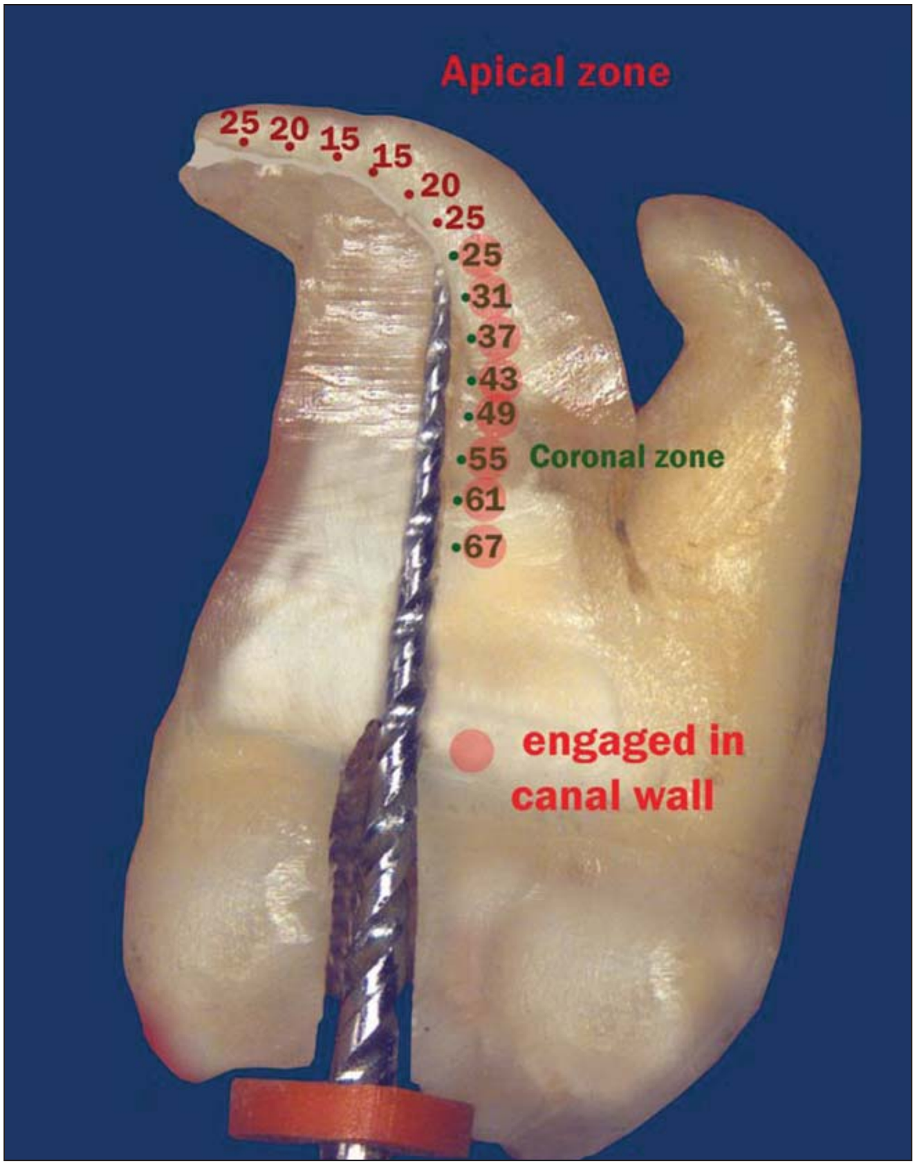

Fig. 127 A 25/.06 Quantec SC is taken to the terminus of the coronal zone (6 mm from the working length). The file, rotating at 350 rpm, should be advanced into the canal in 1 mm increments with insertion-withdraw movements. Each insertion should not require any more pressure than was required for its first insertion once engaged. When a position is reached in the canal that requires more pressure for advancement, that position is a good indication of the terminus of the coronal zone. In order to ascertain the position of the terminus, a file smaller than the canal can be advanced until resistance is met. For instance, if a 15/.02 is carried to the working length and withdrawn and reinserted, and resistance is met at some point, then that point denotes the terminus of the coronal zone. The two positions should be the same. The numbers in pink denote the levels of file engagement.

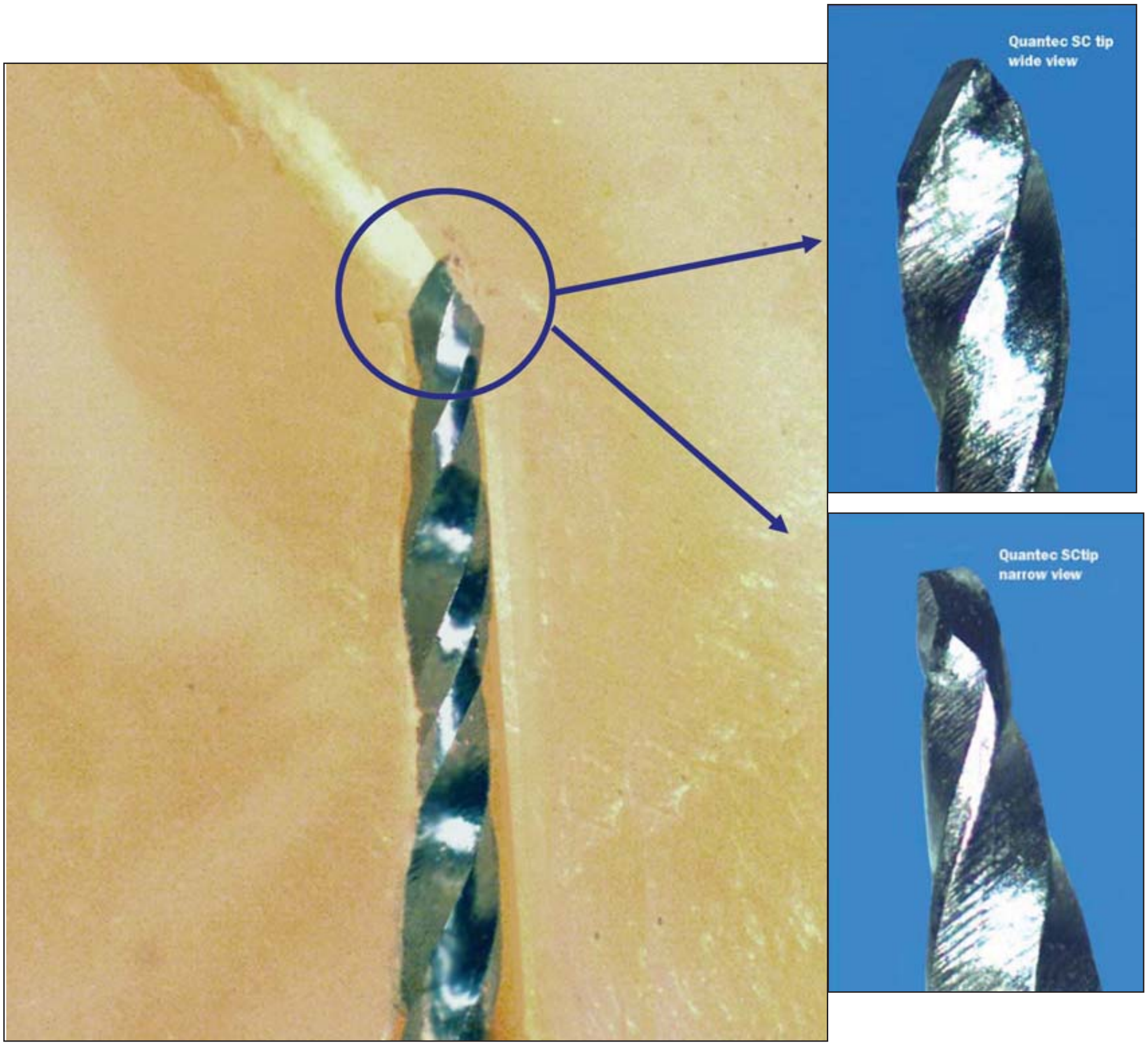

Fig. 128 Defining the coronal zone. The area in the circle illustrates where the file meets the increased resistance of a curvature and defines the terminus of the coronal zone. Images A and B illustrate different views of the .25 SC tip; one rotated 90 degrees from the other. The Quantec SC 25/06 was selected as the first file to negotiate and to define the coronal zone for 3 reasons, (1) The two fluted spade-shaped Quantec SC tip will enter and enlarge a canal orifice as small as .10 mm. as illustrated in the A and B images. (2) The Quantec SC .06 taper file had the most favorable safety ratio of any of the files tested with its dimensions. (3) The .06 taper is small enough to advance into the canal without requiring excessive pressure and it has sufficient rigidity to tactilely detect restrictive curvatures.

2. Determine the diameter needed in the final enlargement at the terminus of the coronal zone.

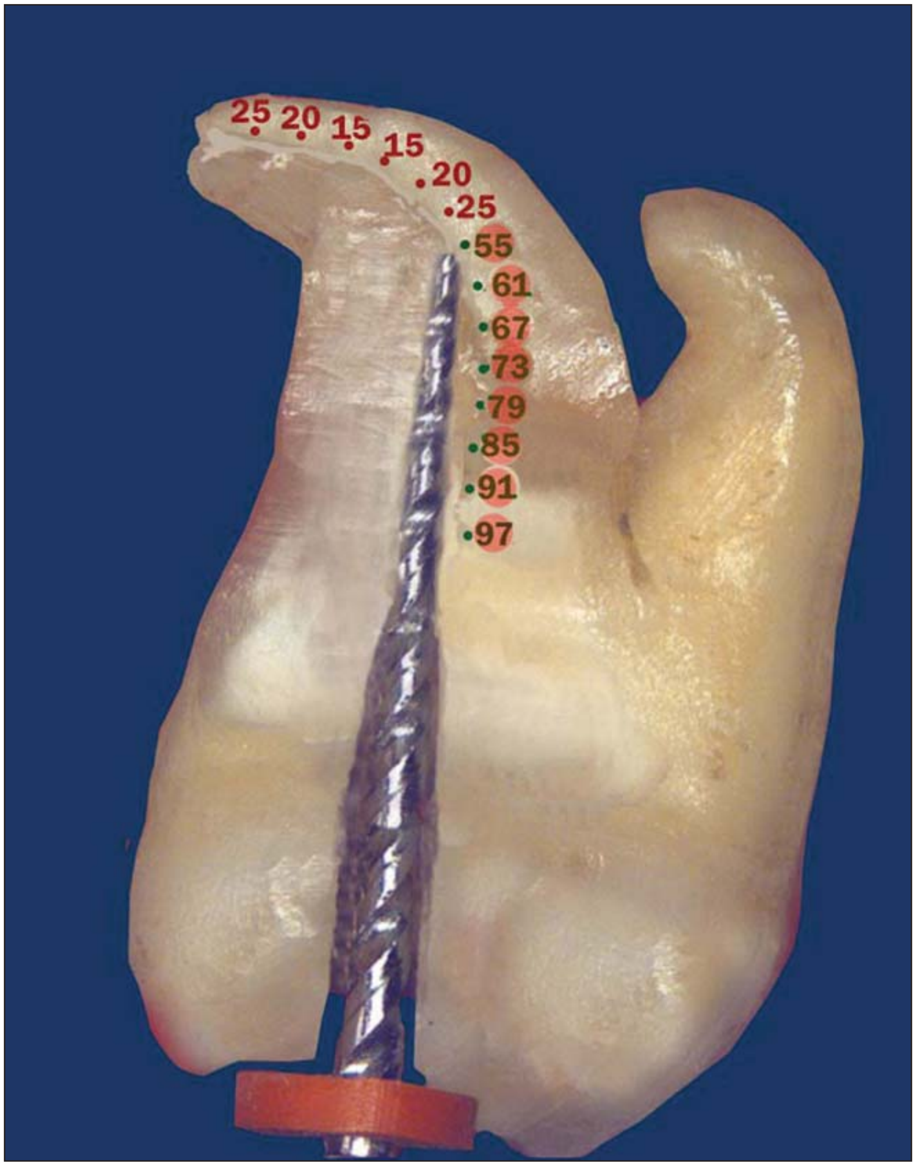

Fig. 129 55/.06 K-3. Having the same taper as the 25/.06 file, it is helpful to circumferentially file the canal during its advancement. This file was selected because of its resistance to distortion and its high cutting efficiency. By cautiously removing this file to a position short of its maximum insertion, the speed of rotation can be increased to 1,000 to 1,200 rpm to selectively reposition the canal orifice and taper of the coronal zone (to reduce the amount of engagement during its progress) to sufficiently enlarge in order that subsequent files will not become engaged, and to enlarge the canal access to conform to dimensions needed for ease of obturation. The Quantec/K-3 design is particularly effective for this type canal enlargement. Care must be taken not to engage the tip of the intrument by carrying it to a greater depth.

Step 3. Enlarge the apical zone to a size 25/.02.

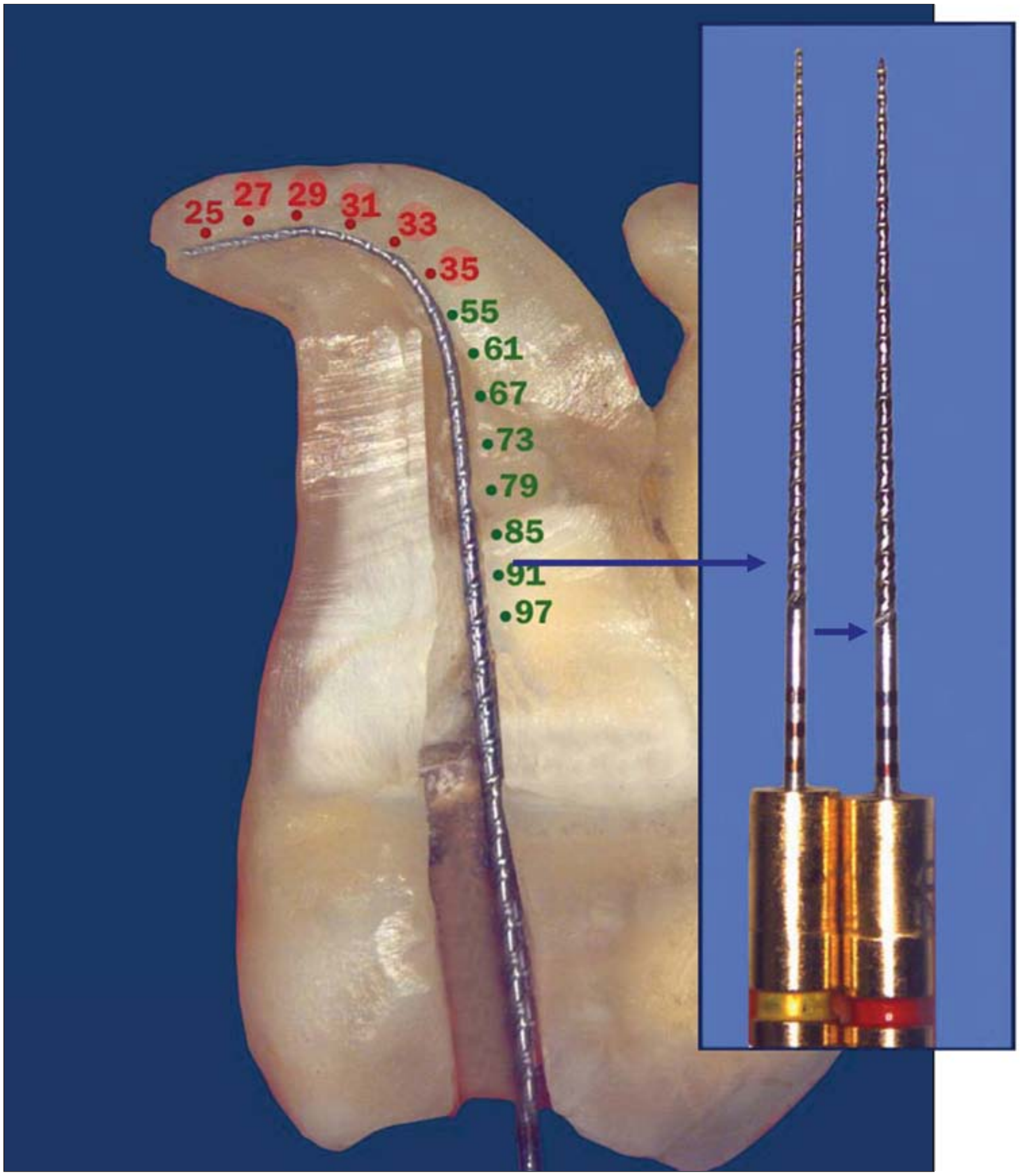

Fig 130 Advance the 15/.02 Quantec SC to terminus of apical zone (working length), followed with a 20/.02 and a 25/.02 Quantec LX to working length. The Quantec .02's were selected because they have the highest safety ratio for .02 files and the greatest cutting efficiency during penetration. The SC tip was selected for the 15/.02 file because of the uncertainty of the canal diameter and the reduced risks of canal transportation with its flexibility. Since the largest diameter at the terminus of the coronal zone was .55, the maximum diameters for the .02 files at the working length are smaller and the files are only engaged for 6mm.

Step 4. Enlarge the apical zone to the desired dimensions permissible.

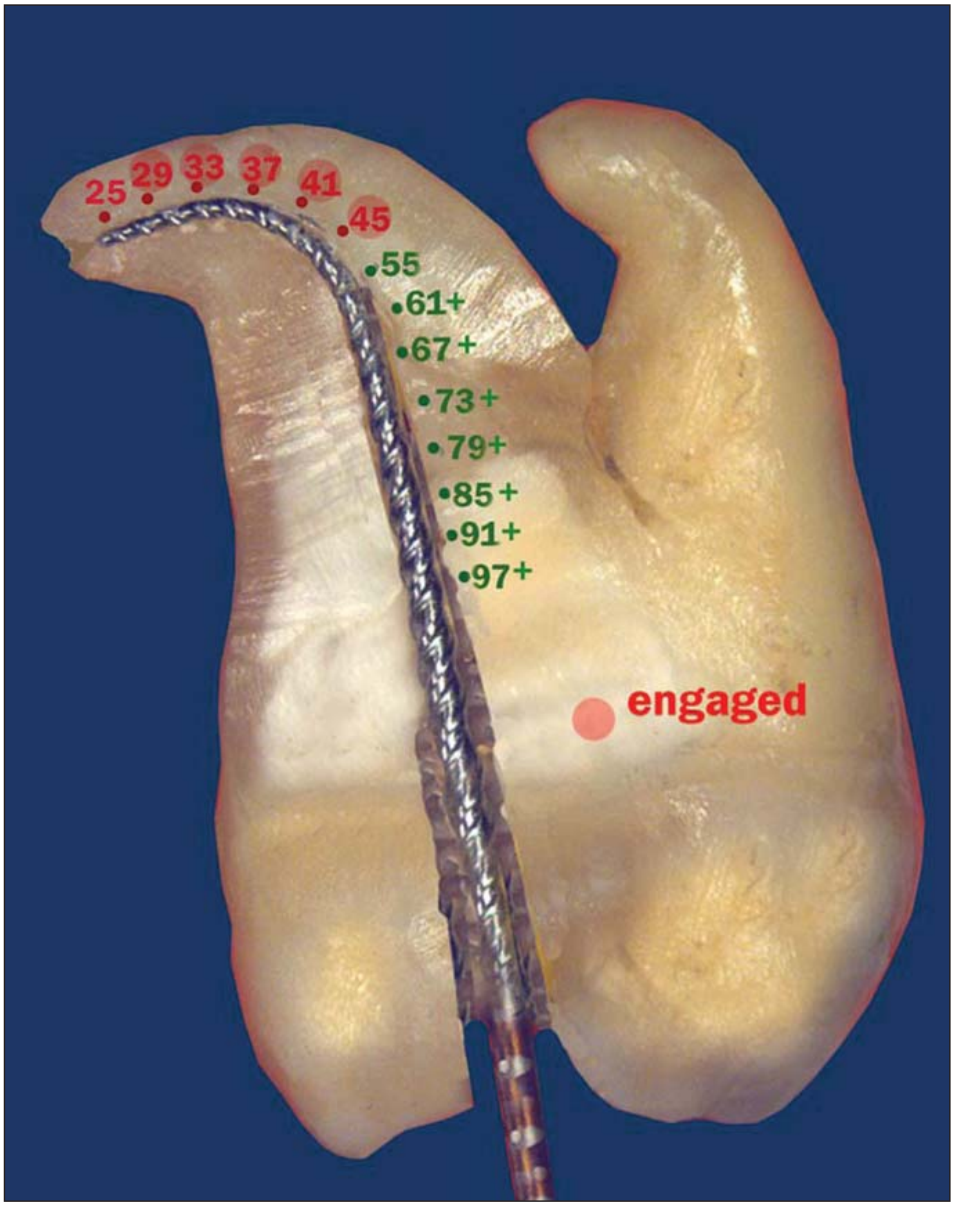

Fig. 131 25/.04 K-3 taken to terminus of apical zone. Following this procedure the file tip remains passive until it reaches the working length and is only engaged for 6 mm. The largest diameter of this file to be engaged is .45. The K-3 file was selected because it demonstrated the highest efficiency of any of the files tested.

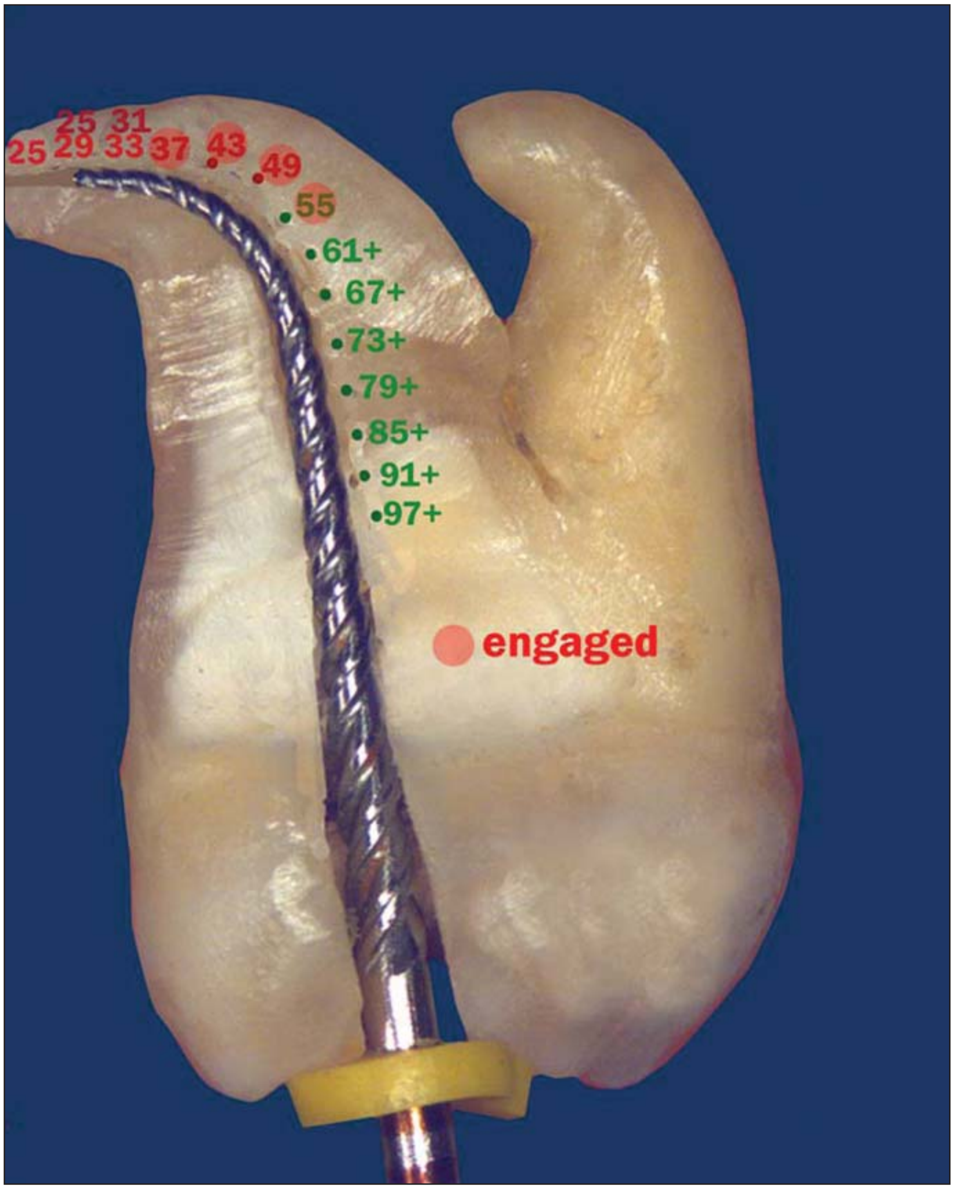

Fig. 132 25/.06 K-3 taken 1mm short of working length. Any additional taper or apical diameter should be provided by using .02 or .04 tapered files with a step-back tachnique in the apical zone. The enlargement of the coronal zone can be determined by the requirements of the operator. Each file in the sequence used conforms to the parameters dicussed above. The K-3 was selected for its high efficiency.

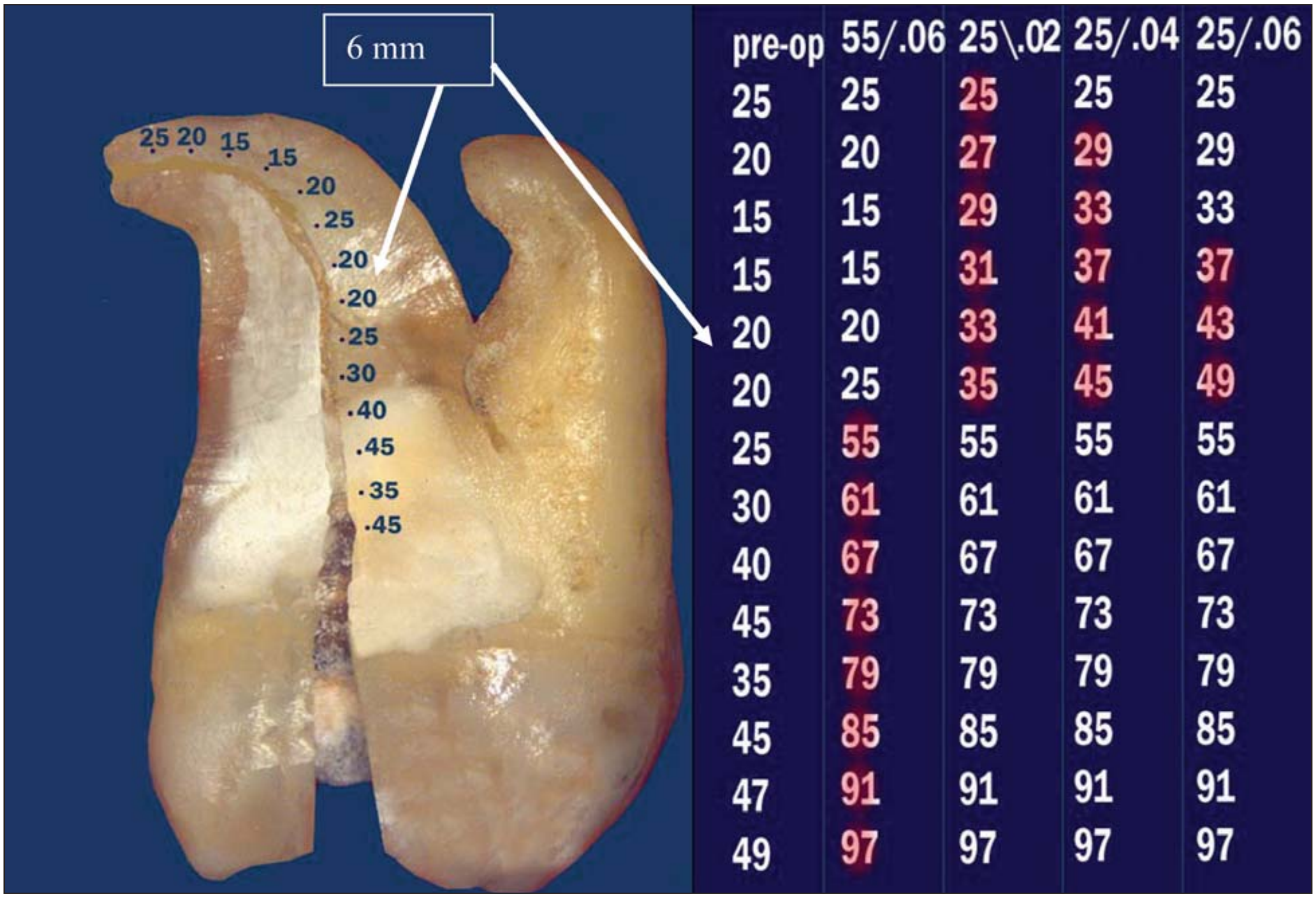

Fig. 133 This illustration is another means of representing the case above indicating the instruments used and the depths of advancement. Using this type representation enables one to determine if all the parameters are followed. Note that the K-3 25/.06 required advancing 1 mm short of the working length in order to conform to the parameters. Depending on the tip design, the use of a size 25/1.0 or larger orifice opener could facilitate enlargement with less engagement if used before the 55/.06 file was used in the coronal zone.

As discussed above, the K-3 files and Quantec files were used because results of the particular tests employed in our evaluations indicated either file provided a better safety ratio or greater preparation efficiency. Most other file series have the same file sizes available and can be used in the same manner to conform to the prescribed parameters. The Protaper Series is an exception that has files with unique accelerating and decelerating tapers. Although the coronal zone can easily be prepared with the Protaper Series, the apical zone cannot effectively be prepared while performing within the parameters, particularly without engaging more than 6 mm of working surface or without using large diameters in the curvature.

The above example was used to illustrate all of the limitations the parameters place on canals that have curvatures that extend six or more millimeters from the working length. Techniques for preparing mid-root and coronal curvatures require more step-back approaches with .04 and .02 tapers to conform to the parameters.

If the parameter of taper and diameter limitations for a canal having a 45-degree curvature and a 8 mm radius is used as a reference, the limitations of file dimensions in canals having different curvatures can be extrapolated mathematically. Two factors, the working length and the curvature radius, need to be considered in determining the file taper and diameter that can be used in the anatomy illustrated above while adhering to the recommended parameters. For instance, if we want to know how far we can advance a 25/.06 file beyond the point of curvature the parameters state the diameter should not exceed a .50 mm diameter which is reached when the file extends only 4 mm beyond the point of curvature. However, if the radius of curvature is16 mm or two times the amount stated in the parameters, the diameter used can be larger. The relationship is based on the square of the file diameter. The square root of two times the .50 mm diameter squared equals a size .70 mm diameter which means a 25/.06 file can be advanced to the working length without undue stress on the file. That determination assumes the other parameters are considered. Although the first impression of this process may seem complicated, little exercise is required to master this approach. The benefit is efficiency and the reduction of the threat of failure. *If the clinician insists on following a routine technique sequence because consistency weighs heavily in their practice efficiency, then the sequence described in Fig. 133 encompasses all of our considerations for minimizing instrument stress while providing an efficient routine for* ***routine canals****. That technique sequence is as follows:*

1. 25/.06 to curvature
2. 55/.06 to curvature
3. 25/.02 to working length
4. 25/.04 to working length
5. 25/.06 1 mm short of working length

The exceptions to "routine" of course, is any canal having an apical zone greater than 6 mm, a curvature less than 45 degrees and a radius less than 8 mm.

54. Can files be designed so you do not have to calculate how to avoid excessive stress?

Excessive stress on files of current designs can be avoided. This can be done if the cause of stress is understood and calculations are made as to where and how files can be used. Files can and are being designed that minimize mistakes in calculations and judgment. Since the two most frequent causes of file breakage are the result of using files having diameters too large for the degree of canal curvatures and engaging too much of the file's working surface, designs can be incorporated to minimize these events. Addressing design changes for reducing potential stress is the purpose of the next section.