CHAPTER 5

DENTAL CARIES

Radiographic interpretation of dental caries should always be undertaken with a clinical examination of the oral cavity. Caries is detected radiographically only in the advanced stages when there is sufficient decalcification of tooth structures. The radiographic appearance of caries is not representative of its actual size, that is, it is much larger clinically than seen on a radiograph. Initial carious lesions are not readily visualized on a radiograph because the visibility of caries is determined by the ratio of enamel to caries through which x-rays penetrate. Although bite-wing radiographs are more useful in caries detection, the importance of periapical radiographs should not be underestimated. The treatment of a carious tooth should not be based on a single radiograph because an incorrect horizontal or vertical angulation of the x-ray beam can result in a number of illusions. Also, errors in exposure factors and errors in processing can produce radiographic illusions of dental caries. A radiographic diagnosis of caries must always be supplemented with a careful clinical examination.

OCCLUSAL CARIES

Occlusal caries originates in the pits and fissures of premolar and molar teeth. When caries is still in the enamel, there is no radiographic evidence of occlusal caries. At this stage, it can only be detected by a careful clinical examination with an explorer. Occlusal caries is observed radiographically only after the decay process has penetrated the enamel fissures to the dentino-enamel junction. Here, the caries spreads and, on a radiograph, shows a radiolucent line at the dentino-enamel junction. This spread of caries along the junction may undermine the enamel cusps and fracture them from the tooth. Histopathologically, the spread of caries in the enamel follows the path of the enamel rods and produces a triangular appearance with the base of the triangle at the dentino-enamel junction and the apex of the triangle towards the occlusal surface of the tooth. In the dentin, the occlusal caries follows the path of the dentinal tubules and forms another triangular radiolucency but with the base of the triangle at the dentino-enamel junction and the apex towards the dental pulp. Thus, occlusal caries progresses to form two triangular areas with a common base at the dentino-enamel junction. It must be noted that the tendency for dentinal caries to be restricted by the path of the tubules is not absolute, such that large carious lesions in the dentin give a diffuse appearance as they expand towards the pulp. The diffuse periphery of occlusal caries differentiates it from facial and lingual caries.

Fig. 5-1 Occlusal caries on a mandibular molar. Notice the intact enamel surface. Also observe the diffuse triangular appearance of the caries with the base of the triangle at the dentino-enamel junction and the apex towards the dental pulp.

Fig. 5-2 Occlusal caries in the first molar. Occlusal caries spreads at the dentino-enamel junction and may undermine and fracture the enamel. In the enamel, caries progresses in the direction of the enamel rods; in the dentin, caries progresses in the direction of the dentinal tubules.

PROXIMAL CARIES

Proximal caries is initially detected on a radiograph by a small notching on the enamel surface just below the proximal contact point. Histopathologically, as the carious lesion in the enamel follows the path of the enamel rods and increases in size, it continues to demonstrate approximately a triangular pattern with its base towards the outer surface of the tooth and with a flattened apex towards the dentino-enamel junction. After reaching the dentino-enamel junction, the carious lesion spreads along the junction and forms a second base. From this second base, the caries proceeds towards the pulp along the path of the dentinal tubules and forms another triangular radiolucency with the apex towards the pulp. Thus, proximal caries progresses to form two triangular areas with the base of the first triangle at the outer enamel surface of the tooth and the base of the second triangle at the dentino-enamel junction. When the undermined enamel fractures, the entire carious lesion radiographically resembles a U shape.

Fig. 5-3 Proximal caries on maxillary and mandibular second premolars, first molars and second molars. Caries is much larger clinically than seen on the radiograph.

Fig. 5-4 Proximal caries on the distal surface of the second premolar. Notice the triangular appearance of caries. In the enamel, caries progresses along the path of the enamel rods; in the dentin, caries progresses roughly along the path of the dentinal tubules.

Fig. 5-5 Proximal caries on anterior teeth.

Fig. 5-6 Radiolucent restorative materials (composite) may be misdiagnosed as caries. Notice the box-like rectangular cavity preparations.

Fig. 5-7 Radiopaque particles added to radiolucent restorative materials (composite) by manufacturer to differentiate them from carious lesions.

Fig. 5-8 The radiopaque cement bases underneath the radiolucent restorations differentiates them from carious lesions.

FACIAL AND LINGUAL CARIES

Facial and lingual (palatal) caries originate in pits and grooves on the facial and lingual surfaces. Similar to occlusal and proximal caries, the facial and lingual caries histopathologically tend to follow the path of the enamel rods and dentinal tubules. The radiographic radiolucency is well demarcated from the surrounding sound tooth structure. Its shape may be round, oval or semilunar, and depends on its location and degree of extension. Carious lesions developing in the facial and lingual pits are usually round (or oval) while those at the free margin of the gingiva are round (or oval) in the initial stages, but become elliptical or semilunar as they increase in size. Even after the carious lesion has penetrated the dentino-enamel junction and has spread along the junction, the undermined enamel tends to retain its integrity and provides a definite periphery to the lesion. This sharp demarcation differentiates facial and lingual caries from occlusal caries. Radiographs are useful in making a clinician aware of the presence of a lesion but its actual location and extent is determined through clinical examination. Facial caries can be differentiated radiographically from lingual caries by changing the angulations of the x-ray beam. However, this is of academic interest only and, therefore, no attempt is made to differentiate facial caries from lingual caries on a radiograph.

Fig. 5-9 Facial or lingual caries on first and second premolars (round or oval), and on first molar (semilunar). Facial and lingual caries usually originate in pits or grooves and later spread at the dentino-enamel junction. Enamel caries tends to follow the lines of the enamel rods; dentinal caries tends to roughly follow the lines of the dentinal tubules. The whole crown of the second molar is carious.

Fig. 5-10 Facial or lingual caries on the canine. Facial and lingual caries are usually well-demarcated from the surrounding sound enamel. This clear-cut outline assists in differentiating such lesions from occlusal caries. The crowns of the first and second premolars are carious.

ROOT CARIES (CEMENTAL CARIES)

Root caries (cemental caries) develops between the cemento-enamel junction and the free margin of the gingiva. It does not occur in areas covered by a well-attached gingiva. Histopathologically, root caries does not follow any specific path, it simply invades the cementum and dentin of the root. On a radiograph, root caries produces a saucer-shaped (scooped-out) appearance. The carious lesion has a diffuse periphery. Frequently, root caries may be erroneously interpreted as cervical burnout, especially when the radiolucency occurs under the proximal step of a metallic restoration. For root caries to occur, there must be loss of crestal bone resulting in the exposure of cementum. Cervical burnout is discussed later on in this chapter.

Fig. 5-11 Root caries (cemental caries) on distal of second premolar. Root caries is usually saucer shaped. Root caries does not occur in areas covered by a well-attached gingiva. There is loss of bone, resulting in the exposure of cementum.

Fig. 5-12 Root caries (cemental caries) on mandibular first molar has a scooped-out appearance. There is loss of alveolar bone height, resulting in the exposure of cementum.

RECURRENT CARIES

Recurrent caries is that which recurs in a previously treated and restored tooth. The caries may occur under a restoration or along its margins. If recurrent caries occurs under the proximal step of a metallic restoration, it may be misdiagnosed as cervical burnout. As the recurrent caries progresses closer to the pulp, a layer of secondary dentin may sometimes form to protect the pulp from the carious lesion. Recurrent caries may sometimes be misdiagnosed as (the non-commercial paste of) calcium hydroxide lining used underneath an amalgam and zinc phosphate base. On a radiograph, calcium hydroxide produces a thin radiolucent line whereas recurrent caries produces a diffuse radiolucency.

Fig. 5-13 Recurrent caries underneath the amalgam restoration of the maxillary first molar. Presence of secondary dentin (radiopaque) between the recurrent caries and the pulp chamber.

Fig. 5-14 In the second molar, the diffuse radiolucent line between the zinc phosphate base and sound dentin may be either recurrent caries or calcium hydroxide lining. Clinically, after removal of the restoration, the radiolucency was diagnosed as recurrent caries.

Fig. 5-15 Calcium hydroxide (thin radiolucent line) between the pulp chamber and zinc phosphate cement in the molar.

CERVICAL BURNOUT

Cervical burnout is an illusion of radiolucency of a radiopaque object. It appears as a radiolucent area or band between two extremely radiopaque areas. For example, the area between the crown and that portion of the root covered by the alveolar bone absorbs fewer x-ray photons than do the adjoining areas. Cervical burnout is also produced by root configuration, shape of the cemento-enamel contour, and exposure factors (peripheral burnout). Burnout due to excessive exposure is called peripheral burnout. Cervical burnout should not be mistaken for root caries or with caries under the proximal step of a Class II restoration. Root caries occurs when the free margin of the gingiva has receded from its normal position. The occurrence of cervical burnout depends partially on the presence of alveolar bone to provide the necessary contrast. The final confirmation must be done clinically with the use of an explorer. A second radiograph made with a slightly different x-ray beam angulation and a change in exposure factors will enable the clinician to differentiate a cervical burnout from root caries.

Fig. 5-16A Cervical burnout (radiolucent band) near the necks of the central incisors. Such burnout is the result of a decrease in total structural thickness and/or a change in the hard tissue composition.

Fig. 5-16B Diagram illustrating the phenomenon of cervical burnout. Lines "a" and "c" penetrate more dense tissue than does line "b".

X-ray "b" penetrates tooth structures (cementum and dentin).

X-ray "a" penetrates tooth structures and alveolar bone.

X-ray "c" penetrates tooth structures and enamel.

Cervical burnout can also be caused by root configuration and the shape of the cemento-enamel contour.

Fig. 5-17 Cervical burnout and root caries. The distal surface of the mandibular second premolar and the mesial surface of the maxillary second molar (arrows) show cervical burnout whereas the distal of the maxillary first molar shows root caries.

Fig. 5-18A Cervical burnout on distal of mandibular first premolar.

Fig. 5-18B Disappearance of cervical burnout when x-ray beam angulation and exposure are changed.

BEAM ANGULATION EFFECTS ON CARIES

Fig. 5-19 Caries visibility is usually better on a bite-wing than on a periapical radiograph.

Fig. A Bite-wing clearly shows the proximal caries on the maxillary second premolar.

Fig. B On the periapical radiograph, the proximal caries is not clearly visible as on the bite-wing.

Fig. 5-20 Caries visibility is better using a paralleling technique than a bisecting angle technique.

Fig. A Paralleling technique. The proximal caries on the second premolar is clearly visible.

Fig. B Bisecting angle technique. The proximal caries on the second premolar is not visible.

Fig. 5-21A Correct horizontal x-ray beam angulation (no overlapping) results in the detection of proximal caries on the mesial of the maxillary first molar.

Fig. 5-21B Incorrect horizontal angulation (overlapping) results in obliteration of the proximal caries. The arrow shows the overlapping between the premolars.

Fig. 5-22 Obliteration of carious lesion when using different vertical angulations of the x-ray beam. Caries visible on bite-wing but not on periapical radiograph.

Fig. A On the bite-wing, the recurrent caries is visible under the amalgam restoration of the maxillary first premolar.

Fig. B On the periapical radiograph, the recurrent caries is not clearly visible because of increase in the positive vertical angulation of the x-ray beam.

Fig. 5-23 Obliteration of carious lesion when using different vertical angulations of the x-ray beam. Caries visible on periapical radiograph but not on bite-wing.

Fig. A Unlike the previous example (fig. 5-22), this bite-wing does not show the recurrent caries under the amalgam restoration of the maxillary molar.

Fig. B The periapical radiograph shows the recurrent caries under the amalgam restoration. Unlike the previous example (fig. 5-22), this periapical radiograph proved to be superior to the bite-wing in the detection of recurrent caries.

Fig. 5-24 Changes in location of a carious lesion with changes in horizontal angulation of the x-ray beam.

Fig. A The recurrent caries in the molar is visible near the distal surface of the tooth.

Fig. B The recurrent caries is now visible near the mesial surface of the tooth because of the change in horizontal angulation of the x-ray beam.

Fig. 5-25 Decrease in the number of amalgam restorations with changes in horizontal angulation of the x-ray beam.

Fig. A Presence of two amalgam restorations in the first molar.

Fig. B Illusion of one amalgam restoration because of a change in the horizontal angulation of the x-ray beam.