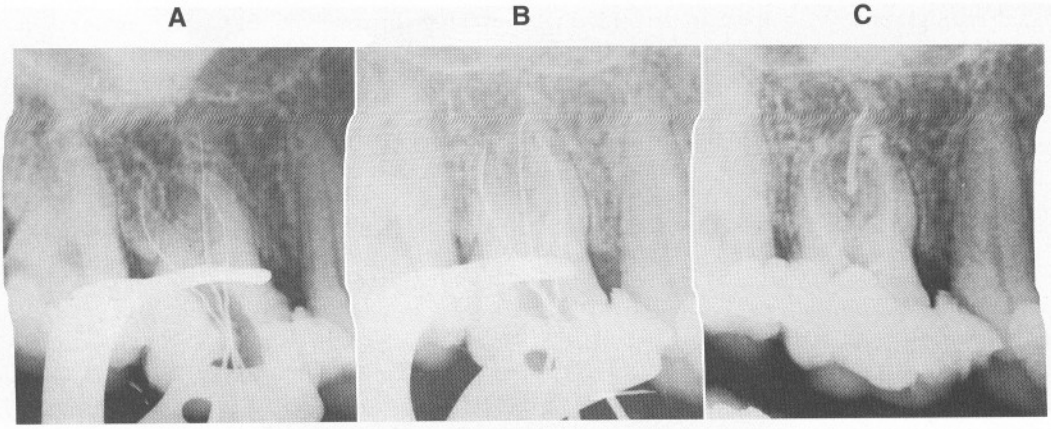


FIGURE 4-34 **A,** Initial determination of working length in maxillary first molar in which both buccal canals were measured at 19.5 mm and the palatal canal at 20 mm. In this first molar, from a buccal view, the mesiobuccal canal curves first to the mesial and then to the distal. The distobuccal canal curves first to the distal and then to the mesial, giving the two buccal canal a horseshoe appearance. **B,** As canals were enlarged to size 30, the buccal canals were measured at 18 mm and the palatal canal at 19.5 mm. **C,** Postfilling radiograph indicates that even these shortened measurements were too long; a considerable amount of excess sealer has been expressed through apices of buccal roots.

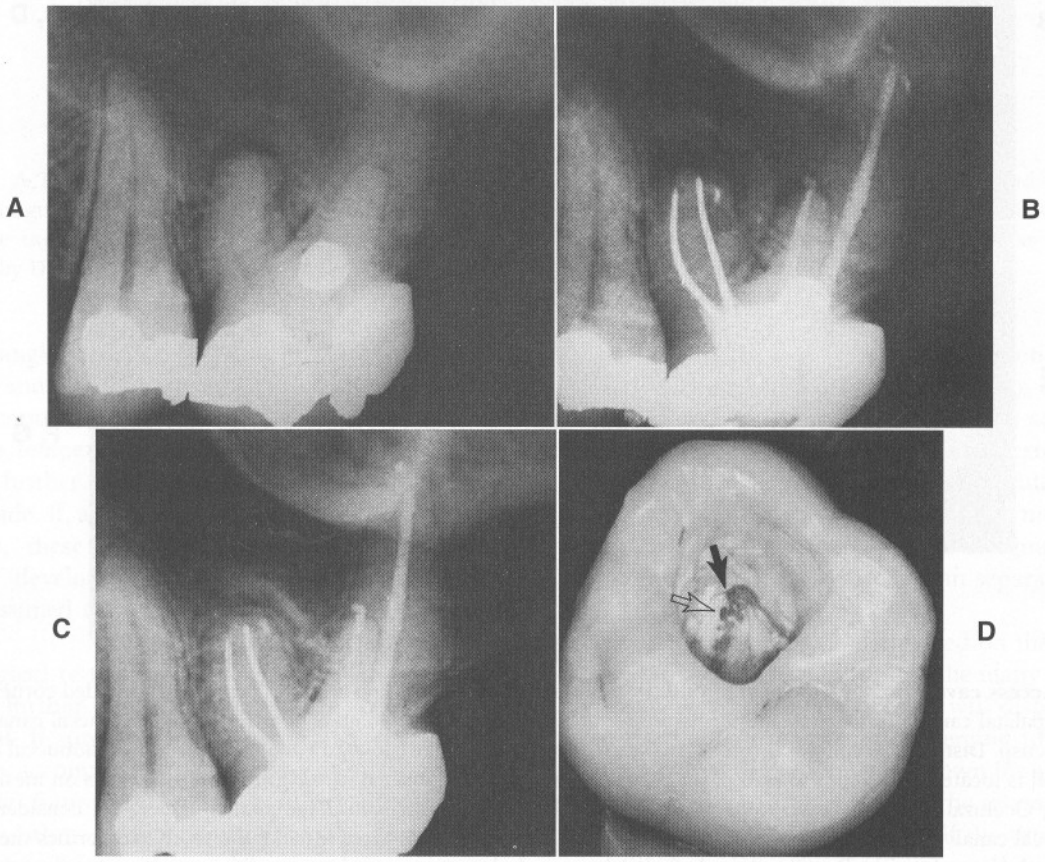


FIGURE 4-35 **Treatment of four separate and distinct canals in a maxillary first molar. A,** One canal was located and prepared in each of three roots, but a chronic draining sinus tract present before treatment failed to close. This view, angled from the distal, projected mesiobuccal root away from any structures that might mask its appearance. Note double image of the root, suggesting a second root or canal. **B,** By next appointment, after second mesiobuccal canal had been located and enlarged, the draining sinus had closed. Immediate postfilling film shows two separate canals in mesiobuccal root filled with silver points, palatal and distobuccal canals with laterally condensed gutta-percha. **C,** Excellent healing 1 year later. **D,** View into the mesiobuccal portion of the access preparation in a maxillary first molar. The larger canal *(solid arrow)* is located 2 to 5 mm buccally from the smaller canal *(open arrow)*. (Restorations by Dr. Neal Baigh, LaGrange, Ill.)

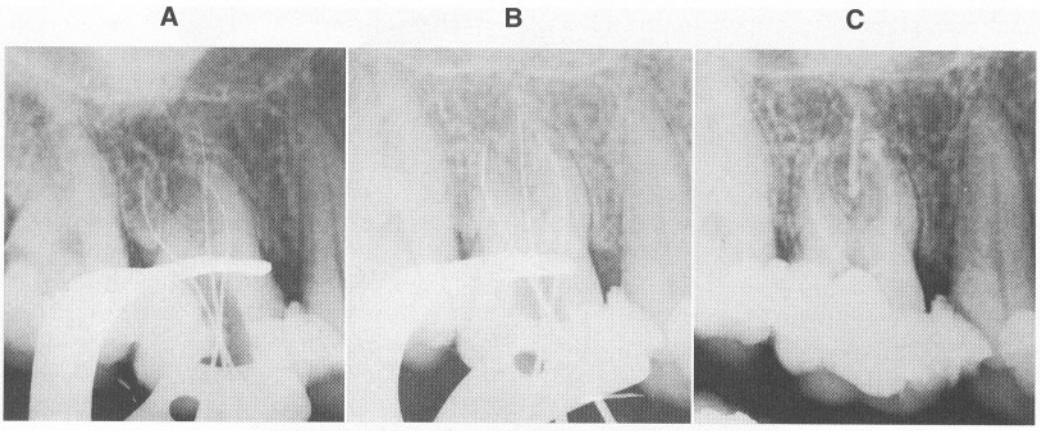


FIGURE 4-34 **A,** Initial determination of working length in maxillary first molar in which both buccal canals were measured at 19.5 mm and the palatal canal at 20 mm. In this first molar, from a buccal view, the mesiobuccal canal curves first to the mesial and then to the distal. The distobuccal canal curves first to the distal and then to the mesial, giving the two buccal canal a horseshoe appearance. **B,** As canals were enlarged to size 30, the buccal canals were measured at 18 mm and the palatal canal at 19.5 mm. **C,** Postfilling radiograph indicates that even these shortened measurements were too long; a considerable amount of excess sealer has been expressed through apices of buccal roots.

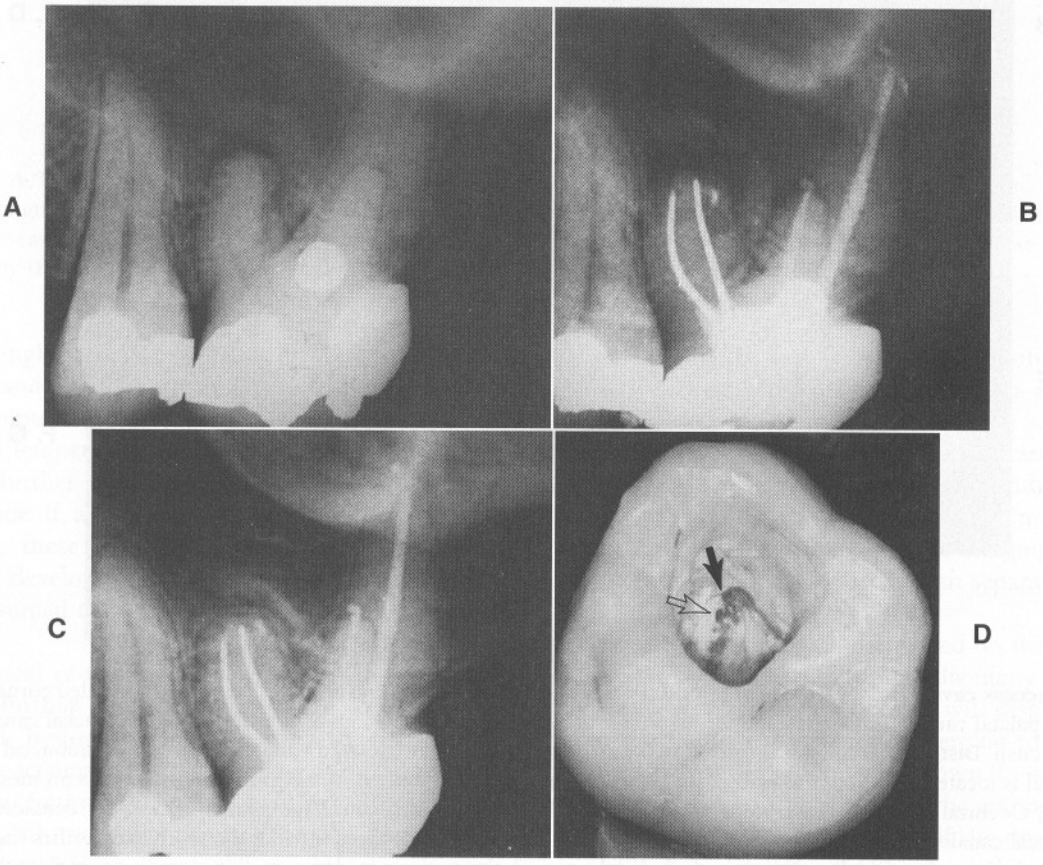


FIGURE 4-35 **Treatment of four separate and distinct canals in a maxillary first molar. A,** One canal was located and prepared in each of three roots, but a chronic draining sinus tract present before treatment failed to close. This view, angled from the distal, projected mesiobuccal root away from any structures that might mask its appearance. Note double image of the root, suggesting a second root or canal. **B,** By next appointment, after second mesiobuccal canal had been located and enlarged, the draining sinus had closed. Immediate postfilling film shows two separate canals in mesiobuccal root filled with silver points, palatal and distobuccal canals with laterally condensed gutta-percha. **C,** Excellent healing 1 year later. **D,** View into the mesiobuccal portion of the access preparation in a maxillary first molar. The larger canal *(solid arrow)* is located 2 to 5 mm buccally from the smaller canal *(open arrow)*. (Restorations by Dr. Neal Baigh, LaGrange, Ill.)

However, angled radiographs are helpful in anticipating the fourth canal before starting treatment. In most posterior teeth, angled views taken from the mesial toward the distal are the most helpful. On the contrary, for the maxillary first molar, greater information is gained by taking the film with the cone pointed from the distal to the mesial direction (Figure 4-36, *C*). This projection gives a profile type of view of the mesiobuccal root and allows for visualization of the presence of the extra canal (Figure 4-36, *D*). The same projection from the distal to the mesial direction is used when taking radiographs for the determination of working length. The view is correct when the files in the distobuccal and palatal canals are approximately superimposed, or when the file in the distobuccal canal is slightly mesial to that in the palatal canal (Figure 4-36, *E*). If the view is taken too far from the distal direction, the mesiobuccal root is projected over the second bicuspid, and visualization of the additional canal is difficult.

Because of the proximity of the two mesiobuccal canals, even this projection may not allow for complete visualization of two separate canals, even when there is strong indication that two are present (Figure 4-37, *A*). The best method for verifying that two canals are present is to place files in both canals. If the canals do in fact merge to form a Type II configuration, when a file is inserted to the full working length in one canal, the file in the other canal will be stopped short (see Figure 4-36, *E*). However, if both files go the full working length, a Type III configuration is verified, even if the film seems to indicate

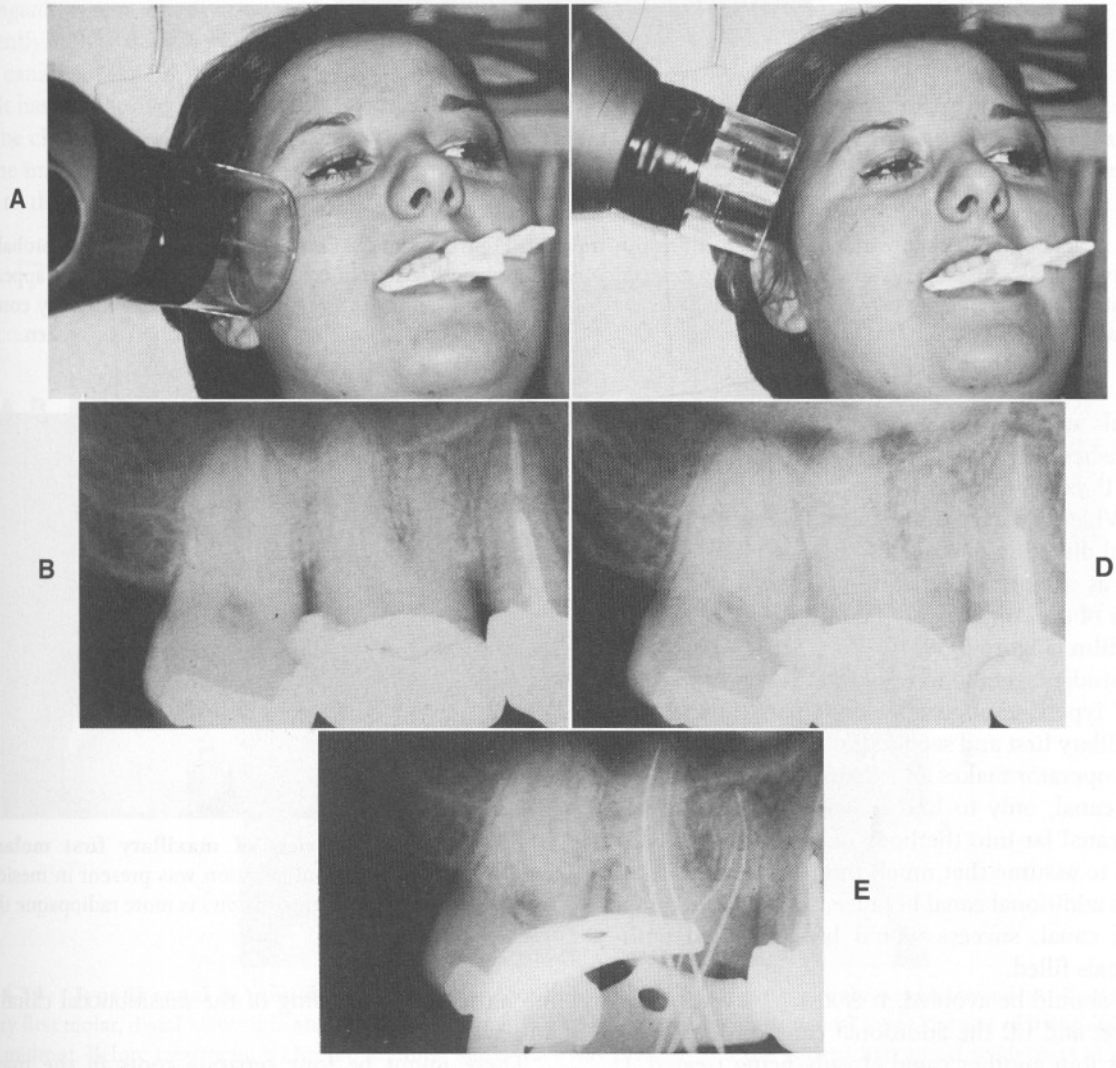


FIGURE 4-36 **Taking radiographs when treating maxillary first molars. A,** Routine cone and film placement. **B,** Typical radiograph from this arrangement. Mesiobuccal root may seem to be in profile, but contrast this with *D*. **C,** Angled view is taken with film placed in routine position, but cone is placed distal to maxillary second molar and pointed to mesial. **D,** Typical radiograph as a result of such cone placement. Now mesiobuccal root is in profile, and the considerable width, capable of accommodating an additional canal, is more clearly seen. **E,** Radiograph for determining working length. Cone placement is the same as in *C*. File in distobuccal canal is slightly mesial to file in palatal canal. Second canal is present in mesiobuccal root and appears to merge with larger canal short of apex.

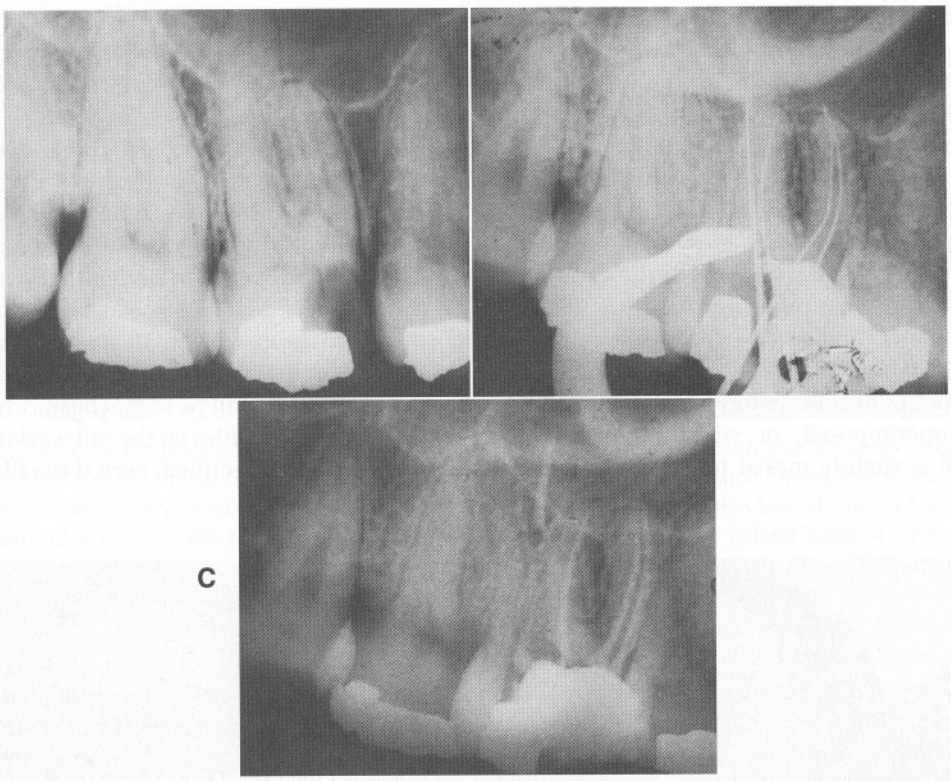


FIGURE 4-37 **A,** Radiograph taken with cone placement as illustrated in Figure 4-36, *C*. Mesiobuccal root is wide and probably will accommodate two canals. **B,** Angled view from distal to determine working length. Mesiobuccal root is in profile, and it appears that files in mesiobuccal root do merge. However, both files independently went to 20 mm. **C,** After canal filling with laterally condensed gutta-percha, radiograph was taken from slightly more distal direction. The two separate mesiobuccal canals are clearly seen.

that the canals merge (Figure 4-37, *B*). This might be further established by the final film (Figure 4-37, *C*).

The Type II configuration is common in the mesiobuccal root. When this occurs, the final radiograph angled from the distal direction demonstrates the site of merging of the canals as a more radiopaque portion of the canal filling because of the superimposed effect of the sealer and cones on the film (Figure 4-38).

The older studies seem to indicate that there is a higher percentage of Type II configurations compared with Type III in the maxillary first and second molars. In some cases, therefore, the operator makes an exhaustive search for the mesiolingual canal, only to find that it merges with the mesiobuccal canal far into the body of the root. The tendency then is to assume that much time has been wasted in finding this additional canal because, since it joined the already-found canal, success would have resulted with only three canals filled.

This belief should be avoided. It is always favorable to locate, prepare, and fill the additional canal in any root, even if it does join another canal already being treated. I have had several cases where a chronic sinus tract did not heal in association with a mesiobuccal root until the mesiolingual canal was located and prepared, even when a Type II condition was present (Figure 4-39). The undiscovered canal contained sufficient irritants to perpetuate the lesion. Conceivably, it could hinder obtaining the most desirable filling of the mesiobuccal canal if left untreated.

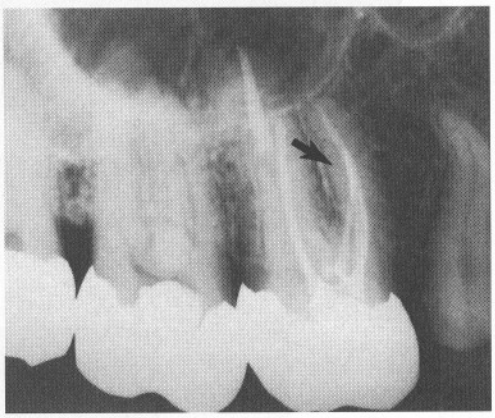


FIGURE 4-38 **Angled view of maxillary first molar after canal filling.** Type II configuration was present in mesiobuccal root, and the site of merging *(arrow)* is more radiopaque than the rest of the fill.

There might be four separate roots in the maxillary first molar, with two roots at the mesiobuccal, each with a single canal. The radiograph angled from the distal direction will give a hint of this type of configuration (Figure 4-40, *A*), which subsequently will be determined and confirmed during the course of treatment (Figure 4-40, *B* to *D*).

Two palatal canals, in some cases with two separate roots present, have been reported in some maxillary first and second molars. Though this does occur, I, personally, have only found this condition very rarely (Figure 4-41). I have not treated any first or second molar with two separate and distinct distal canals (Type III); all have had Type II. I am not certain that in these cases that root originally ever had two canals, but that the canals were more oval than round and the two poles of the oval were each prepared and filled.

Names of Canals in Mesiobuccal Root

When the early studies on the configuration of the mesiobuccal canal were first reported, the newly discovered canal was often referred to as "the second mesiobuccal" because no one expected more than one canal in this root. However, soon it was called, and properly so, the *mesiolingual* or occasionally the *mesiopalatal* canal.

Recently it has become fashionable for some to refer to this canal as *MB-2*. MB-2 is a poor and inappropriate name. It has no parallel in endodontic terminology and is, as will be clearly described soon, patently incorrect.

In the mandibular first or second molars (the situation closest to the maxillary molars), the canals are referred to as the *mesiobuccal* and the *mesiolingual*, not *MB-1* and *MB-2* or even *M-1* and *M-2*. This canal is not an upstart that must be described in terms of the well-known father or older brother.

Anatomically the names of the canals typically describe the path of entrance to be opposite. Therefore, in the bicanaled mandibular first bicuspid, the buccal canal is reached from the lingual and the lingual canal from the buccal. In the maxillary molar, the palatal canal is entered from the buccal, the distobuccal from the mesiolingual, and the mesiobuccal from the distolingual. Because the mesiolingual canal should be approached from the distobuccal, this verifies its proper name.

Mistakes are made in entering this canal by those who approach it from the distolingual, as one would to enter the mesiobuccal canal. The correct path of entry is from the distobuccal, and the name of the canal is the mesiolingual.

Maxillary Second Molar

The maxillary second molar usually has similar canal configuration combinations to the first molar: two buccal roots and one palatal root. The distobuccal and palatal roots each have one canal, but the mesiobuccal may have



FIGURE 4-39 **Type II canal in mesiobuccal root, but area did not heal until both canals were cleaned. A,** Preoperative film of maxillary first molar, distal view, indicating a probable Type II canal system in the mesiobuccal root. The site of merging *(arrow)* can be seen in midroot. Before treatment, a chronic draining sinus tract was present, and the patient had apical tenderness at the apex of the mesiobuccal root. At the first appointment I was able to locate and enlarge the three major canals only and did not enter the mesiolingual canal. At the second appointment the tract was still draining, and apical tenderness was still present. I located the mesiolingual canal, enlarged it to size 25 apically, flared to size 35, and did moderate enlargement of the previously located canals. At the next appointment the tract had closed, and no tenderness was present, so I was able to fill the tooth. **B** and **C,** Straight view and angled view from the distal after filling tooth with laterally condensed gutta-percha and Wach's paste. Site of merging actually was much more toward the apex than it appeared in *A*. **D,** Two years after treatment. **E,** Five years after treatment, indicating perfect healing. (Restorations by Dr. Kerry Voit, Chicago.)

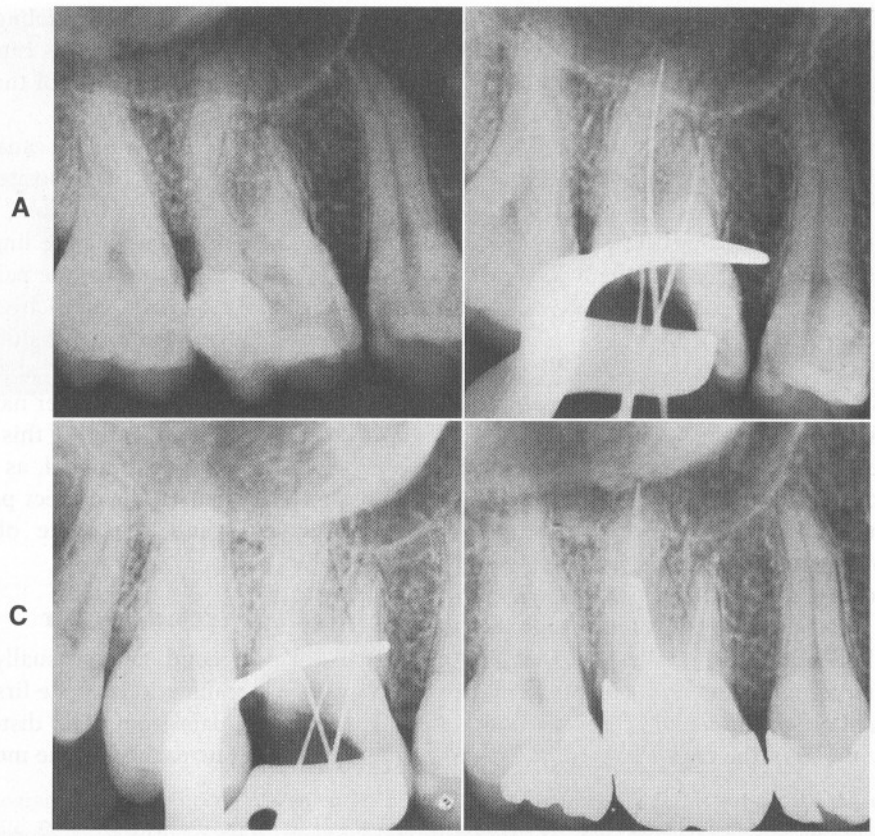


FIGURE 4-40 Treatment of four-rooted maxillary first molar (a four-bagger). A, Preoperative angled film from distal aspect, giving hint of two separate mesiobuccal roots. **B,** Initial film for determination of working length shows that file in mesiobuccal root is not well centered. **C,** Further exploration yielded orifice to fourth root. **D,** Six months after treatment, film shows separate mesiobuccal roots. (Restorations by Dr. Edward LeMire, Chicago.)

two canals (Figure 4-42), with either canals merging short of the apex (Type II) or remaining separate and distinct (Type III). Until recently the exact percentages for the configurations present in the mesiobuccal root of the maxillary second molar were only the object of speculation. However, recent studies have published some interesting percentages, listed in Table 4-7. Even though the second canal is known to be present in many instances, it may be very difficult to locate and prepare it because the tooth is so far posterior in the mouth. Therefore the total number of maxillary second molars with four canals filled is certainly far below the total number with four canals present, even in the most conservative estimate.

In their in vitro study, Kulild and Peters found that in this tooth, 78.2% of the mesiobuccal roots had two canals (Type II plus Type III), as uncovered by access and bur penetration, rising to 93.7% when uncovered using a microscope and sectioning. These numbers can never be reached clinically with the presently available equipment.

The access cavity is prepared in the same manner and shape as for the first molar, except that the buccal side of the quadrilateral is not as long because the buccal canals are usually found closer together (see Figure 4-33, *E* to *G*). In second molars with sclerotic canals or those that have crowns compressed mesiodistally, the distobuccal orifice may be located toward the center of the access, rather than near the mesiobuccal orifice. If the distobuccal canal is not found near the mesiobuccal canal in teeth with these conditions, exploration in the center will usually yield the missing canal.

A differing type of root configuration may also be present in the maxillary second molar that contains only two roots, one buccal and the other palatal (Figure 4-43). In still another modification, these two roots merge near the apex (Figure 4-44). The total frequency of the two-rooted maxillary second molar among all such teeth is approximately 10%, with the separate root condition much more common.

The access cavity for the two-canaled second molar differs from those with three or four canals (see Figure 4-43, *F*). The access shape is more rectangular, with the longest walls being the mesial and distal, fairly parallel to each other. The single buccal and palatal canals are beneath the shorter sided buccal and palatal segments of the access. The access should not be too constricted mesiodistally because, on occasion, there still may be three canals (two buccal canals) in the two-rooted second molar, and there must be room to the buccal to locate the third orifice.

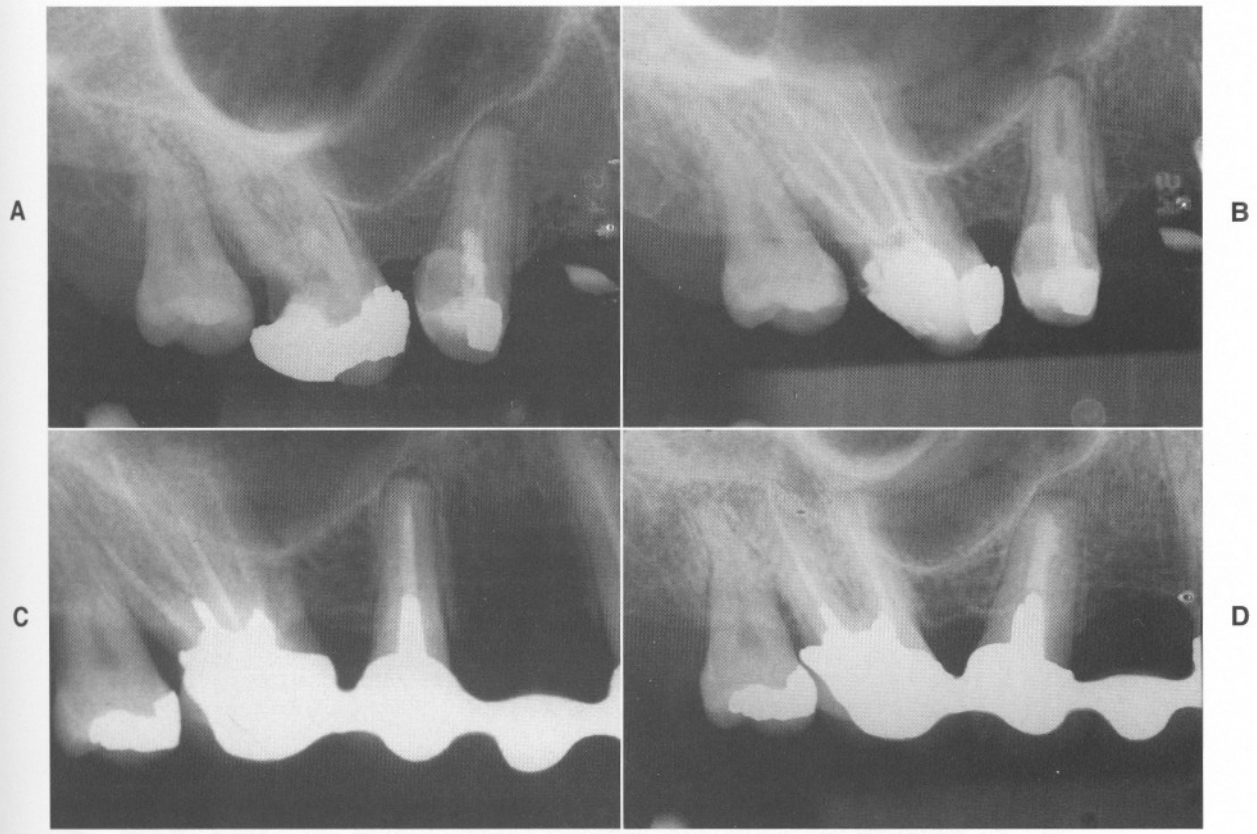


FIGURE 4-41 **Treatment of maxillary molar with two palatal roots. A,** Preoperative radiograph of maxillary molar, bicuspid area, indicating poor canal filling and apical radiolucency on the bicuspid and considerable decay into the distal portion of the pulp distal of the molar. **B,** Two separate and distinct palatal canals were located and prepared as well as single canals in both buccal roots. Canals were filled with lateral condensation of gutta-percha and Wach's paste. **C,** The bicuspid, too, was treated and a new bridge constructed. **D,** Sixteen years later, both teeth now display normal periapical areas, and four separate canals are distinctly filled in molar.

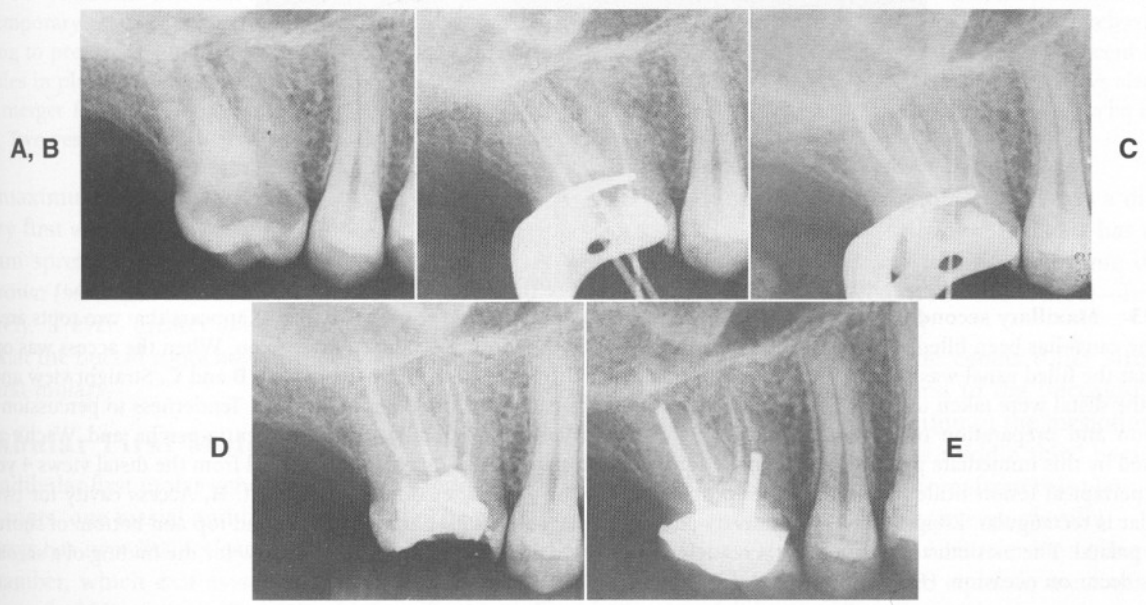


FIGURE 4-42 **Maxillary second molar with two mesiobuccal canals. A,** Preoperative radiograph of maxillary second molar requiring endodontic therapy. The first molar had been extracted several years earlier, and the second molar had rotated somewhat to the mesial to close the space. **B,** Radiograph of three master cones in place before filling the canals. It appears that the master cone in the mesiobuccal root is well centered, indicating only a single canal in that root. **C,** After canal filling with laterally condensed gutta-percha and Wach's paste, I noticed an additional orifice palatal to the mesiobuccal canal and placed a file easily to this length. **D,** That canal was enlarged and filled similarly. **E,** Two years later, everything appears normal.

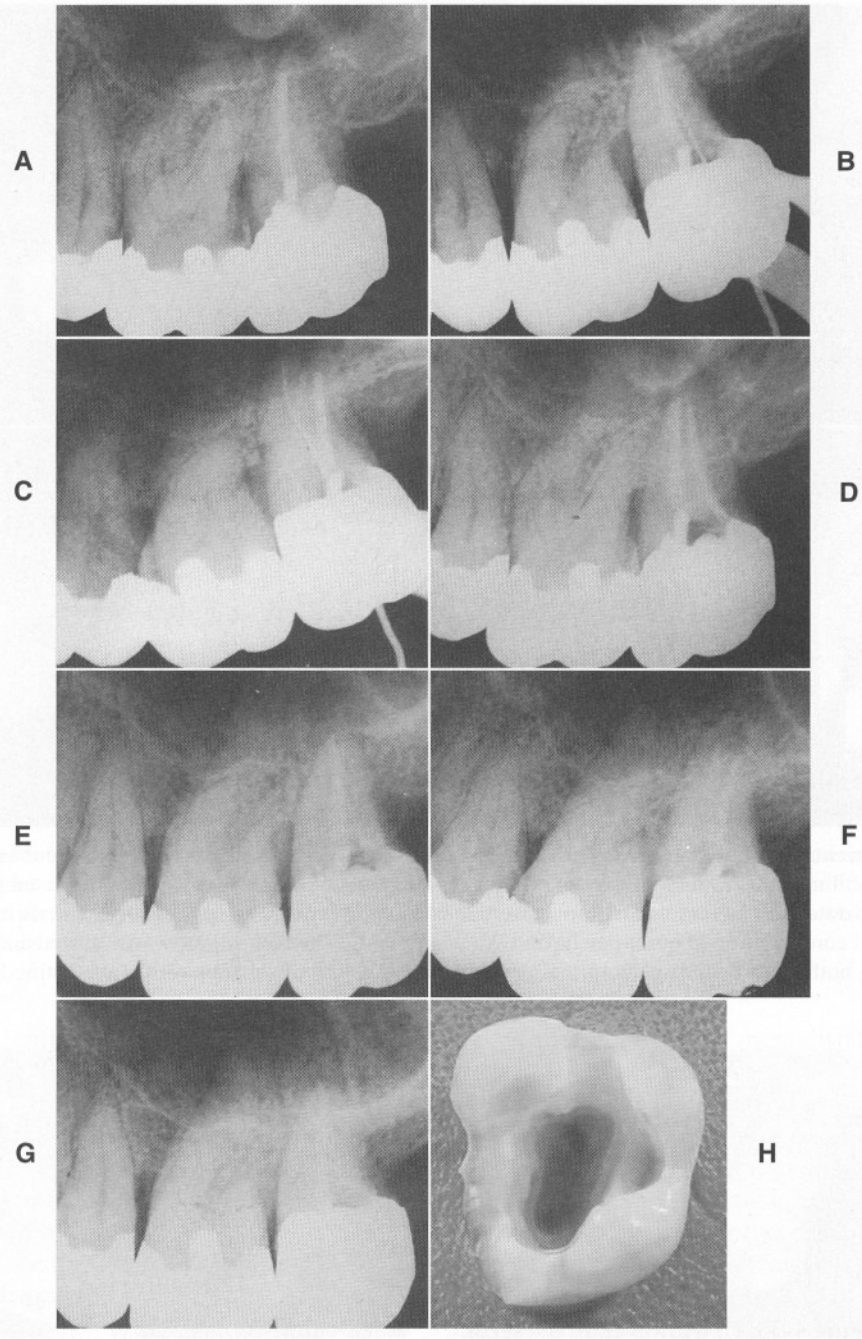


FIGURE 4-43 Maxillary second molar with two roots and two canals. A, In preoperative film, it appears that two roots are present, but only one canal has been filled. A periapical lesion is present, and the tooth is tender to percussion. When the access was opened, it was seen that the filled canal was to the palatal. A canal was located to the buccal, and a file placed. **B** and **C,** Straight view and angled view from the distal were taken to verify that the file was within the canal and not a perforation. **D,** Tenderness to percussion stopped after location and preparation of the buccal canal, which was filled with laterally condensed gutta-percha and Wach's paste, as demonstrated by this immediate postfilling film, angled from the mesial. **E** and **F,** Straight and angled from the distal views 4 years after treatment, periapical lesion healed and no further problems. **G,** Nine years after original treatment. **H,** Access cavity for two-rooted second molar is rectangular. Longer sides are relatively parallel mesial and distal. Canals can be found top and bottom of shorter sides, buccal and palatal. The mesiodistal width of the rectangle must be wide enough at the buccal to allow for the finding of a second canal, which does occur on occasion. (Restoration by Dr. Kerry Voit, Chicago.)

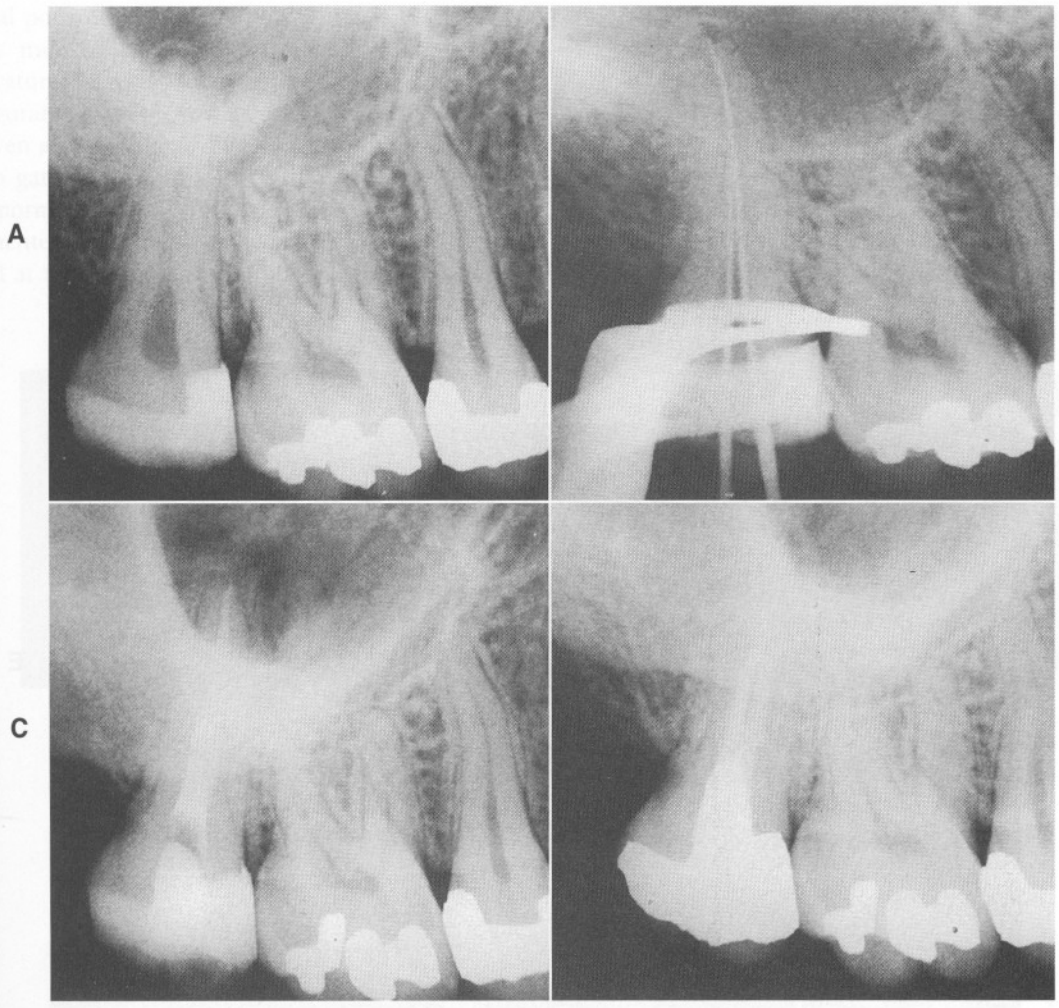


FIGURE 4-44 **Maxillary second molar with two roots merging near the apex. A,** Preoperative radiograph of maxillary molar area shows temporary restoration in the second molar in proximity to the pulp. The tooth had been exposed by the referring dentist attempting to prepare the tooth for an onlay. Note the difference in the exterior shape of the second molar to the adjacent first molar. **B,** Two files in place, one in each canal, indicating site of merging several millimeters from the apex. Other angled views also indicated a site of merger for the two canals. **C,** Immediate postfilling film, two canals filled with laterally condensed gutta-percha and Wach's paste. **D,** Two years later, normal appearance.

The maximum spread of roots also differs between the maxillary first and second molars. In the first, usually the maximum spread is greater than the maximum diameter of the crown (see Figure 4-33, *C*). However, in the second, it is rarely, if ever, greater (see Figure 4-33, *F*), which means that the buccal roots have less curvature than those in the first molar.

Mandibular First Molar

The mandibular first molar generally has two separate and distinct roots, one mesial and the other distal. The mesial root always has two distinct canals leaving the floor of the pulp chamber, which exit as separate apical foramina in approximately 85% of cases (Type III canal configuration) but merge to form one apical foramen (Type II) in the remainder.

From the buccal view, as the mesial root leaves the crown it curves to the mesial initially, but then it makes a gradual turn to the distal and generally has a distal curve in its apical third. From this view, the root has a crescent shape. The two mesial canals have the same directional curvatures when viewed from the buccal—first to the mesial and then to the distal.

From the mesial view the canals differ strongly. The mesiobuccal canal curves first to the buccal and then to the lingual. The coronal portion of the mesiolingual canal is straighter and then in the middle third begins a more gradual buccal curve. Therefore, from this view, the canals diverge coronally but then converge apically.

The distal root is slightly narrower buccolingually than the mesial root, but they are equal in mesiodistal width. The distal root often has a mesial curvature. Usually only one distal canal is present, with a large, kidney-shaped orifice (Figure 4-45, *A*), in approximately 70% of first molars, but Type II or III configurations are present occasionally.

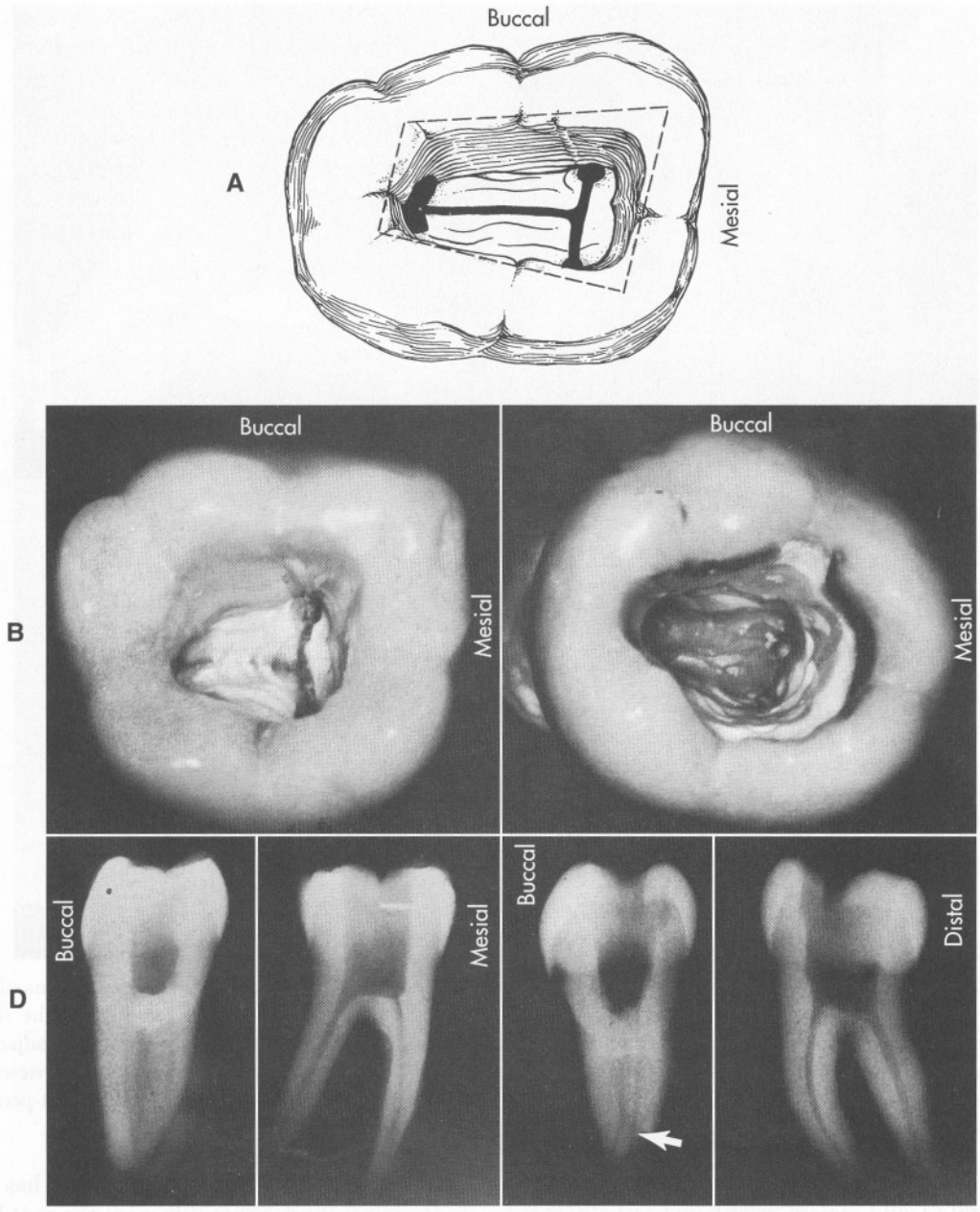


FIGURE 4-45 Access canal preparations and canal configurations in mandibular molars. A, General outline advised for mandibular molars is a trapezoid with rounded corners rather than a triangle. Distal canal is usually kidney shaped, or two separate canals may be present. Working through apex of a triangular section does not give sufficient access for proper canal location and preparation. **B,** Occlusal view of access preparation for three-canaled mandibular first and second molars. Distal canal has a kidney-shaped orifice, widest buccolingually, whereas mesial canals are located beneath their cusps and are quite far apart with a line on the floor of the chamber connecting them. **C,** Proximal view shows entry funneled to afford access to apices, well centered in buccolingual dimension of the tooth. Note mesial canals far apart at their orifices but curving toward each other as they approach their apices. **D,** Buccal view shows distal canal to be straight, whereas mesial canals have a gradual curve toward distal aspect. Entire access is within mesial two thirds of crown. **E,** Occlusal view of access preparation for mandibular first and second molars in which two mesial canals merge short of apex (Type II configuration). Mesial orifices are much closer together than in *B,* but the trapezoidal configuration is still required for large distal canal. **F,** Proximal view shows point of merging of two mesial canals short of root tip *(arrow).* Canal appearing to buccal side of merged canal is the distal one because rays traveled through the tooth from the mesial aspect to the distal to give this film. **G,** Buccal view showing straight distal canal and curved mesial canals.

The distal portion of the mandibular first molar has a tremendous number of variations, including types of canals, curvatures, shapes, and inclinations. Type II or III canal configurations are present approximately 30% of the time and even a separate and distinct distolingual root is possible. To gain additional information, the straight-on projection normally taken (Figure 4-46, *A* and *B*) must be supplemented by at least one angled view, with the cone placed at the mesial and pointing toward the distal direction giving the most information (Figure 4-47, *C* to *O*). During the course of treatment, these angled views taken from the mesial direction will aid greatly in correctly categorizing the configuration present (Figure 4-48).

When two separate canals are present in the distal root, they are much thinner than single distal canals. Therefore, when a distal canal will not accommodate a size 25 file at initial entrance, it is a good indication that the root has a Type II or III configuration. The presence of two separate

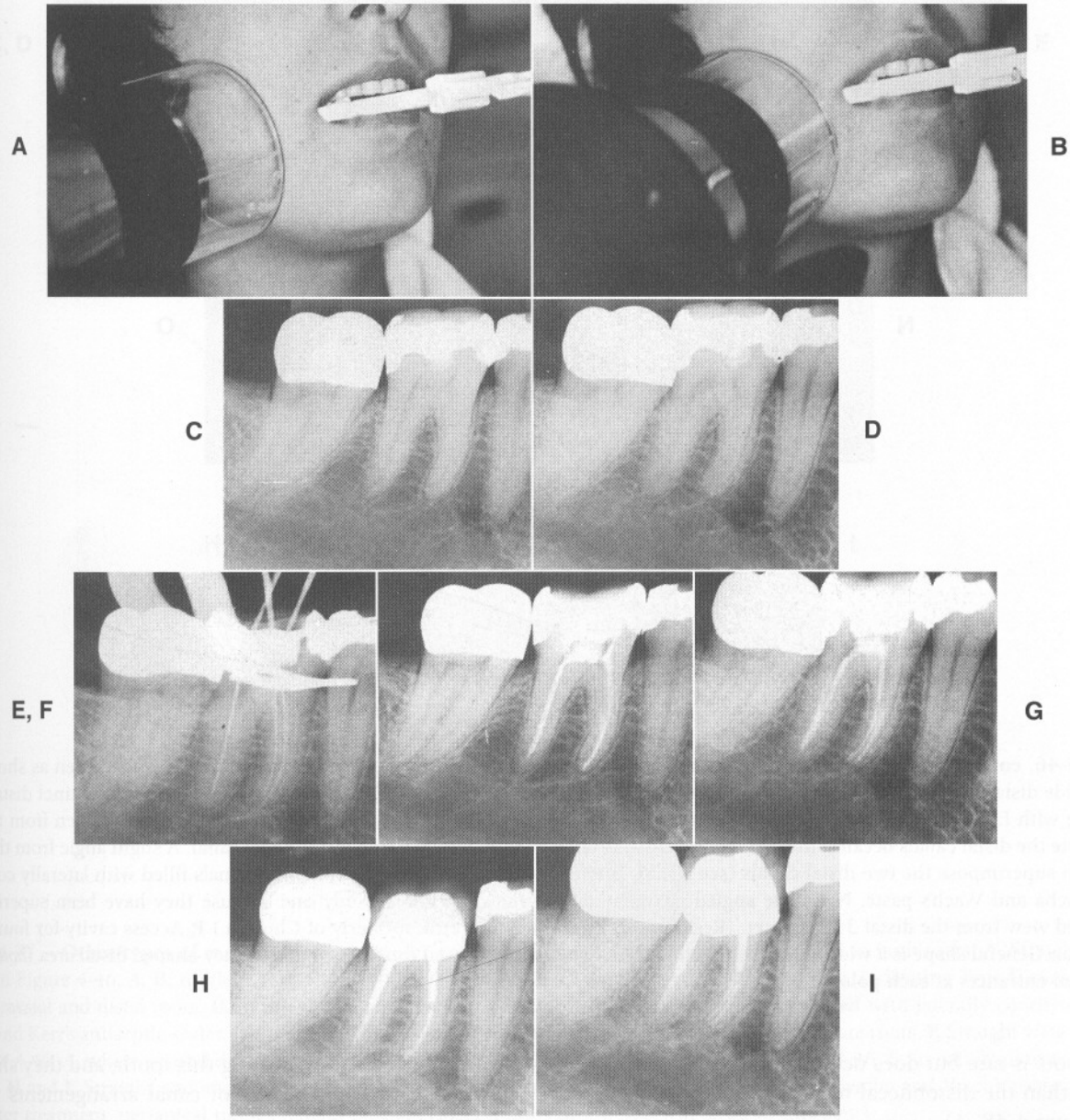


FIGURE 4-46 **Two most common configurations for the mandibular first molar and the radiographs needed for their evaluation. A,** Routine cone and film placement, three canals present. **B,** Angled view is obtained with film holder in the same position, cone tip in the same position, but cone head pointed to the distal at an angle of 20 to 30 degrees. **C** to **I,** Three canals present. **C,** Film taken as shown in *A*. **D,** Film taken as shown in *B*. **E,** Angled view of files in place. **F,** Immediate postfilling straight view, canals filled with laterally condensed gutta-percha and Wach's paste. Canals are superimposed and cannot be differentiated from this view. **G,** Postfilling angled view, demonstrates two mesial canals, separate and distinct. **H** and **I,** Three years after treatment, straight and angled views. (Restorations by Dr. Carle Kibbitt, Chicago.)

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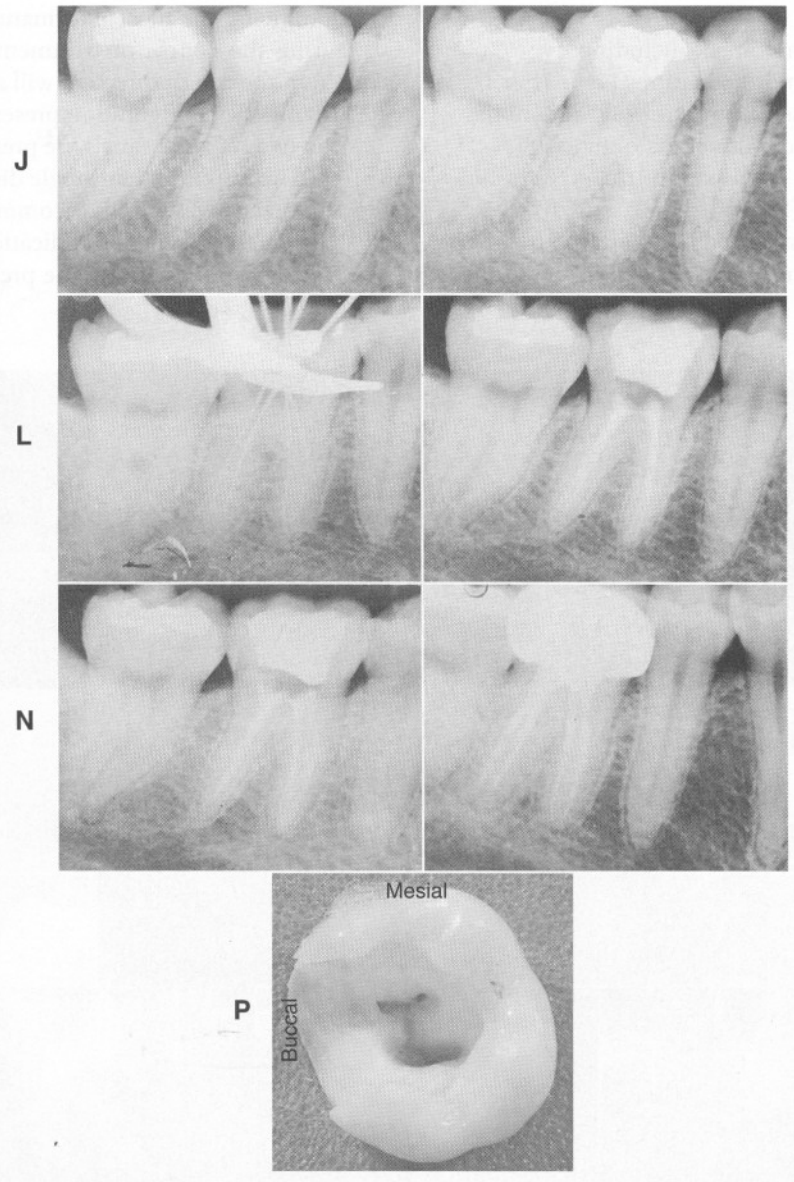


FIGURE 4-46, cont'd **J** to **O,** Mandibular first molar, four canals present. **J,** Film taken as shown in *A*. **K,** Film taken as shown in *B*. Large, wide distal root, suspicious of having 2 canals. **L,** Angled view of files in place, indicating two separate and distinct distal canals. Compare with *E* and note that when only one distal canal is present, it is well centered in that root. This view is taken from the distal to separate the distal canals because the distobuccal canal is often slightly mesial to the distolingual canal. A slight angle from the mesial will often superimpose the two distal canals (see *N*). **M,** Immediate postfilling straight view, four canals filled with laterally condensed gutta-percha and Wach's paste. **N,** In the angled view, the distal canals seem to be only one because they have been superimposed. **O,** Angled view from the distal 3 years later. (Restorations by Dr. Wilbur Pettit, formerly of Chicago.) **P,** Access cavity for four-canaled first molar. General shape is a wide rectangle that uncovers two separate mesial canals *(top)* and kidney-shaped distal area *(bottom)* that have canal entrances at each pole.

distal roots is rare but does occur. The distolingual root is smaller than the distobuccal root and usually very curved (see Figure 4-48, *A*).

The mandibular first molar is the most frequently exposed tooth and as such requires endodontic treatment frequently. However, many dentists are reluctant to perform the needed therapy because they believe such treatment is complex. It would be well for general dentists to practice on extracted teeth and plastic blocks (see Chapter 5) prior to treating this tooth, and they should be aware of the multiplicity of canal arrangements that are possible.

A mesiodistal section through the tooth reveals that the orifices of both the mesial and the distal canals lie in the mesial two thirds of the crown and that the canals are well centered in their roots (see Figure 4-45, *D*). A buccolingual section shows that the pulp chamber is in the center of the crown and that the distal canal is wide

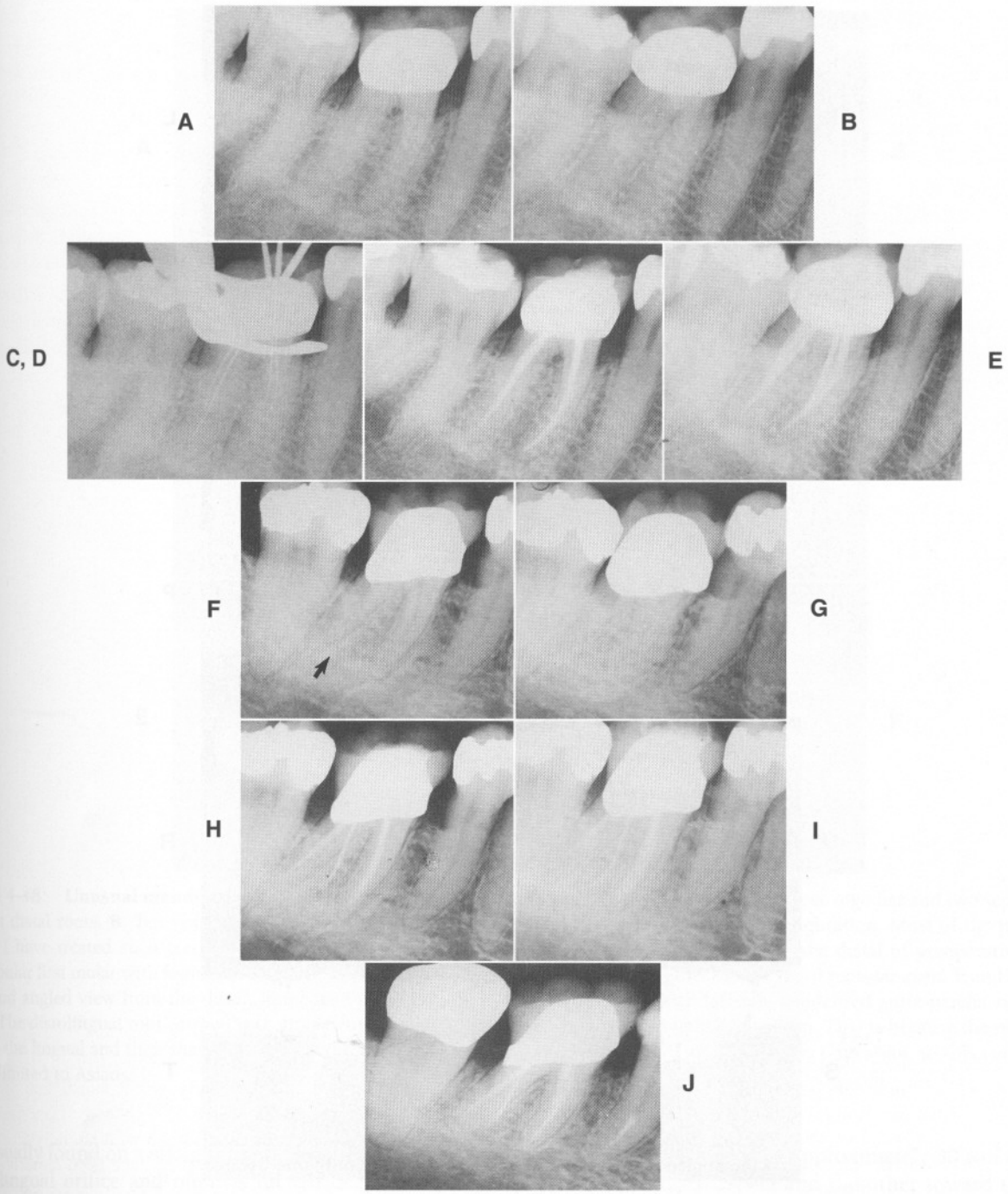


FIGURE 4-47 **Other types of mandibular first molar configurations. A** to **E,** Four canals, Type II in both roots. **A,** Straight view as shown in Figure 4-46, *A*. **B,** Angled view as shown in Figure 4-46, *B*. **C,** Angled view of files in place, indicating Type II canal systems in both mesial and distal roots. **D** and **E,** Immediate postfilling straight and angled views, canals filled with laterally condensed gutta-percha and Kerr's antiseptic sealer. (Restorations by Dr. Steve Potashnick, Chicago.) **F** to **I,** Four separate roots. **F,** Straight view as shown in Figure 4-46, *A*, where second distal root can be seen *(arrow)*. **G,** Angled view as shown in Figure 4-46, *B*, in which all four roots can be seen. **H** and **I,** Straight and angled views taken after canal filling with laterally condensed gutta-percha and Wach's paste. **J,** Twelve years after treatment, periapical tissues remain normal. (Restorations by Dr. Sherwin Strauss, Chicago.)

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