牙體形態學Dental morphology

Application of Root and Pulp Morphology Related to Endodontic Therapy

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學習目標

能辨識及敘述牙齒之形態、特徵與功能意義，並能應用於臨床診斷與治療

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參考資料

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Summary

The course of Dental Morphology provides the student with knowledge in the morphological characteristics of the teeth and related oral structures upon which a functional concept of intra-arch relationships may be based for the clinical application to patient assessment, diagnosis, treatment planning, and oral rehabilitation.

I. Internal pulp cavity morphology related to endodontic and restorative therapy

A. The shape of pulp cavities and configuration of, pulp canals
B. Shape of pulp cavities in sound young teeth
C Why pulp cavities get smaller in older teeth
D. Clinical application of pulp morphology related to restorative dentistry
E. Clinical application of pulp morphology related to endodontics

II. Location of root and cervical crown concavities, furcations, depressions, and canals

A. Maxillary central incisors
B. Maxillary lateral incisors
C. Mandibular central and lateral incisors
D. Maxillary canines
E. Mandibular canines
F. Maxillary first premolars
G. Maxillary second premolars
H. Mandibular first premolars
I. Mandibular second premolars
J. Mandibular first and second molars
K. Maxillary first and second molars

OBJECTIVES

This chapter is designed to prepare the learner to perform the following:

~ Describe the four types of root canal configurations I to IV.

~ Describe the normal shape and location of the pulp chamber for each class of tooth.

~ Identify the number of pulp horns normally found within each type of secondary (adult) tooth.

~ Identify the number of canals most likely to be found within the roots of each type of secondary (adult) tooth.

~ Describe the scope of responsibility for an endodontist.

~ Describe endodontic therapy.

Section I. Internal pulp cavity morphology related to endodontic and restorative therapy

A. THE SHAPE OF PULP CAVITIES AND CONFIGURATION OF PULP CANALS

The pulp cavity is the cavity in the central portion of the tooth containing the nerves and blood supply to the tooth. It is divided into the pulp chamber (more coronal) and the root canals (in the roots).

1. PULP CHAMBER AND PULP HORNS

The pulp chamber is the most occlusal or incisal portion of the pulp cavity. There is one pulp chamber in each tooth. It may be located partly in the crown of anterior teeth, but in posterior teeth, it is mostly in the cervical part of the root. Its walls are the innermost surface of the dentin. Each pulp chamber has a roof at its incisal or occlusal border often with projections called pulp horns, and the pulp chambers of multirooted teeth have a floor at the cervical portion with an opening (orifice) for each root canal (Fig. 9-1).

The number of pulp horns found within each cusped tooth (molars, premolars, and canines) is normally one horn per functional cusp, and in young incisors, it is three (one horn per facial lobe, which is the same as one lobe per mamelon). An exception is one type of maxillary lateral incisor (called a peg lateral with an incisal edge that somewhat resembles one cusp) that forms from one lobe so has only one pulp horn. Refer to Table 9-1 for a summary of the number of pulp horns related to the number of cusps normally found within different tooth types.

2. ROOT CANALS (PULP CANALS)

Root canals (pulp canals) are the portions of the pulp cavity located within the root(s) of a tooth. Root canals connect to the pulp chamber through canal orifices on the floor of the pulp chamber and open to the outside of the tooth through openings called apical foramina (singular foramen) most commonly located at or near the root apex (Fig. 9-1). The shape and number of root canals in any one root have been divided into four major, anatomic configurations (Fig. 9-2). The type I configuration has one canal, whereas types II, III, and IV have either two canals or one canal that is spilt into two for part of the root.

The four canal types are defined as follows:

Type I--one canal extends from the pulp chamber to the apex.

Type II--two separate canals leave the pulp chamber, but they join short of the apex to form one canal apically and one apical foramen.

Type III--two separate canals leave the pulp chamber and remain separate, exiting the root apically as two separate apical foramina.

Type IV--one canal leaves the pulp chamber but divides in the apical third of the root into two separate canals with two separate apical foramina.

Accessory (or lateral) canals also occur, located most commonly in the apical third of the root (Fig. 9-3A and B) and, in maxillary and mandibular molars, in the furcation area [64% of the timel].

B. SHAPE OF PULP CAVITIES IN SOUND YOUNG TEETH

LEARNING EXERCISE

Section extracted teeth to expose the pulp cavity: the size, shape, and variations of pulp cavities are best studied by the interesting operation of grinding off one side of an extracted tooth. Wearing a mask and gloves, you can use a dental lathe equipped with a fine-grained abrasive wheel about 3 inches in diameter and 3/8-inch thick to remove any part of the tooth. Simply decide which surface is to be removed, hold the tooth securely in your fingers, and apply this surface firmly to the flat surface of the abrasive wheel. Operating the lathe at a fairly high speed is less apt to flip the specimen from your fingers than operating it at a Iow speed.

If you can devise an arrangement by which a small stream of water is run onto the surface of the wheel as the tooth is ground, you will eliminate flying tooth dust and the bad odor of hot tooth tissue. If such an arrangement is not feasible, keep the tooth moist by frequently dipping the surface being ground in water or by dripping water onto the wheel with a medicine dropper. Look often at the tooth surface you are cutting and adjust your applied pressure to attain the plane in which you wish the tooth to be cut. A high- speed dental handpiece and bur will greatly facilitate your exploration of the insides of teeth.

Extracted teeth should always be sterilized as described in the introduction of this text, and kept moist. As you remove different sides of each kind of tooth, notice how the external contours of the pulp chamber are similar to the external morphology of the tooth. On incisors and canines, remove either the facial or lingual side from some teeth to view the mesiodistal plane (as seen in Fig. 9-4A and E), and remove the mesial or distal side from others to view the faciolingual plane (as seen in Fig. 9-4B, C, and D).

On premolars and molars, the removal of either the mesial or distal side will expose the outline of the roof of the pulp chamber where pulp horns can be seen extending beneath the cusps (as seen in premolars in Fig. 9-4C and D). When the buccal or lingual sides are removed to the level of the buccal and lingual cusp tips, pulp cavities can be seen in a mesiodistal plane (as seen in Fig. 9-4E), the view similar to that seen on a dental radiograph. Finally, on molars, the removal of the occlusal surface will reveal the openings (orifices) to the root canals on the floor of the pulp chamber (as seen later in the diagram in Fig. 9-9 and the close-up view in Fig. 9-13).

1. PULP SHAPE IN ANTERIOR TEETH (INCISORS AND CANINES)

a. Pulp Chamber and Pulp Horns of Anterior Teeth

When cut mesiodistally and viewed from the facial (or lingual) (similar to the view on dental radiographs), the pulp chambers of incisors are broad and may have a suggestion of multiple pulp horns. (Only two horns can be seen in the maxillary central incisors in Fig. 9-5.) However, the incisal border of the pulp wall (roof of chamber) of a young tooth may show the configuration of three mamelons (that is, has developed with three pulp horns: located mesially, centrally, and distally). Also, recall that the unusual peg lateral incisor only has one pulp horn. Knowing the number and location of these pulp horns becomes important when the tooth is fractured or badly decayed and must be prepared for an incisal restoration.

When cut labiolingually and viewed from the proximal, the pulp chambers of anterior teeth taper to a point toward the incisal edge (Fig. 9-6). In maxillary and mandibular canines, the incisal wall or roof of the pulp chamber is often rounded, having only one pulp horn (Fig. 9-7).

b. Root Canal(s) of Anterior Teeth

Recall that all anterior teeth are most likely to have one root. The number of root canals in each type of anterior tooth is also most frequently one. Maxillary central incisors, lateral incisors, and canines almost always have one canal (type I), whereas mandibular anterior teeth, although most likely to have one canal (60% of the time), may have two canals (one facial and one lingual) with the frequency varying depending on the study cited. [For example, mandibular central incisors may have two canals with two separate apical foramina (type III) 3% of the time, and two canals converging to one foramen (type II) from 17 to 43% of the time.

a. Pulp Chambers and Pulp Horns in Premolars

Mandibular lateral incisors may have two canals from 20 to 45% of the time (usually type II with one foramen or type III with two separate foramina about 3% of the time).] Mandibular canines may have two canals from 4 to 22% of the time. When two canals are present, one is facial, and one is lingual [often with type IV formation]. (Recall that the mandibular canine is the anterior tooth most likely to have two roots: one facial and one lingual.)

2. PULP SHAPE IN PREMOLARS

a. Pulp Chambers and Pulp Horns in Premolars

When premolars are cut mesiodistally and viewed from the facial (or lingual) similar to the view on dental radiographs, the occlusal border or roof of the pulp chamber is curved beneath the cusp similarly to the curvature of the occlusal surface (Fig. 9-8A). When cut buccolingually and viewed from the proximal, the pulp chamber often has the general outline of the tooth surface, sometimes including a constriction near or apical to the cervix (seen in Fig. 9-8B).

The pulp horns on the roof are visible beneath each cusp, and their relative lengths are similar to the relative heights of the cusps. Thus, the buccal horn is longer than the lingual horn. In general, premolars have one pulp horn per functional cusp. Therefore, the premolars that are the two-cusp type most often have two pulp horns, but mandibular second premolars that are the three-cusp type have three pulp horns, and the mandibular first premolars that have a functionless lingual cusp may have only one pulp horn, similar to a canine.

b. Root Canal(s) and Orifices of Premolars

Maxillary first premolars most often have two roots (one buccal and one lingual) and two canals (one in each root). Approximately 57% of these first premolars have two roots, but only 39% have one root. The average incidence of two canals, one in the buccal root and one in the lingual root, is 90%. [When two roots are present, the canals in both roots exhibit a type I configuration, and, when one root is present, the canal configuration is either a type II or type III] The incidence of three roots is approximately 4%.

b. Root Canal(s) and Orifices of Premolars

The dentist must know the location of each canal opening on the pulp chamber floor in order to remove diseased pulpal tissue from the entire pulp cavity. The buccal canal orifice in the maxillary first premolar (viewed through the prepared access opening and the roof of the pulp chamber removed in Fig. 9-9) is located just lingual to the buccal cusp tip. The lingual canal orifice is located just lingual to the central groove.

Maxillary second premolars most often have one root but may have one or two canals. According to one researcher, the average incidence of two canals is about 59% [type II or type III]. Three canals occur about 1% of the time. When there is one canal, its orifice on the pulp chamber floor is located in the exact center of the tooth (Fig. 9-9). If the orifice is located toward the buccal or the lingual, it probably means that there are two canals in the root.

Mandibular first and second premolars most frequently have one root and one root canal (type I) about 70% of the time in first premolars (Fig. 9-10A) and 98% in second premolars. Mandibular first premolars may have two canals (type IV) 24% of the time (Fig. 9-10B), but mandibular second premolars have two canals only 2.5% of the time. The single canal orifice is located on the floor of the pulp chamber just buccal to the center of the occlusal surface (see Fig. 9-9).

3. PULP SHAPE IN MOLARS

a. Pulp Chambers and Pulp Horns in Molars

The pulp chamber of maxillary first and second molars is broader buccolingually than mesiodistally (like the crown) and is often constricted near the floor of the chamber (seen best in Fig. 9-11A and B). On mandibular first and second molars, the chamber is broader mesiodistally than buccolingually (like the overall crown shape). This difference in shape of pulp chambers for maxillary versus mandibular molars can be appreciated by studying the openings used to access the pulp chambers for molars in Figure 9-9. As in all cusped teeth, molars have one pulp horn per functional cusp, and they are located in the roof of the pulp chamber well beneath each cusp. Therefore, if we consider the cusps of Carabelli to be functionless, all four- cusp types of molars have four pulp horns, and the mandibular first molar with five cusps is the only type of molar to have five pulp horns. (Notice the three pulp horns under the three buccal cusps in Figure 9-12A.)

The pulp chamber is normally deep to, or some distance from, the occlusal surface, actually located within the cervical part of the root trunk (Fig. 9-12). Surprisingly, the pulp chamber on a maxillary molar often is not penetrated by the dentist until the drill reaches the level of the gum line. One exception might be the pulp horn of the prominent mesiolingual cusp of the maxillary molars (Fig. 9-11A). The floor of the pulp chamber is considerably apical to the cervical line; it is located in the root trunk. The pulp floor has multiple openings (orifices), one for each root canal. The floor is level or flat in young teeth. It may become convex in older teeth with the deposition of additional dentin over time.

b. Root Canal(s) and Orifices of Molars

Maxillary first molars most frequently have three roots (mesiobuccal, distobuccal, and palatal), but four canals: one each in the distobuccal and palatal root, but two in the mesiobuccal root. In the palatal root, the canal is larger and more easily accessible from the floor of the pulp chamber than for the other two roots, but this root and its canal often curve toward the buccal in the apical third, requiring skillful procedures to clean and treat it. The mesiobuccal root of the maxillary first molar has two canals 90% of the time [one located more buccally within this root called mesiobuccal canal, and one located more lingually within this root called the mesiolingual canal. Type III canal systems have been reported to occur 33-60% of the time.] The distobuccal root most often has one canal.

On maxillary first molars, there are four orifices on the floor of the pulp chamber: one for each canal (Fig. 9-13). Opening into the palatal root canal, the palatal orifice on the floor of the pulp chamber is located beneath the mesiolingual cusp (Fig. 9-9). Opening into the mesiobuccal root, the mesiobuccal orifice is located slightly mesial to and beneath the mesiobuccal cusp tip. The mesiolingual orifice is located slightly to the palatal aspect of the mesiobuccal orifice. Usually, this orifice is difficult to locate because of an overhanging dentin shelf. Opening into the distobuccal root, the distobuccal canal orifice is located on a line between the palatal orifice and the buccal developmental groove at a point just short of the angle formed by the buccal and distal walls of the pulp chamber.

Maxillary second molars, like maxillary first molars, most frequently have three roots and four canals. The distobuccal and palatal roots each have one canal. The mesiobuccal root has two canals 70% of the time. The location of the orifices in the maxillary second molar is similar to the maxillary first molar, except that they are closer together (Fig. 9-9). Both mandibular first and second molars most frequently have two roots (mesial and distal) and three canals (two in the wider mesial root and one in the distal root). The roof of the pulp chamber is often at the same level as the cervical border of the enamel, with only the pulp horns extending into the anatomic crown (Fig. 9-12). Most of the pulp chamber is located within the root trunk.

The mesial root usually has two canals: mesiobuccal and mesiolingual. [The mesial roots of mandibular first molars have two canals virtually all of the time: a type III canal system is present 60% of the time and a type II canal system is present 40% of the time.9 The mesial roots of mandibular second molars have two canals 64% of the time: a type II canal system 38% of the time and a type III canal system 26% of the time, but one canal 27% of the time.] The distal roots of mandibular first and second molars usually have one canal [but, on mandibular first molars, there are two canals approximately 35% of the time, usually type II configuration, whereas the distal roots of mandibular second molars have one canal 92% of the time].

In both mandibular first and second molars, the mesiobuccal canal orifice on the chamber floor is located slightly mesial but close to the mesiobuccal cusp tip (Fig. 9-9). The mesiolingual canal orifice is just lingual to the mesial developmental groove of the mesial marginal ridge. It is not under the mesiolingual cusp tip but is in a more central location. If the distal root has one canal, the distal canal orifice is large and located just distal to the center of the crown. When two canals are present, the distolingual orifice is small and is located centrally just lingual to the central fossa. Careful inspection of the chamber floor toward the buccal will successfully locate the distobuccal orifice.

Maxillary third molars usually have three root canals and mandibular third molars usually have two. However, they do vary considerably in form with some teeth having only two root canals. Third molars are 9-11 years younger biologically than first molars, completing their development later in life than first and second molars. Therefore, on radiographs (x-ray films), their pulp chambers and root canals are generally larger than in the other molars in the same mouth, especially for patients between the ages of 15 and 35 years. Refer to Table 9-2 for a summary of the number of root canals related to the number of roots normally found within different tooth types.

4. PULP SHAPE IN PRIMARY TEETH

The shape of the pulp chamber in primary (deciduous) teeth will be discussed in Chapter 10. Briefly, these teeth generally have thinner amounts of dentin and enamel, so their pulp cavities are proportionally much larger than on secondary teeth, and their pulp horns are closer to the occlusal surface.

C. WHY PULP CAVITIES GET SMALLER IN OLDER TEETH

In a young tooth, the pulp chamber is large and resembles the shape of the crown surface. It has projections called horns extending beneath the cusps or mamelons in the roof of the chamber and is usually constricted somewhat at the cervix. In old teeth, the pulp chamber becomes smaller and is more apically located because of deposits of secondary (additional) dentin produced by specialized cells called odontoblasts lining the pulp chamber. Dentin formation normally continues as long as the pulp is intact or vital. Dentin forms on the wall of the pulp cavity, thickening the dentin and making the pulp chamber and canals smaller. Dentin formation over a lifetime may be stimulated to occur more rapidly or in greater quantity when the tooth is subjected to attrition (wear), trauma, or caries (that is, tooth decay), or when calcium hydroxide dental cement is applied on the pulp. A pulp cap is a term describing a procedure where the dentist places calcium hydroxide next to the pulp (an indirect pulp cap) or over a small bit of exposed healthy pulp (a direct pulp cap) at the depth of a very deep cavity preparation in order to stimulate the formation of a new layer of dentin to help the tooth heal.

The deposition of dentin over time results in reduction in size of the pulp chamber. In some cases, it may become entirely filled. Reduction in size makes finding and accessing the pulp chamber more difficult in an older patient than in the younger patient where the teeth still have larger chambers. The floor of the pulp chamber is nearly fiat in young teeth, later becoming convex, fin a radiographic study of 259 children in England, from their 11th to 14th birthdays, the mesiodistal and roof-to-floor pulp dimensions were recorded with a Lysta-Dent Digitizer. Mesiodistal reduction in size in mandibular first molars over 3 years was minimal (1-3.5%) compared to a considerable height reduction (15%) of the pulp chambers. This was mostly the result of secondary dentin deposition on the floor, not the roof, of the chamber,n]

The diameter of the root canal also decreases in size with age, getting small in older teeth because of the gradual addition of dentin of the internal wall over the years. The canal may be round, fiat, or ribbon shaped. Teeth, other than third molars, exhibiting unusually large pulp chambers on dental radiographs are immediately suspected of having necrotic pulps (that is, pulps that no longer have vital nerve or blood. supply), which can be a possible source of infection. Without vital pulp tissue, dentin formation ceases, and the pulp chamber size remains constant (once the pulp died) rather than continuing to decrease in size as is normal for vital teeth.

D. CLINICALAPPLICATION OF PULP MORPHOLOGY RELATED TO RESTORATIVE DENTISTRY

The dentist's knowledge of normal pulp shape, size and depth beneath the enamel is important to the dentist when preparing teeth that have deep decay. When the dentist determines that the tooth can be restored without the need to remove the pulp, he or she prepares the tooth in such a way to avoid disturbing or injuring the pulpal tissues. Whenever possible, the goal is to leave some sound (undecayed) dentin on the floor of the cavity preparation to provide support for the restoration (such as a filling using composite resin or amalgam), and to avoid exposing any part of the pulp cavity with a cutting bur or hand instrument.

This is accomplished through a knowledge of the shape of the pulp chamber and canals, and a careful evaluation of the patient's radiographs to determine the location of the pulp relative to the decay and external surface of the tooth. An example of deep decay relative to the pulp is seen in Figure 9-14. Also, the dentist must avoid overheating or drying out (desiccating) the tooth during preparation by using water to reduce the heat that is generated by the cutting burs used in a high-speed handpiece.

Sometimes, however, signs (what is seen), symptoms (what the patient feels), and diagnostic tests may indicate that a pulp inflammation (pulpitis) is irreversible, and cannot be resolved without removing the pulp tissue. When these signs, symptoms, and diagnostic test results indicate a pulp is not likely to respond well by placing just a filling (dental restoration of amalgam or composite), the pulp tissue must be removed and a root canal filling placed (endodontic therapy must be performed).

E. CLINICAL APPLICATION OF PULP MORPHOLOGY RELATED TO ENDODONTICS

1. ENDODONTICS DEFINED

Endodontics is a specialty branch of dentistry concerned with the morphology, physiology, and pathology of human dental pulp and periapical tissues. Its study and practice encompasses the related basic and clinical sciences, including biology of the normal pulp; the etiology, diagnosis, prevention, and treatment of diseases and injuries of the pulp; and resultant pathologic periradicular conditions (that is, pathosis around the root). An endodontist is a dentist who specializes in endodontics (root canal therapy). An endodontist is specially trained to provide root canal therapy, including treating patients with more difficult and complex endodontic situations that may be referred from a general dentist. Treatment may involve difficult root canal anatomy, medically compromised patients, and/or surgical treatments of periapical pathosis and infection.

2. DIAGNOSIS OF PULPAL AND PERIAPICAL DISEASE

Irreversible pulpitis (inflammation of the pulp that cannot be healed) is a condition of the pulp tissue where the pulp will not heal and root canal treatment is indicated. The tooth is unusually sensitive to cold or hot, and sometimes either stimulus may cause an exaggerated response (prolonged pain). The patient may also experience spontaneous pain in the tooth (that is, pain felt without provocation of such stimuli as heavy chewing, or exposure to hot or cold). The usual cause of irreversible pulpitis is deep caries (decay), although deep or poorly adapted restorations may also contribute.

The proximity of caries to the pulp can often be evaluated best using dental radiographs (Fig. 9-14). As the caries approaches the pulp, a normal defense reaction will occur involving inflammation and formation of reparative dentin. However, when the caries reaches (exposes) the pulp, bacteria will overwhelm the defenses, and the tooth usually becomes painful. This prompts the patient to seek emergency dental treatment. Access to, and removal of, affected pulp tissue will provide relief from the pain. The pulp tissue cannot be successfully treated with medications alone once the pulp is irreversibly damaged.

Periapical disease occurs when the pulp has died (becomes necrotic). When the pulp has been overwhelmed by the disease process in the crown, the pulp tissue in the root canals gradually dies. The bacteria and products of pulpal breakdown contained within the root canals cause the periapical tissue around the tooth to react to this insult. A chronic inflammatory response ensues in the bone with the formation of a granuloma (that is, a mass of chronic inflammatory tissue enclosed within a fibrous capsule). Since a granuloma is less dense than bone, a radiograph will usually reveal a radiolucency (periapical radiolucency is the dark area at end of the root; Fig. 9-15). In some cases, the granuloma undergoes degeneration and a cyst is formed. A cyst is an epithelium-lined sac filled with liquid or semiliquid material. The difference between a granuloma and a cyst cannot be determined on a radiograph.

When the bacteria from the root canal overwhelm the defenses of the periapical tissues or the patient's immune system is compromised, bacteria invade the surrounding bone and soft tissue, resulting in severe pain and/or facial swelling. Cleaning the root canals and draining the area of infection will usually provide relief within 2 to 3 days.

Another sequela to pulpal trauma (like being hit in the mouth with a baseball) is the discoloration of the tooth crown to a gray or brownish color, which indicates the need to evaluate the tooth for possible endodontic treatment. After the root canal, the discoloration can be greatly reduced by using an intracoronal bleaching technique where the bleach is placed within the access opening to the pulp chamber for a period of time. See the change on tooth color in Color Plate 20A and B.

3. ENDODONTIC THERAPY

The goal of endodontic therapy is to relieve pain, control infection, and preserve the tooth so it may function normally during mastication. Endodontic treatment is normally preferred to extraction because if the tooth was extracted, the patient would be without the tooth throughout the healing process and during the time required to construct and place the replacement tooth. Further, endodontic therapy is less expensive than having a tooth extracted and subsequently replaced with a dental prosthesis (bridge) or an implant.

The first step of the endodontic procedure is for the dentist to gain access to the pulp chamber and the root canals of teeth through an access opening in the crown of the tooth. On anterior teeth, the opening is made on the lingual surface and on posterior teeth through the occlusal surface. These access openings vary considerably from cavity preparations used in operative dentistry. The shape (outline form), size, and position of the access opening are determined by studying ideal openings of maxillary and mandibular teeth shown in Figure 9-9, and then modifying them to conform to what is present on the initial radiograph of the tooth. Finding the pulp may be difficult in older teeth or teeth that have large or deep restorations since the formation of secondary or reparative dentin may obliterate the pulp chamber, making endodontic access difficult. Further, if the tooth is covered with a metal crown, the pulp chamber will not be visible on the radiograph.

Once the access opening is complete, the dentist locates the root canal orifices on the floor of the pulp chamber. A knowledge of the number of root canals present in teeth is critically important to successful endodontic treatment. Not locating and cleaning all the canals may result in continued discomfort for the patient or unsuccessful endodontic treatment with ensuing periapical disease. When the canal orifices have been located, endodontic files are used to remove the diseased pulp tissue, and to clean and refine the canals.

The files are carefully inserted into the root canals after the file length is approximated by measuring the length of the corresponding root and crown on the preoperative radiograph. A radiograph is then made with the files in the root (Fig. 9-16). The positions and length of the files are adjusted to extend to approximately 1 mm short of the radiographic apex of the root (which corresponds to the natural constriction of the canal at the cementodentinal junction).

The canals are then cleaned and shaped at this length with incrementally larger diameter files until the root canal system is ready to be filled. Following this cleaning procedure, the root canals may be filled with gutta percha (a rubber-type material) and a sealer (Fig. 9-17). Examples of sealers used today include resin, glass ionomer, zinc oxide and eugenol, and calcium hydroxide. When there is sufficient tooth structure remaining, the opening through the crown used to access the pulp may be restored with a tooth-colored composite or silver amalgam restorative material. Since teeth requiting endodontic treatment usually have large restorations or are weakened by extensive decay, tooth structure may be restored with a crown. In some instances, a post placed into the prepared root canal space is used in order to provide sufficient retention for the prosthetic (artificial) crown (Fig. 9-18).

Once a tooth has had endodontic therapy and the pulp has been removed, it should not be considered a "dead tooth" even though it no longer has a vital pulp. Although it cannot respond to stimuli like hot or cold, and cannot form reparative dentin, the periodontal support is the same as if it never had endodontic treatment. Therefore, if the periodontium remains healthy, the treated tooth generally can last for the lifetime of the patient.

Section II. Location of root and cervical crown, concavities, furcations, depressions and canals

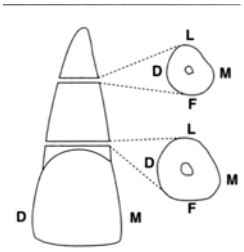
OBJECTIVES The purpose of this section is to summarize the shape of the external root surface and the internal pulp shape at the level of the cementoenamel junction and halfway clown the root toward the apex. The following tooth drawings are labeled: M = Mesial, D = Distal, F = Facial, and L = Lingual

A. MAXILLARY CENTRAL INCISORS

~ The cross section of the root at the cervix is somewhat triangular with the mesial side longer than the distal side, consistent with the slight distal placement of the cingulum.

~ There are no prominent root grooves (depressions) on this incisor, though the mesial surface may be flattened or have a slight longitudinal depression. The distal root surface is convex.

~ It has one root canal close to 100% of the time.



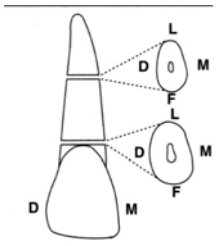
Tooth #8

B. MAXILLARY LATERAL INCISORS

~ The cross section of the root at the cervix is "egg shaped" or ovoid, with the widest mesiodistal portion on the labial.

~ A shallow longitudinal root depression is often found on the middle of the mesial root surface extending about half of the root length, but not on the distal surface.

~ There is one root canal close to 100% of the time.



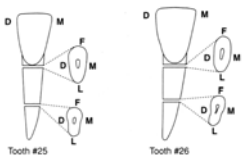
Tooth #7

C. MANDIBULAR CENTRAL AND LATERAL INCISORS

~ In cross section, the cervical portion of the root is ovoid, considerably broader labiolingually than mesiodistally [by about 2 mm].

~ Longitudinal root depressions are present on both proximal sides with the distal depression more distinct than the mesial.

~ Most commonly there is one root canal [about 70% of the time for centrals and 55% for laterals].

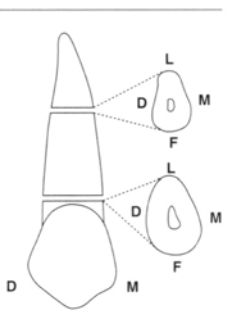


D. MAXILLARY CANINES

~ The cervical cross section is broad labiolingually and appears ovoid.

~ Developmental grooves (depressions) are present on both the mesial and distal sides providing better anchorage. The groove may be more distinct on the distal.

~ As in other maxillary anterior teeth, there is one root canal almost 100% of the time.



Tooth #6

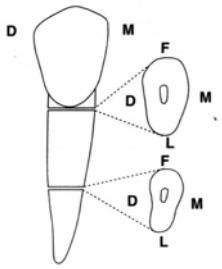
E. MANDIBULAR CANINES

~ Roots are wide labiolingually in the cervical half.

~ Longitudinal root depressions are present on both sides, often deeper on the distal.

~ Variations in double-root depressions include clearly separated roots (one labial and one lingual) to deep proximal grooves.

~ There is most often one root canal [70% of the time].



Tooth #27

F. MAXILLARY FIRST PREMOLARS

~ There are most often two canals [90% of the time].

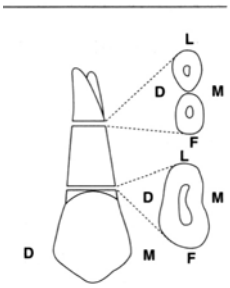
~ Most have two roots (one buccal and one lingual) and two canals, or when one root is present, two pulp canals are usually found.

~ Mesial and distal root depressions occur on both one- and two-rooted first premolars.

~ The prominent mesial developmental depression of the crown continues across the cervical line to join the deep mesial root depression (between the buccal and lingual roots or between the buccal and lingual halves of a single root).

~ When considering all premolars, it has the only root where the mesial root depression is deeper than a distal root depression.

~ When two roots are present, the bifurcation occurs in the apical third to half of the root.



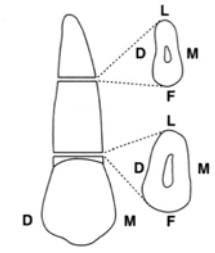
Tooth #5

G. MAXILLARY SECOND PREMOLARS

~ Although there is normally only one root, there may be two roots 11% of the time.

~ There may be a shallow developmental groove on the mesial side of the root, but it does not extend onto the crown, as was seen on the maxillary first premolar. A root depression can usually be found on the distal side, often deeper than on the mesial.

~ There is most often one root canal [over 59% of the time].



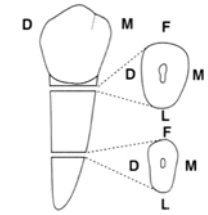
Tooth #4

H. MANDIBULAR FIRST PREMOLARS

~ In cross section, the cervical portion of the root is ovoid and is widest buccolingually.

~ Longitudinal depressions are often present on both sides, deeper on the distal. Sometimes these depressions may be quite deep and end in a buccolingual apical bifurcation.

~ There is usually one root canal [70% of the time].



Tooth #28

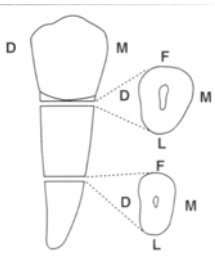
I. MANDIBULAR SECOND PREMOLARS

~ The cross section of the cervical portion of the root is ovoid buccolingually.

~ Longitudinal depressions are not common on the mesial root surface but are frequent on the distal surface in the middle third.

~ The cervical cross section of the root of the three-cusp premolars is particularly wide on the lingual, more so than on two-cusp types.

~ The root is rarely bifurcated and normally has one root canal [96% of the time].



Tooth #29

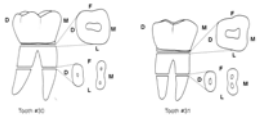
J. MANDIBULAR FIRSTAND SECOND MOLARS

~ Mandibular molars normally have two roots: mesial (broader and longer) and distal. Both roots are broad buccolingually.

~ Mandibular first and second molars normally have three root canals, two in the mesial root and one in the distal root.

~ The mesial root of both molars commonly has prominent root depressions on the mesial and distal surfaces, and there are usually two root canals [nearly 100% of the time]. This root may even be divided into a buccal and lingual part. The distal root surface contours are more variable but may be convex.

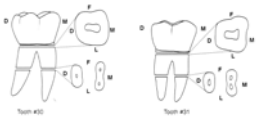
~ The distal roots in the mandibular first and second molars usually have one canal [65% of the time in the first molar and 92% of the time in the second molar.]



~ Access to the root bifurcations is located near the midbuccal and midlingual root surfaces.

~ The root trunk is shorter on first molars than on second molars; the furcation is nearest to the cervical line on the buccal of first molars. The cervical line is more occlusal on the lingual of first molars. Buccal and lingual depressions are seen on the relatively short root trunk, extending from the cervical lines to buccal and lingual furcations. (Recall that enamel at the buccal and lingual cementoenamel junction may extend into the bifurcation.)

~ First molar roots are broader and more widely separated than second molar roots, which may exhibit a distal inclination.



K. MAXILLARY FIRSTAND SECOND MOLARS

~ There are normally three roots: mesiobuccal, distobuccal (shortest), and lingual (longest).

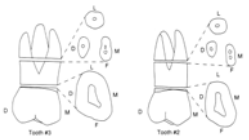
~ Maxillary first and second molars usually have four root canals: two in the wide mesiobuccal root and one each in the distobuccal and lingual roots.

~ The mesiobuccal root has mesial and distal side root depressions (and usually has two root canals).

~ The distal contour of the distobuccal root varies but is normally convex (and normally has one canal).

~ There is usually a slight longitudinal depression on the lingual side on the lingual root (which has one canal).

~ Access to furcations between the roots is located in the cervical third of the root: on the buccal surface near the center mesiodistally and on the mesial and distal surfaces, located slightly lingual to the center buccolingually.



~ Often a depression extends from the trifurcation to the cervical line and sometimes into the enamel of the crown on first molars. A distal crown depression is often noted on the distal surfaces of maxillary first molars.

~ Separation between roots is more pronounced on first molars than on second molars; on second molars, the buccal roots are more nearly parallel and inclined distally in their apical third.

~ The root trunk is broader (longer) than on mandibular molars, so the furcation between the mesiobuccal and distobuccal root may be at the junction of the cervical and middle thirds of the mesiobuccal root, especially on second molars. A summary of the presence and relative depth of longitudinal root depressions is presented in Table 9-3.