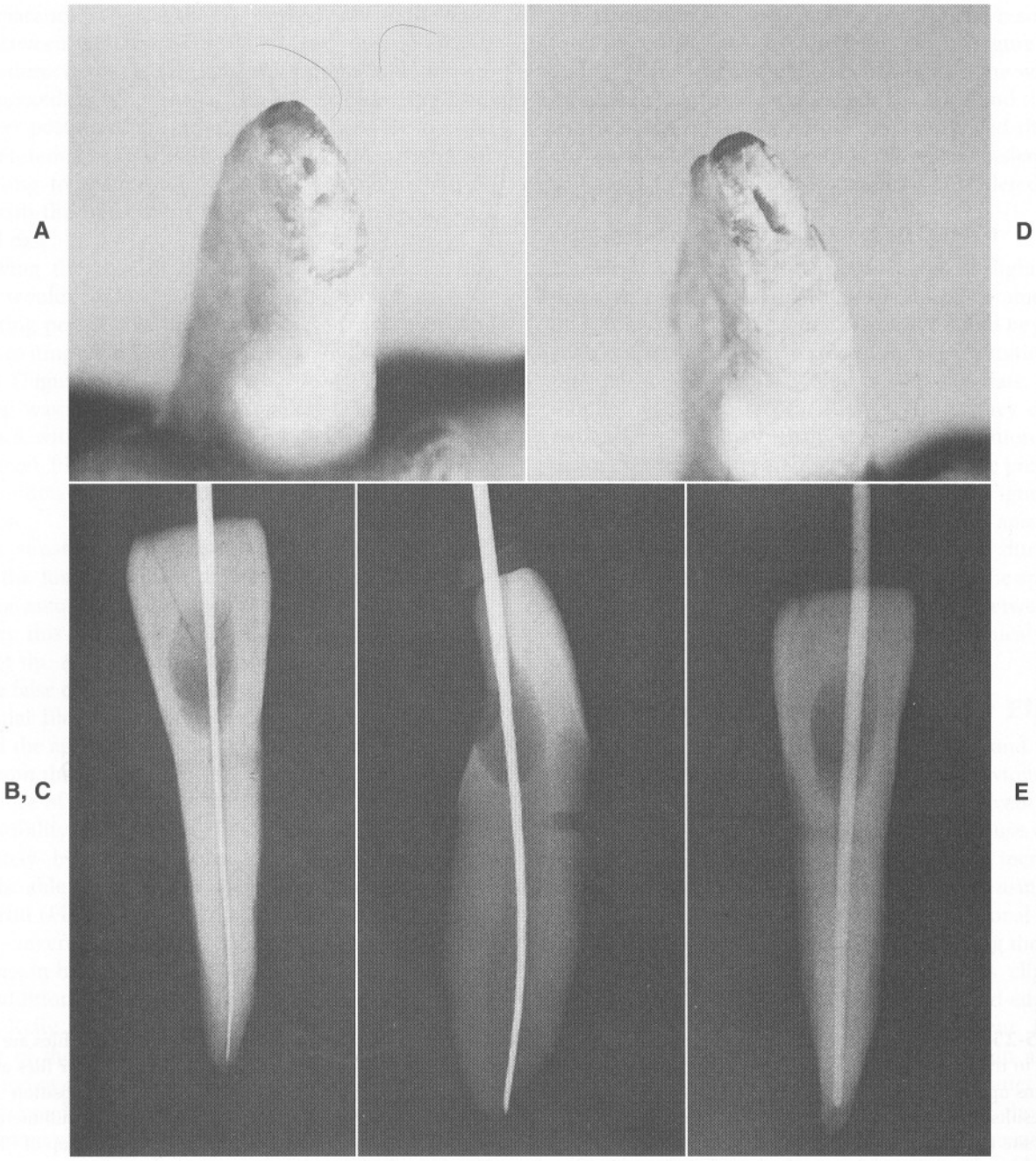


FIGURE 5-26 Zipped, teardrop shaped mandibular incisor after preparation through apex. A, Apical view of mandibular incisor root with canal exiting short of apex to the buccal. This is a tooth that typically will be overinstrumented. **B,** Radiograph of file in place seems to be well within confines of the tooth. **C,** Profile radiograph of labiolingual view, never seen with normal projection. Canal will be overinstrumented at a length that might seem satisfactory. **D,** Apical view after canal enlargement to size 35 at length indicated in *C*. This canal would be difficult to seal. **E,** Master gutta-percha cone size 35 appears to be approximately 0.5 mm too short. In fact, it was at least 0.5 mm too long.

lessened the need for clipping and removing of flutes for the more severe curves. However, if larger sized instruments do not seat easily at the apex, the ability to clip and/or remove flutes remains available.

I prefer to call these files with flutes removed according to the position of the elbow *customized files* because they are prepared for canals with specific dimensions and therefore can never be reused in another canal. Some prefer to use the words *modified files* to connote that a regulation file as it would come from the manufacturer would be altered for use. Further discussion of modified files will appear later in this chapter.



FIGURE 5-27 Condition in Figure 5-26 is not uncommon. A, After canal filling of tooth no. 24. Although I thought an apical dentin matrix was present, obviously I was incorrect; a considerable amount of sealer went past the apex. Poor as that case was, however, it was not as faulty as my attempt to fill no. 25 **(B),** in which I forced much sealer plus master and auxiliary cones past the nonexistent apical dentin matrix. Obviously these teeth both had apical configurations similar to those shown in Figure 5-25.

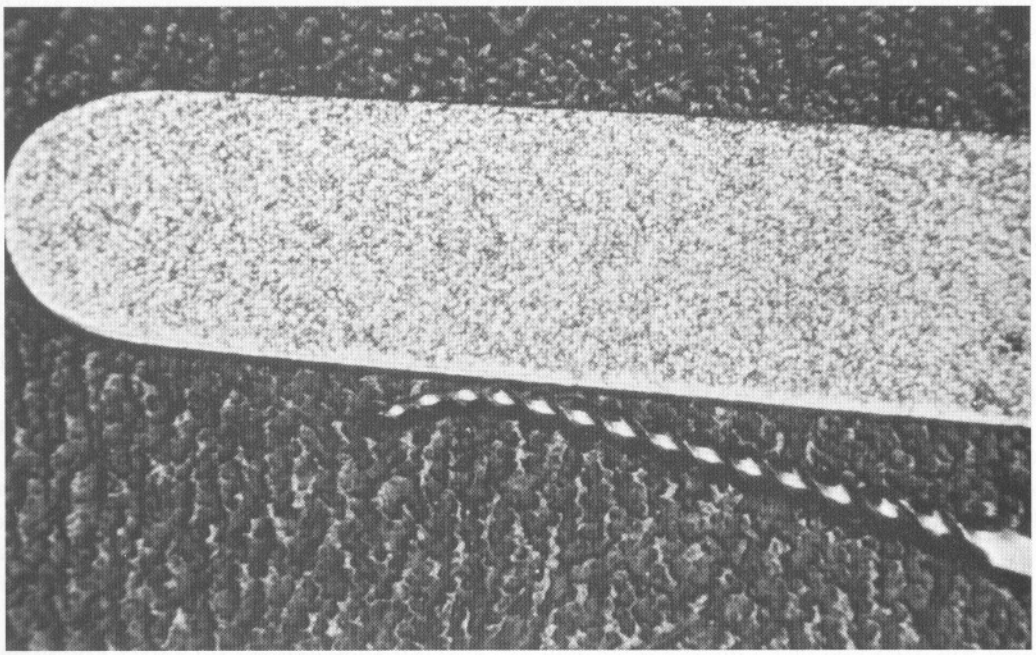


FIGURE 5-28 Producing a customized hand file. Diamond-edged fingernail file is used to remove flutes from outside edge of instruments of intermediate sizes in treatment of curves of 30° or greater. Flutes are removed from tip of file to approximate area of the elbow.

Theories for Flaring in Complex Cases Versus Crown-Down Preparation

The method of flaring presented earlier is the presently preferred development of flaring whereby the coronal portion of the preparation is flared before the completion of the apical portion. Four aspects of preparation are carried out. First, minimal filing is done at the tip, followed by enlargement of the coronal portion. Then the apex is completed, and finally, apical flaring is performed.

A type of flaring different than the type described in this book was adopted by some dentists 10 to 15 years ago, referred to as the *crown-down method.* In this technique, the canal was prepared from the coronal portion down to the apex using larger files first and then

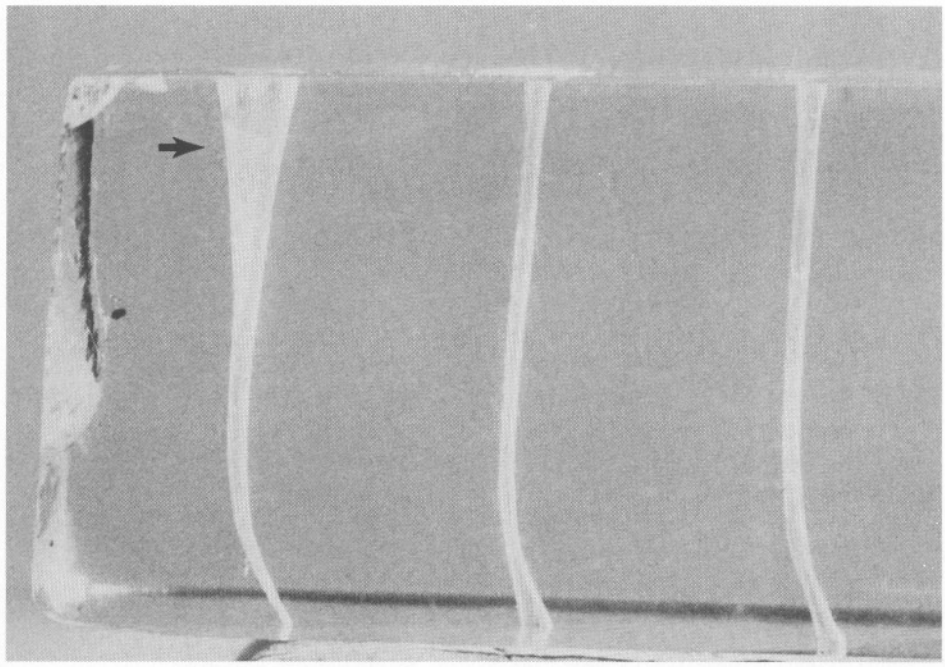


FIGURE 5-29 Plastic block canals enlarged with several techniques. Canal to left *(arrow)* was prepared by removing flutes for sizes 12, 17, 22, and 27 files, enlarging to size 30 apically, and flaring to size 45. Removal of flutes has prevented apical zipping, and the flaring has eliminated the elbow. This preparation is narrowest at apex, widest at orifice, and may be filled with many types of materials and techniques. Preparation was entirely with hand files because non-ISO rotary tapers were not yet introduced. Center canal was enlarged with a mechanical handpiece and has an elbow and zip. Canal at right was enlarged, by reaming action, apically to size 30 and demonstrates an elbow and a zip.

decreasing to smaller sizes. This was opposed to the classical method of enlarging first at the apex with small files and then working up coronally using successively larger files.

If the crown-down method is used in relatively straight canals, it seems to work satisfactorily and, in all probability, more quickly than classical preparation. This is because by opening the orifice area early in the preparation, the files do not bind prematurely and more effective preparation in the apical area occurs. The problem is that comparatively few canals are perfectly straight. In molar teeth, virtually all canals are curved. In these cases, the crown-down method works well in the coronal portion where the canal is relatively straight (see Figure 5-22). However, as the curve begins, larger, less flexible files stay straight and often will ledge and block the apical portion. With the advent of the non-ISO tapers, the suggested preparation went from the coronal portion with large files down through the smaller files near the apex (Figure 5-30).

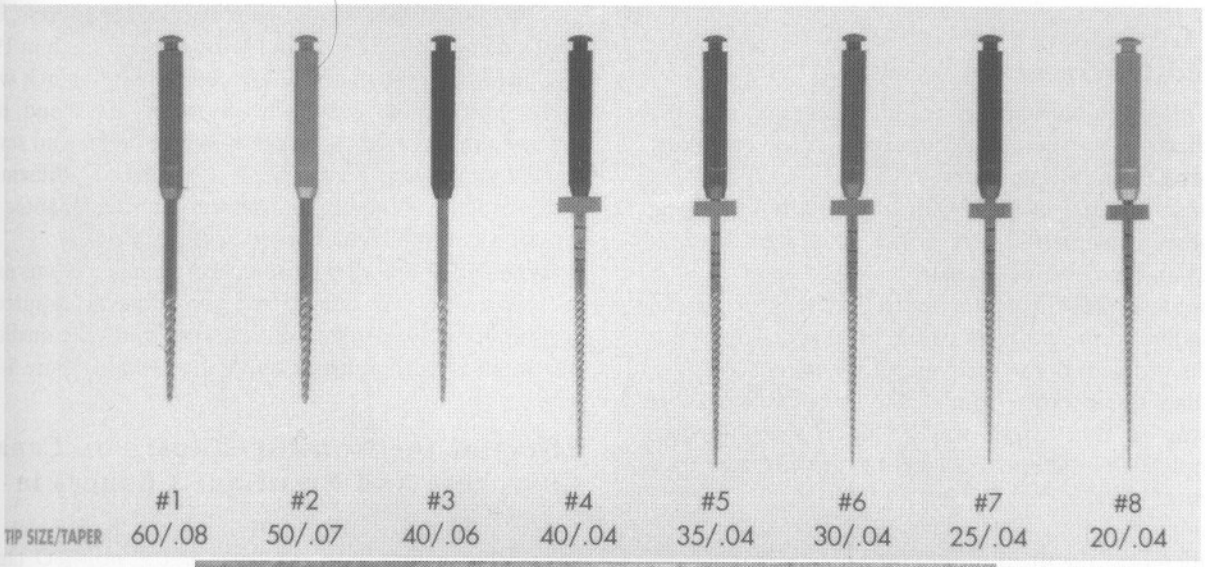
As stated earlier, my strong preference has always been to use a small file to the apex (such as the IAF) after using any larger file short of the apex. The validity of this view has been proven because most early endorsers of the crown-down technique have modified it to include the use of the smaller files to the apex between the larger files usage.

The coronal portion of flaring may be performed by hand instruments, ultrasonic devices, or mechanical instruments such as the Gates-Glidden bur or Peeso reamers. Before the use of the non-ISO tapers, these alternatives were used with generally good results. However, in my opinion, the new instruments specifically designed for flaring give even better results, which will be discussed in the next section.

The third edition of this textbook suggested early flaring only for canals with curvatures of 60 degrees or greater. Since that time I have used such flaring more and more, and now I recommend its use in every complex case. It may be used in all endodontic cases, even those that are relatively simple.

New Instruments for Early Flaring. Because of the immediate popularity attained by early flaring, it was only a short time later that several new instruments were developed specifically for this technique. All of them have used some deviations from the ISO taper of standardized instruments.

If one wants to enlarge only the coronal portion of the canal to a greater extent earlier in the preparation procedure, examination of Figure 5-11, *A* and *D*, suggests that a useful instrument would be one that is quite wide from the middle of the file up the shaft, but narrower as you approach the apex. Such an instrument would have an



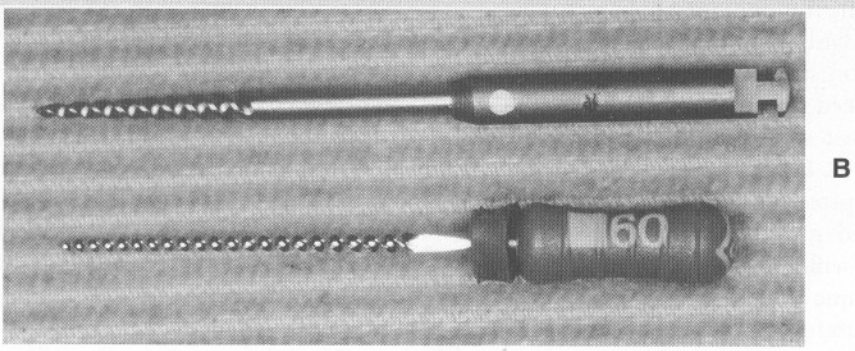


FIGURE 5-30 **A,** Instructional guide for use of non-ISO tapered instruments, in crown-down technique. Sizes of greater taper and .04 tapers are placed sequentially in order of use from left to right. Note that the first, second, and third files are intended to reach short of the apex but are quite wide (tapers .08, .07, and .06, respectively) and very inflexible. The other files, #4 through #8, are in descending order of width. Note, no MAF is indicated for use. Such a preparation technique is fraught with dangers such as ledging and perforation. **B,** .08 taper size 60 *(top)* compared with size 60 hand file *(bottom)*. If the .08 tapered instrument was run down even 10 mm in the tooth shown in Figure 5-14, B, it would surely cause a strip perforation.

increase over the standard degree of tapering. This is exactly what has been accomplished with these new instruments that have been made with non-ISO standard tapers.

As described in the discussion of the standardized hand instrument, the taper of .02 mm of width per millimeter of length is present. For the instruments designed for early flaring, the taper has been increased (Figure 5-31). The .04 tapers* are mechanical instruments produced to be used in a gear-reduction handpiece. They are made of nickel-titanium metal with a taper twice as great as standardized instruments. The widths of the .04 tapers at D_0 and D_{16} are listed in Table 5-1.

*Tulsa/Dentsply, Tulsa, OK 74136.

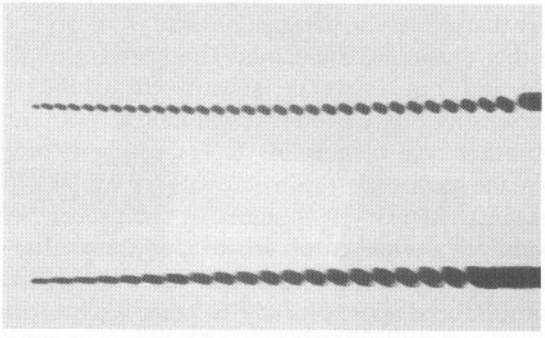


FIGURE 5-31 Shadowgraph of .04-taper instrument *(bottom)*, approximately size 25 at the tip, but 0.89 mm at D_{16}, compared to a size 25 Flex-o-file *(top)*, which is 0.57 mm at D_{16}. The .04-taper instruments are made for a low-speed/high-torque mechanical handpiece out of nickel-titanium material.

Rules Governing the Use of Non-ISO Tapered Instruments

Because of their difference in design and usage from the standardized files, there are important rules to follow when using the non-ISO tapers:

1. The instructional tapes present in the early packaging of these instruments have errors (based on current usage) and may be incomplete.
2. Do not use these instruments to the apex of curved canals due to the problem of file breakage. This was a serious problem in the early use of the non-ISO tapers. Calculate the distance from a cusp tip to the *elbow.* Set the stop to this length and do not go any further. (Complete instructions on locating the elbow will be presented shortly.)
3. Do not drill into the canal. Place the apical few millimeters of the file into the canal and then move the handpiece apically. Only go as far as the file goes easily.
4. Use a gear-reduction handpiece—do NOT try to use regulation slow speed and govern the RPM with the rheostat. The correct speed is between 300 and 350 rpm (see Figure 5-46, *B*)
5. Practice, practice, practice. Do not attempt to treat a considerably curved root as soon as you start using these systems. You will have serious problems and will feel that the technique is flawed. We are fortunate that we have several useful and realistic substitutes for practicing all endodontic situations (e.g., extracted teeth and plastic blocks) (see Figure 5-24, *A*). Use these aids to gain experience with the system. Then try a few clinical cases where the curvatures are mild and work up to the more complex situations.

Several other dental firms also produce varying tapers similar to the .04s. The closest to the one I usually use is made by Maillefer, of Switzerland, also a subsidiary of Dentsply, and a company with many years of manufacturing quality endodontic instruments. Their non-ISO tapers* (see Figure 5-12, *B*) come in the standardized, rather than Series 29, designations and the color coding is also that of the ISO standards. The instruments are well made and can easily be substituted in the specific directions for preparation that will follow.

Another type of non-ISO tapers has been produced, using the prefix of "Quantec" plus a year designation. These instruments were designed by McSpadden, who has introduced a number of other applications for endodontics. The McXim (pronounced "maxim") file system** was introduced approximately 10 years ago, utilizing five to six files of the same tip size and varying tapers from .03 to .055. I used this system with reasonable success, both clinically and in research on plastic blocks. Then in 1999, McSpadden introduced the Quantec 2000,* which was a more complicated system with many sizes and taper designs ranging from no taper to severe tapers and several flute designs (see Figure 5-12, *C*). Several adjustments were made from the original system, but the Quantec files do not seem to be widely used at this time.

When any of these instruments are used, it seems easier to prepare curved canals, and less time is required to accomplish this normally difficult task. Still the quality of treatment is maintained at a very high level (Figure 5-32).

Effect of the Non-ISO Tapers on Canal Curvature and Resultant Changes in Canal Shape

Using the theories of Leeb, use of the non-ISO tapers, especially at the low speeds of 300 to 350 rpm, allows the operator to remove the triangle of dentin that often protects the orifice of the curved canal. The Gates-Glidden and Peeso reamers essentially are centering burs, that is, drill down the center of the canal and widen it in all directions. The slower revolving non-ISO tapers may be pressed toward and directed to eliminating this triangle and effectively reduce the canal curvature (Figure 5-33). Reducing the curvature lessens the chances for serious and destructive zipping.

The ability to work effectively at lower speeds allows the placement of the non-ISO tapers directly against a canal wall, enhancing anticurvature filling (see Figure 5-14, *E*).

Typical Cases

The instrumentation for typical cases is discussed next. Early flaring is used in this preparation schedule, and the apical portion of the canal is slightly enlarged prior to any flaring. This is provided by clipping the IAF and making an incremental size, called the *temporary master apical file* (TMAF) and is used to the full working length after each flaring file, or any other file, used short of that distance. Flaring with non-ISO standard instruments is included in the step-by-step preparations of the complex curved canal systems that follow.

Curvatures of 30 to 60 Degrees. First I will describe the treatment provided on two maxillary molars. The first is for the mesiolingual canal (fourth canal) on a first molar with a short distance between the elbow at the apex. The second is for the mesiobuccal canal on a second molar with a relatively long distance between the elbow

*Maillefer/Dentsply, Balligues, Switzerland

**NT Co., Chattanooga, TN 37421.

*NT Co., Chattanooga, TN 37421.

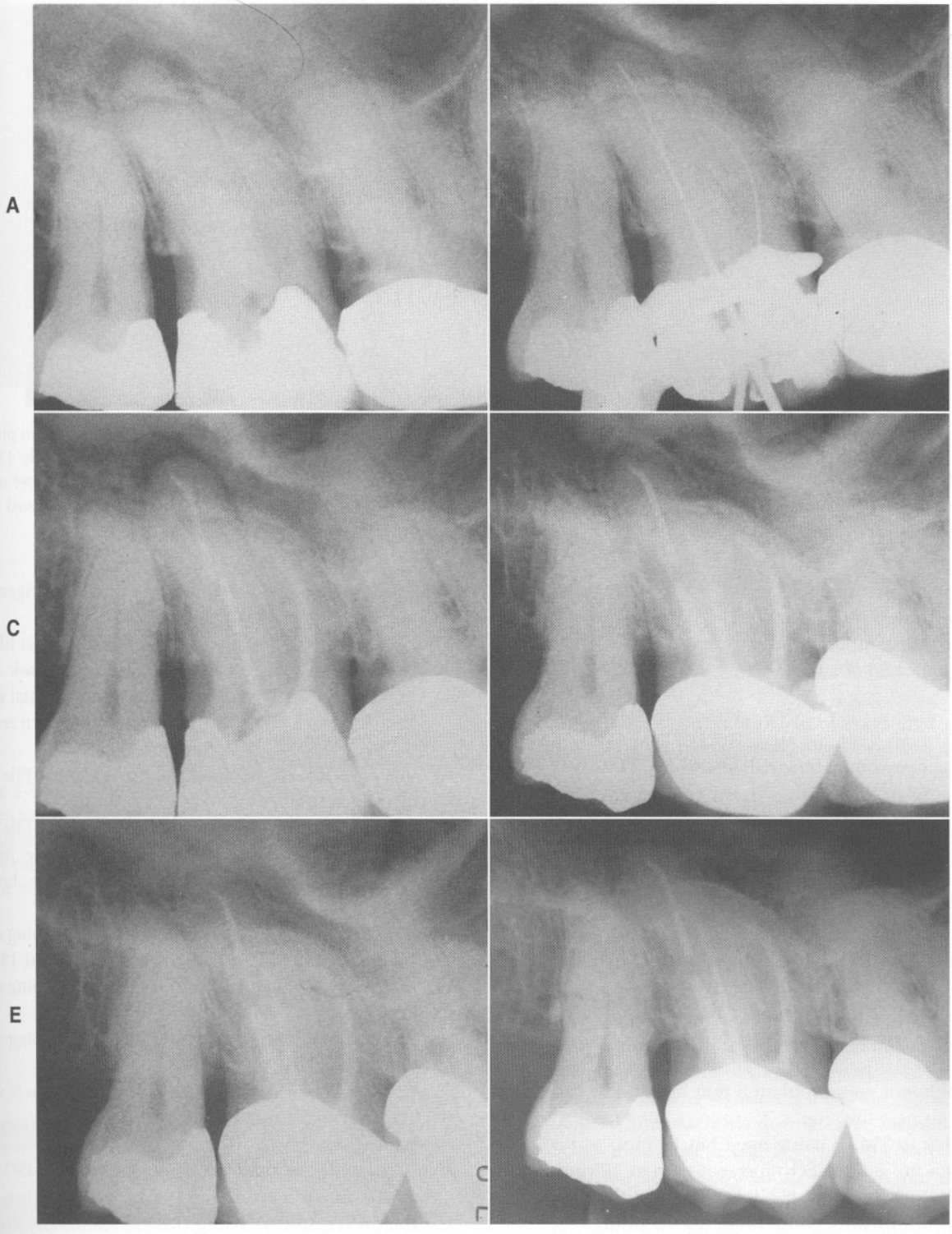


FIGURE 5-32 Maxillary second molar, the first tooth that I treated with early flaring by .04-taper instruments. A, Preoperative radiograph of maxillary molar area. Periapical lesions are associated with palatal and mesiobuccal roots. **B,** Film of files in place, indicating curvature of almost 90° in mesiobuccal canal and curves near the apices of the palatal and distobuccal canals. **C,** Canals were flared using .04-taper instruments. Once this was accomplished, canal preparation seemed to proceed more easily than anticipated in this difficult case. Note that the orifice of the mesiobuccal canal has been moved to the mesial, thus decreasing the curvature to approximately 60° (compare to *B*). Canals were filled with laterally condensed gutta-percha and Wach's paste, with post room prepared. **D,** Perfect periapical healing is apparent in this film taken 9 months later. **E,** Eighteen months after original treatment. **F,** Seven years after original treatment, normal appearance of periapical tissues. (Restorations by Dr. Phil Finkle, Chicago.)

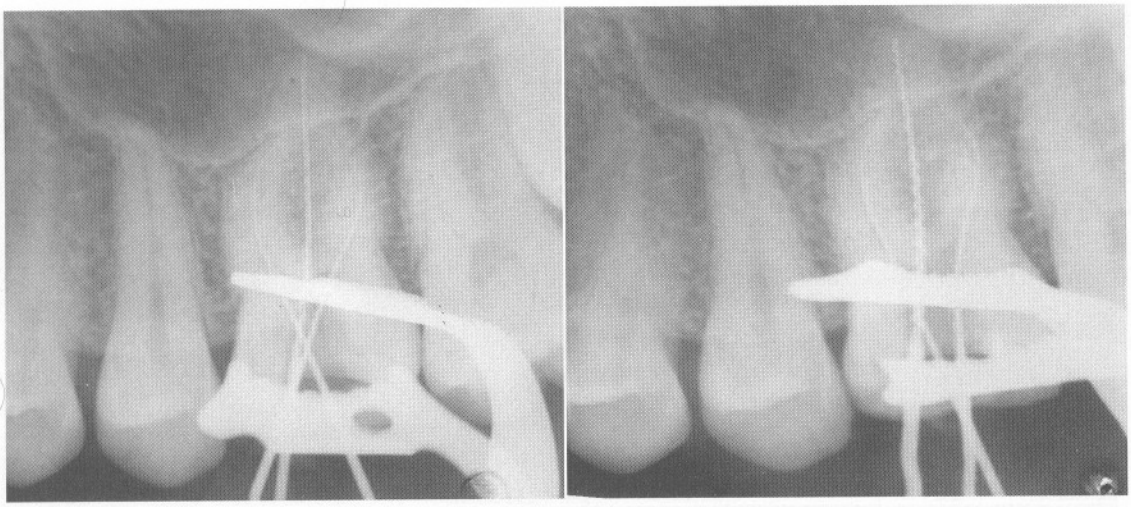


FIGURE 5-33 Reducing angle of curvature by use of non-ISO tapered files. A, Maxillary first molar with initial files in place, no. 10 files in buccal canals. The angle of curvature in the MB canal is approximately 50° and in the DB canal is approximately 45°. Note that the 2 files in the buccal canals cross in the middle of the access cavity. **B,** After using an IAF, a TMAF, and #2, #3, and #4 non-ISO tapers, the 2 files cross beyond the occlusal surface of the tooth because the triangles guarding the orifices have been removed and the files have straightened. Now the curvature of the buccal canals is approximately 30°.

and the apex. Instrumentation for these cases with early flaring is as follows.

Maxillary first molar (re-treatment), mesiobuccal root, mesiolingual canal (Figure 5-34):

Curvature = 35 degrees
Distance from elbow to apex (estimated) = 2 to 3 mm
Working length = 15 mm (measured from reduced cusp with temporary bridge removed)

The silver points and posts were removed with an ultrasonic, which was also used on the floor of the chamber, exposing the orifice to the mesiolingual canal.

1. File with no. 10 file at 15 mm.
2. Clip 1 mm from no. 10 file (making it a no. 12); remove 2 to 3 mm of flutes from outside of curve and file at 15 mm. This file becomes the TMAF and will be used after each file during early flaring.
3. Select a no. 2 non-ISO taper, set the stop at 12 mm (working length of 15 minus 3 mm distance to elbow) and file orifice portion of the canal. (File will probably not go more than 8 mm but, in any case, do NOT go past the stop.)
4. Go back to TMAF, using no. 12 at 15 mm.
5. Select a no. 3 non-ISO taper, set stop at 12 mm, and file the orifice portion slightly deeper than step 3. (File will probably go no more than 9 mm.)
6. Repeat step 4.
7. Select a no. 4 non-ISO taper, set the stop at 12 mm, and file the orifice portion slightly deeper than step 5. (File probably will not go more than 10 mm but, in any case, do NOT go past the stop.)
8. Repeat step 4. Early flaring is now completed; the apical portion of the canal has been minimally prepared without zipping, and the orifice portion has been widened considerably. The files now used at the apex will work more effectively and the irrigants will penetrate throughout the canal.
9. Place a no. 15 flexible file to 15 mm. If this file does not go easily to measured length, go back to the previously TMAF and make it an incremental no. 14. Use this instrument until it is loose and then retry the no. 15. Use rasping action.
10. Place a no. 20 flexible file to 15 mm. File using rasping action.
11. Place a no. 25 flexible file to 15 mm. File using rasping action. The apical portion of the preparation is completed and this no. 25 file becomes the MAF.
12. Place a no. 30 file to 14 mm. File using rasping action.
13. Go back to the MAF, using the no. 25 file at 15 mm.
14. Place a no. 35 file to 13 mm. File using rasping action.
15. Repeat step 13.
16. Place a no. 40 file to 13 mm. File using rasping action.
17. Repeat step 13.
18. Use the previously used #2 taper. This time it should go easily to 12 mm.
19. Repeat step 13.
20. (Optional) You may use the #3 and #4 non-ISO tapers or the finishing files (Figure 5-35) to further widen the orifice, always using the MAF after any file short of the apex to maintain length.
21. Verify completeness of preparation by finger plugger insertion.

Maxillary second molar, mesiobuccal canal (see Figure 5-32):

Curvature = 60 degrees (Figure 5-32, *B*)
Distance from elbow to apex (estimated) = 6 to 7 mm
Working length = 24 mm (verified by Figure 5-32, *B*)

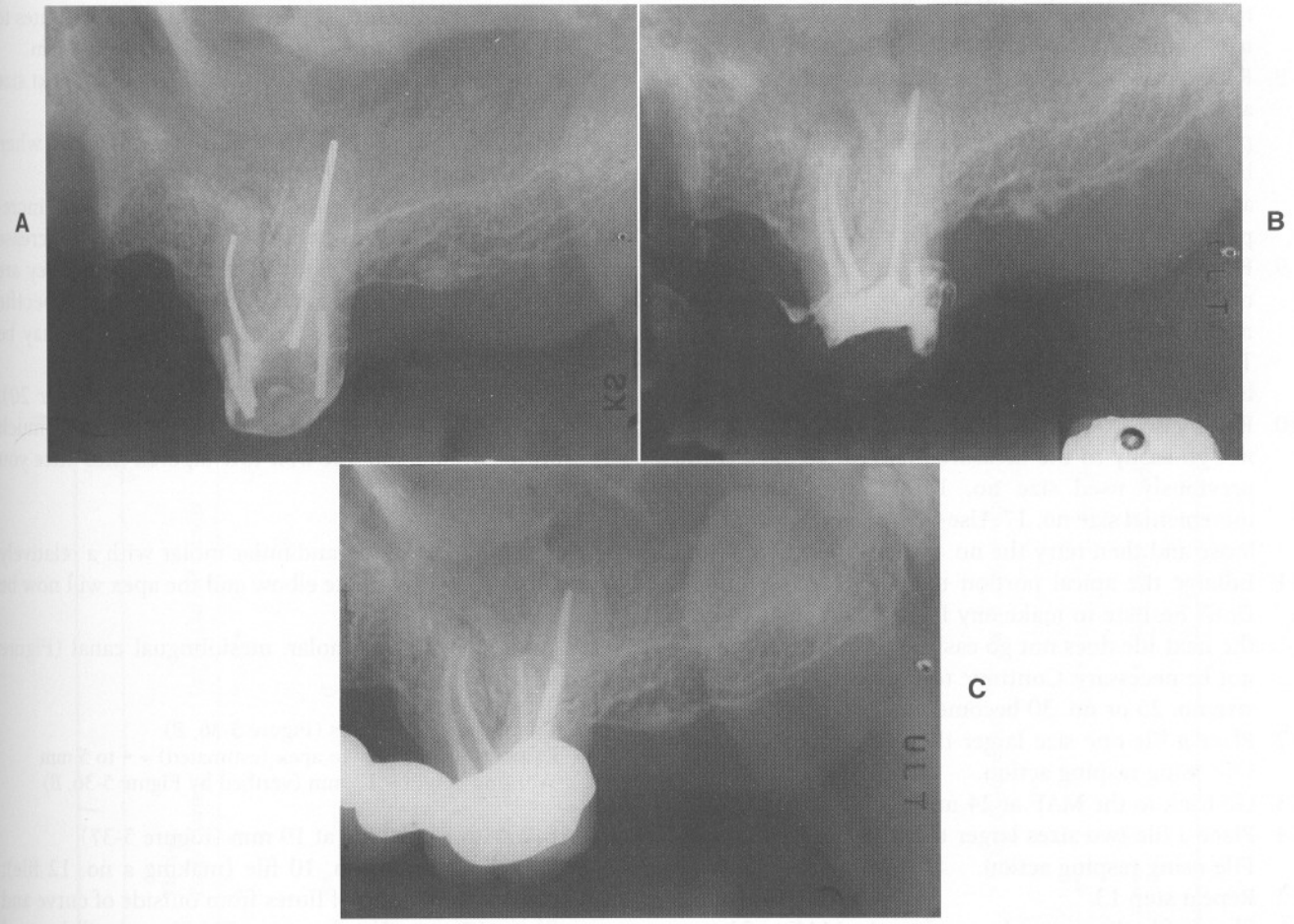


FIGURE 5-34 **A,** Preoperative radiograph of maxillary first molar, treated with silver points 6 years earlier. A periapical radiolucency is associated with the MB root. The points and pins were removed with ultrasonics, which were also used on the floor of the chamber, exposing an untreated ML canal. The temporary bridge had been removed. **B,** Immediate postoperative film, four canals filled with laterally condensed gutta-percha and Wach's paste, post room prepared. **C,** Eighteen months later, lesion is almost totally healed, view from the distal (see Chapter 4). (Restorations by Dr. Steve Pothashnick, Chicago.)

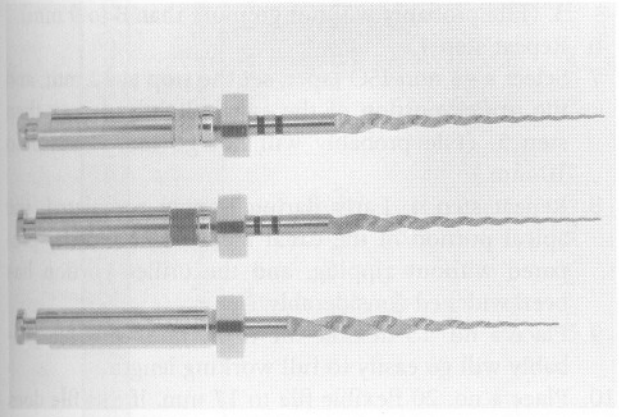


FIGURE 5-35 Finishing files, used to widen orifice areas after apical preparation in revised crown-down technique. There are variable tapers throughout the files, most pronounced in the "shaper" file *(bottom)*.

1. File with no. 10 file at 24 mm.
2. Clip 1 mm from no. 10 file (making a no. 12 file); remove 6 to 7 mm of flutes from outside of curve and file at 24 mm. This file becomes the TMAF and will be used after each file during early flaring.
3. Select a no. 2 non-ISO taper, set the stop at 17 mm (working length of 24 mm minus 7 mm distance to elbow), and file orifice portion of the canal. (File probably will not go more than 11 to 12 mm, but in any case do NOT go past the stop.)
4. Go back to TMAF, using no. 12 file at 24 mm.
5. Select a no. 3 non-ISO taper, set the stop at 17 mm, and file the orifice portion of the canal slightly deeper than step 3. (File probably will not go more than 12 to 13 mm.)
6. Repeat step 4.
7. Select a no. 4 non-ISO taper, set the stop at 17 mm, and file the orifice portion of the canal slightly deeper

than step 5. (File probably will not go more than 13 to 14 mm.)
8. Repeat step 4. Early flaring is now completed; the apical portion of the canal has been minimally prepared without zipping, and the orifice portion has been widened considerably. The files now used at the apex will work more effectively, and the irrigants will penetrate throughout the canal.
9. Place a no. 15 flexible file to 24 mm (this is a normal no. 15 file of a flexible system as it comes from the manufacturer with no flutes removed or tip reduced). This file probably will go easily to the full working length.
10. Place a no. 20 flexible file to 24 mm. If this file does not go easily to the measured length, go back to the previously used size no. 15 file and make it an incremental size no. 17. Use this instrument until it is loose and then retry the no. 20. Use rasping action.
11. Enlarge the apical portion to size no. 25 or no. 30. Don't hesitate to make any file an incremental size if the next file does not go easily, but this probably will not be necessary. Continue to use rasping action. The size no. 25 or no. 30 becomes the MAF.
12. Place a file one size larger than the MAF to 23 mm. File using rasping action.
13. Go back to the MAF at 24 mm.
14. Place a file two sizes larger than the MAF to 22 mm. File using rasping action.
15. Repeat step 13.
16. Place a file three sizes larger than the MAF to 21 mm. File using rasping action.
17. Repeat step 13.
18. Use the previously used #2 taper. This time it should go to the elbow.
19. Repeat step 13.
20. Use the previously used #3 taper. This time it should go close to the elbow.
21. Repeat step 13.
22. Use the previously used #4 taper. This time it should go to within 2 mm of the elbow.
23. (Optional) You may use the finishing files (Figure 5-35) to further widen the orifice area, always using the MAF after any file sort of the apex to maintain length.
24. Verify completeness of preparation by fitting finger plugger.

Points to remember:
1. Keep all canals heavily irrigated. I prefer to irrigate up to size 20 with large amounts of carbamide peroxide (Gly-Oxide) and lesser amounts of sodium hypochlorite (NaOCl). Sizes 25 and above, I use mostly NaOCl, with lesser amounts of Gly-Oxide.
2. Be certain to set the indicator direction on your stop (see Figure 5-18), so you know where the flutes are removed when the files that have been trimmed are within the canal.
3. Do *not* rotate the file, or you will distribute the flutes to portions of the canal where you do not want them.
4. Be prepared to make additional file clips if the next size of file does not go to place easily.
5. Proceed slowly. Use flexible file systems only when working apical to the elbow (Table 5-4).
6. Any customized files—those clipped to make incremental sizes and then flutes removed to decrease zipping—must be discarded after use because they are made to prepare canals with certain specific dimensions. Use of these files in other canals may be detrimental.
7. Despite the fact that many steps are listed (over 20), you will find that the total preparation time is much shorter when using the non-ISO tapered files once you master the system.

The treatment of a mandibular molar with a relatively long distance between the elbow and the apex will now be described:

Mandibular second molar, mesiolingual canal (Figure 5-36):

Curvature = 50 degrees (Figure 5-36, *B*)
Distance from elbow to apex (estimated) = 4 to 5 mm
Working length = 17 mm (verified by Figure 5-36, *B*)

1. File with no. 10 file at 19 mm (Figure 5-37).
2. Clip 1 mm from no. 10 file (making a no. 12 file); remove 4 to 5 mm of flutes from outside of curve and file at 17 mm. This becomes TMAF and will be used after each flaring file in flaring procedure.
3. Select a #2 non-ISO taper, set the stop at 12 mm (working length of 17 mm minus 5 mm distance to elbow), and file orifice portion of the canal. (File probably will not go more than 7 to 8 mm, but in any case do not go past stop.)
4. Go back to TMAF, using no. 12 file at 17 mm.
5. Select a #3 non-ISO taper, set the stop at 12 mm, and file orifice portion of the canal slightly deeper than step 3. (File probably will not go more than 8 to 9 mm).
6. Repeat step 4.
7. Select a #4 non-ISO taper, set the stop at 12 mm, and file orifice portion of the canal slightly deeper than step 5. (File probably will not go more than 9 to 10 mm.)
8. Repeat step 4. Early flaring is now completed; the apical portion of the canal has been minimally prepared without zipping, and the orifice portion has been widened considerably.
9. Place a no. 15 flexible file to 17 mm. This file probably will go easily to full working length.
10. Place a no. 20 flexible file to 17 mm. If this file does not go easily to measured length, go back to the previously used no. 15 and make it a no. 17 file. Use this instrument until it is loose and then retry no. 20. Use rasping action.



TABLE 5-4 Relative Ability of File Systems

Instrument Type	*Manufacturer*	*Process, Blank*	*Penetrating Ability*	*Flaring, Early Flaring*	*Use in Curved Canals*	*Best Use; Comments*
Reamer	Many	Twisted, triangular	*	*	* + ½*	1st intracanal instrument (?); place sealers, medicaments, remove gutta-percha with solvents
K-file	Kerr, then many	Twisted, square	Nos. 08 and 10* Nos. 15 and 20**	**	0	1st improved instruments; straight canals, flaring above elbow
Hedstrom	Many	Ground	½*	*** (above elbow, only)	Only small sizes	Aggressive cutting, flaring; use in irregular canals as for child patients
K-Flex	SybronKerr	Twisted, diamond	*	** (past elbow) * (above elbow)	***	1st instrument designed for curved canals; slow cutter
Flex-R-Files	Moyco	Ground, safety tip	0	** (past elbow) ½ * (above elbow)	**	1st file manufactured with noncutting tip
Flex-o-file	Dentsply/Maillefer	Twisted, triangular, chlorinox metal	*	** (past elbow) ½ * (above elbow)	***	Curved canals; may be slightly undersized
Golden Mediums	Dentsply/Maillefer	Twisted, triangular, chlorinox metal	*	** (past elbow) ½ * (above elbow)	***	Intermediate sizes only; used for narrow, curved canals
Pathfinder	SybronKerr	Twisted	***	0	*	Penetrating narrow, sclerotic canals, non-ISO taper, about .013; old Kerr No. 01
NiTi	Many	Ground, Nickel-Titanium alloy	−*	*	**	Different metal than previously listed files; used in most rotary files
Rotary Files						
Pro File.04 Tapers	Dentsply/Tulsa Dental	Ground, NiTi, safe tip, U-shape	0	***	*** (only to elbow)	Excellent use for over 10 years; non-ISO taper, mechanical low speed/high torque; series 29 sizing
Pro File .04 Tapers	Dentsply/Maillefer	Ground, NiTi, safe tip, U-shape	0	***	*** (only to elbow)	Same as above, only standardized sizing
Greater Tapers	Dentsply/Tulsa Dental	Ground, NiTi, safe tip, U-shape	0	** (see comments)	*** (well above elbow)	.06 relatively safe, .08-.12 must be used with care, especially on roots with proximal depressions
Quantec 2000, 2001	Originally NT Co., now SybronKerr	Ground, NiTi, some have H-shape	0	**	**	Gone through several design changes; H-shape improves flexibility
K-3	SybronKerr	Ground, NiTi, K-shape	0	***	*** (well above elbow)	K-shape decreases flexibility; good cutter

0, None; ½, poor; *, fair; **, good; ***, excellent.

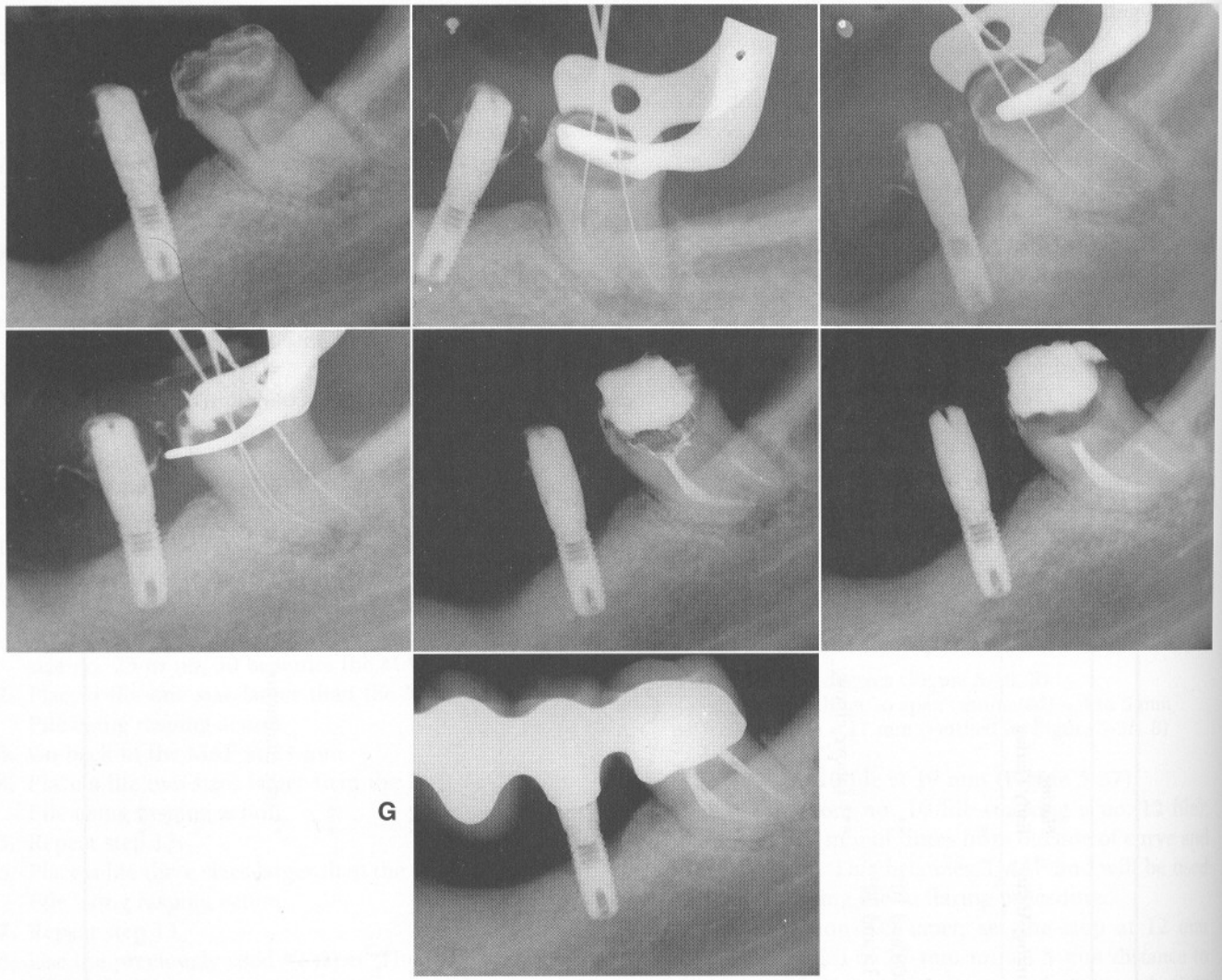


FIGURE 5-36 **A,** Preoperative radiograph of mandibular second molar. Occlusal caries under a poor crown had caused pulp exposure of long standing. The pulp is necrotic and periapical and distal lesions are present that seem to communicate. **B,** Files are in place in the distal and ML canals. Although I knew a MB canal was present, I had not located it as yet. The file in the ML indicates a curvature of approximately 60°. **C,** The files shown in Figure 5-37 were used in the ML canal, removing the triangle of dentin over the orifice, reducing the angle of curvature to approximately 30° with this no. 20 file. **D,** The non-ISO tapers were moved toward the MB, exposing that orifice and now all three canals have files to working length. **E,** At the next appointment, all canals were filled with laterally condensed gutta-percha and Wach's paste. Note the communicating distal and periapical lesions still present. **F,** A temporary bridge was constructed while other procedures were performed and to allow for evaluation of healing. This film was taken 6 months after canal filling, indicating perfect healing of the lesions. **G,** Radiograph taken 2 years after original treatment, indicating complete healing and normal appearance of periapical tissues, and treated tooth is functioning well as posterior bridge abutment. (Restorations by Dr. Kerry Voit, Chicago.)

11. Enlarge the apical portion to size no. 25 or no. 30. Don't hesitate to make any file an incremental size if the next fill does not go easily, but this probably will not be necessary. Continue to use rasping action. The size no. 25 or no. 30 becomes the MAF.
12. Use a file 1 size larger than the MAF and file to 16 mm. Use rasping action.
13. Go back to the MAF at 17 mm.
14. Use a file two sizes larger than the MAF and file to 15 mm. Use rasping action.
15. Repeat step 13.
16. Use a file three sizes larger than the MAF and file to 14 mm. Use rasping action.
17. Repeat step 13.
18. Use a file four sizes larger than the MAF and file to 13 mm. Use rasping action.
19. Repeat step 13.
20. Use the previously used #2 non-ISO taper. This time it should go easily to 12 mm.
21. Repeat step 13.

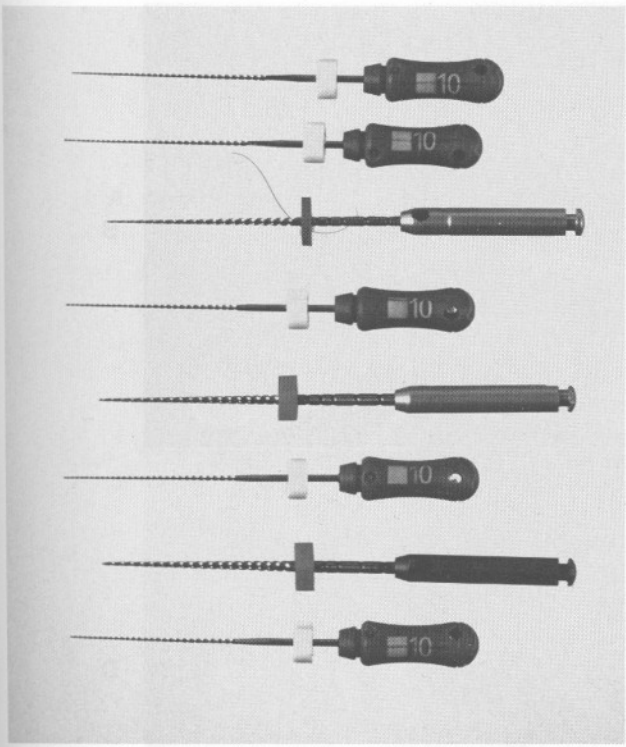


FIGURE 5-37 Files used sequentially in ML root of case shown in Figure 5-36. *From top,* no. 10 file (IAF), no. 12 file (TMAF), #2 .04 taper, TMAF, #3 .04 taper, TMAF, #4 .04 taper, TMAF. Preparation was completed to MAF of size 30.

22. (Optional) You may use the #3 and #4 non-ISO tapers or the finishing files (see Figure 5-35) to further widen the orifice, always using the MAF after any file short of the apex to maintain length.
23. Verify completeness of preparation by fitting finger plugger, and prepare for filling.

Curvatures of Greater Than 60 Degrees. The previous three sample preparation schedules can be modified for curvatures of 30 to 60 degrees. In canals with curvatures even greater, it is still possible to gain a desirable result (Figures 5-38 to 5-40) by clipping 0.5 mm increments and removing flutes to produce many incremental, customized sizes, if necessary. Cases of this type should not be attempted unless the operator has had considerable experience in curved canals and has mastered completely the techniques for lesser curvatures. Also, it is difficult to enlarge these canals safely apically beyond size 25. Therefore, in order to fill these canals, the dentist must be able to manipulate gutta-percha cones for that narrow diameter.

The critical portion of the preparation technique recommended for curvatures of 60 degrees and greater is the very small amount of increase in file tip width for successive files used to widen the apical portion. It has long been known that in these very difficult canals, everything may seem to be going smoothly, but suddenly, when a new file is introduced, a ledge, zip, or other undesired incident results.

Consequence of Position of the Elbow. The objective for using a customized file technique is to prepare an instrument for the individual variabilities of a canal. The position of the elbow can vary tremendously, from only 1 or 2 mm (see Figure 5-34) to 6 mm or more (see Figure 5-36). This calculation must be made in each case and retained throughout the preparation phase for optimal results.

Preparation of Bayonet-Curved Canals. The bayonet, or double-curved, canal often poses considerable problems during endodontic therapy, and not without cause (Figures 5-41 and 5-42). In actuality, it is not as complicated as it appears and can be safely enlarged and filled as long as several factors are kept in mind.

1. Protect against the zip in the area of the more apical curve, but the more coronal curve is straightened to gain better access to the apex. The distance to the elbow and the angle of curvature are calculated as before. Flutes will be removed from the outer side of the curve accordingly.
2. Once the working length is established with a small file, that file must not be totally removed from the canal until it is very loose. In many instances, the initial small flexible file will reach to the apical portion of the canal. However, if the file is removed prematurely, it becomes extremely difficult to gain the correct length with another file, even one of the same size. Therefore, once the correct working length is established by radiograph, the file is not removed but is worked up and down only several millimeters per movement until minimal resistance is felt. Only then may the instrument be removed.
3. Clip minimal increments from each file, working up at not more than 0.5 mm removals and then only when that file is very loose within the canal. The danger of enlarging the bayonet curve is that the file becomes stuck at the first curve and ledges or starts to perforate at that site. If the operator panics and attempts to force the instrument, the condition will quickly worsen. Working up too rapidly through the sizes only increases the chances for this undesired ledging.
4. Flare very carefully, but widen the orifice portions liberally and early in a buccolingual direction. It is more critical to flare extensively in bayonet cases than single curvatures. Because the more coronal curve will be greatly straightened, that portion of the canal is not enlarged evenly, and it does not retain its original shape.
5. The reader should realize that the cases presented in Figures 5-41 and 5-42 came out extremely well.