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Inflammatory Diseases of the Teeth and Jaws

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The teeth are unique in that they provide a direct pathway for spread of infection into surrounding osseous and soft tissue structures. Periodontal disease is the most common cause of tooth loss worldwide, referring to infection of the supporting structures of the tooth, principally the gingiva, periodontal ligament, cementum, and alveolar bone. Periapical disease refers to an infectious or inflammatory process centered at the root apex of the tooth, usually occurring when deep caries infect the pulp chamber and root canals. We review the pathogenesis, clinical features, and radiographic findings (emphasis on computed tomography) in periodontal and periapical disease.
Semin Ultrasound CT MRI 36:434-443

Relevant Anatomy

A brief review of tooth anatomy, as described in detail in this issue's chapter by Zohrabian et al.[1] (and as depicted in Figures 4 and 5 of that chapter), is necessary to understand periodontal and periapical disease. A tooth is divided into 2 parts: an *anatomical crown* projecting into the oral cavity, and a *root* embedded in alveolar bone and projecting below the gingival margin (gum line). The number of roots varies between different teeth. A tooth is composed primarily of *dentin*, a bonelike substance of intermediate radiodensity. Dentin lies deep to hard, protective *enamel* overlying the crown, which is the most radiopaque substance in the human body, and *cementum* covering the root(s), which is of nearly the same radiodensity as that of dentin. Dentin surrounds the radiolucent *pulp chamber* and radiolucent *root canal(s)*. The neurovascular bundle enters the radiolucent *apical foramen* at the root apex of a tooth and travels through the root canal(s) to enter the pulp chamber at the center of a tooth. The *lamina dura* is the thin cortical lining of the bony tooth socket. The *periodontal ligament* holds a tooth in its socket by attaching to both the lamina dura of the socket and the cementum of the root.

Periodontal Disease

Periodontal disease affects the supporting structures of the tooth (periodontum) and is the most common cause of tooth loss worldwide.[2] In the setting of poor oral hygiene, chronic accumulation of anaerobic bacteria—laden plaque around the gingival margin of the tooth results in inflammation of the gums, termed gingivitis. If the infection persists, it can travel along the periodontal ligament, termed marginal periodontitis. This results in resorption of bone adjacent to the sides of the root and the formation of a periodontal pocket (Fig. 1). An even larger abscess may form if a foreign body becomes lodged in a periodontal pocket or if a pocket becomes occluded. Marginal periodontitis may be localized or generalized, depending on whether, respectively, less or more than 30% of residual teeth in the oral cavity are affected. Conditions that negatively affect host immunity and predispose to periodontal disease include, but are not limited to, smoking, diabetes, and human immunodeficiency virus. Moreover, mechanical pressure on gingival tissues resulting from misaligned teeth, suboptimal (ie, overhanging) restorations, dental anomalies such as enamel pearls (ectopic enamel formation on the root surface), or habitual tooth picking may also predispose to periodontal disease.

Patients with gingivitis have easily bleeding gums because of the hyperemia caused by the inflammatory process. Clinical features of periodontal disease include gingival redness, swelling, gingival recession, suppuration, and tooth hypermobility. Clinically, a dentist or dental hygienist examines for periodontal disease using a thin blunt-tipped, metallic periodontal probe called a Michigan-O probe with Williams markings at 3, 6, and 8 mm. If the periodontal ligament is intact, the probe should not advance significantly when inserted between the gingiva and tooth (Fig. 2A). However, with periodontal disease, the probe advances to the depth of the periodontal pocket (Fig. 2B). The measurement of the pocket is made from the cementoenamel junction, or the

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 http://dx.doi.org/10.1053/j.sult.2015.09.003
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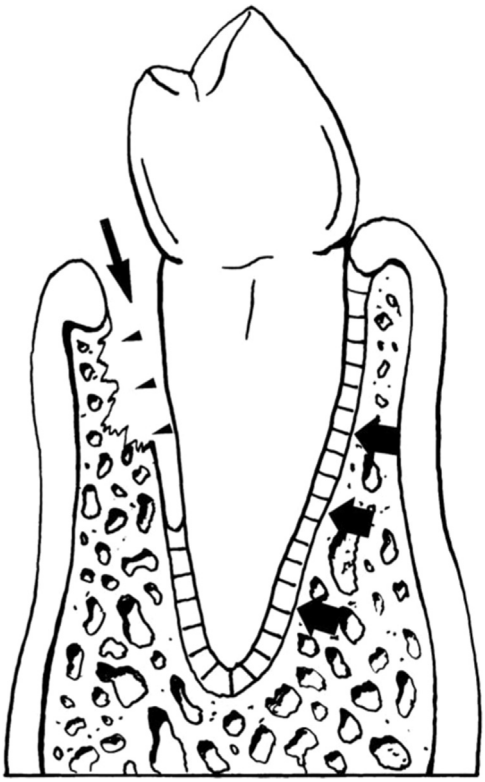

Figure 1 Illustration of periodontal disease. The normal periodontal ligament space is thin and has a constant width along the surface of the root (short black arrows). In periodontal disease, infection of the ligament causes erosion of adjacent alveolar bone (black arrowheads), resulting in focal widening of the periodontal ligament space and formation of a periodontal pocket (longer black arrow). (Adapted with permission from Abrahams and Kalyanpur.[31]) (Color version of figure is available online.)

junction between anatomical crown and root of a tooth, to the base of a periodontal pocket. The cementoenamel junction demarcates where the gingiva attaches to a healthy tooth and is normally located 1-2 mm above the bony alveolar crest. Thus, a probe can normally insert to a depth of approximately 1-3 mm, with anything beyond 3-4 mm diagnostic of a periodontal pocket.

The radiographic evaluation of periodontal disease provides useful information on bone levels, patterns of bone loss, root lengths, and most importantly, length of root surrounded by remaining alveolar bone. Radiographs may also be useful in revealing predisposing factors, such as overhanging restorations and root anomalies or malformations. The examination typically begins with intraoral radiographs, specifically vertical bitewings and periapical radiographs. No radiographic abnormality is typically demonstrated in the early stages of gingivitis as the inflammatory response is limited to the gums without periodontal ligament involvement and alveolar bone loss. Early radiographs may show loss of cortical density, blunting or rounding of the normally sharp angle between the alveolar crest and the lamina dura, as well as a slight loss of alveolar crest height. The imaging hallmark of marginal periodontitis is widening of the normally thin, radiolucent periodontal ligament space adjacent to the surface of the root (Fig. 3). Chronic periodontitis may result in reactive sclerosis of the adjacent bone, termed condensing osteitis (Fig. 4). Widening of the periodontal ligament space most commonly results from periodontal infection; however, this finding is nonspecific, and may also be seen in apical periodontitis, orthodontic treatment, trauma, and malignancy (ie, leukemia, metastases, and osteosarcoma). Malignancy should be considered whenever radiolucency is ill defined and localized to only 1 or 2 teeth, with relative preservation of the periodontal ligament space surrounding the remainder of the dentition.

Treatment of Periodontal Disease

Regular brushing and flossing help in eliminating bacterial buildup and plaque adherent to the tooth surfaces, and therefore, are critical in the prevention of dental caries and periodontal disease. When oral hygiene is insufficient, plaque mineralizes into calculus, also known as "tartar," and as such, routine cleaning is no longer effective in removing these hardened deposits. A professional cleaning by a dentist or dental hygienist is needed to remove tartar through the use of special tools, such as curettes.

The treatment of periodontal disease typically begins with nonsurgical scaling and root planning, also known as periodontal cleaning or "deep cleaning," to remove bacteria-laden plaque from deep periodontal pockets. Scaling involves removing plaque from tooth surfaces, whereas root planning refers to smoothening the root surfaces and removing any infected tooth structures, although both are done at the same time. As offending bacteria are mostly anaerobic, patients may afterward be instructed to brush with dilute hydrogen peroxide to prevent the deposition of dental calculus. Dilute hydrogen peroxide can also be delivered mechanically to deep periodontal pockets by patients using a water pick. Moreover, germicidal mouthwashes and site-specific antibiotics may be prescribed to promote further disinfection and healing.

More severe cases of periodontal disease may necessitate gingival flap surgery to clean and reduce the size of deep periodontal pockets. Bone grafts, soft tissue grafts, or guided tissue regeneration, in which tissue-stimulating proteins are used to enhance bone growth, may also be required (Fig. 5). Minimally invasive laser-based therapy, PerioLase MVP-7, has revolutionized gum surgery by using a 6-W, free-running Nd:YAG laser to remove bacteria and regenerate soft tissues.

Dental Caries

Colloquially referred to as a "cavity," dental caries is caused by demineralization of enamel and dentin by lactic acid produced by bacterial fermentation of carbohydrates.[3] Remineralization of enamel may cause a carious lesion to regress, especially in the presence of fluoride and acid-neutralizing saliva.[3] Caries are typically diagnosed using dental radiographs, as further discussed in this issue's chapter by Koenig[4]; however, they can also be seen on computed tomography (CT), appearing as a focal radiolucency in the opaque enamel or dentin extending from the surface of the tooth.[5] Caries commonly occur at