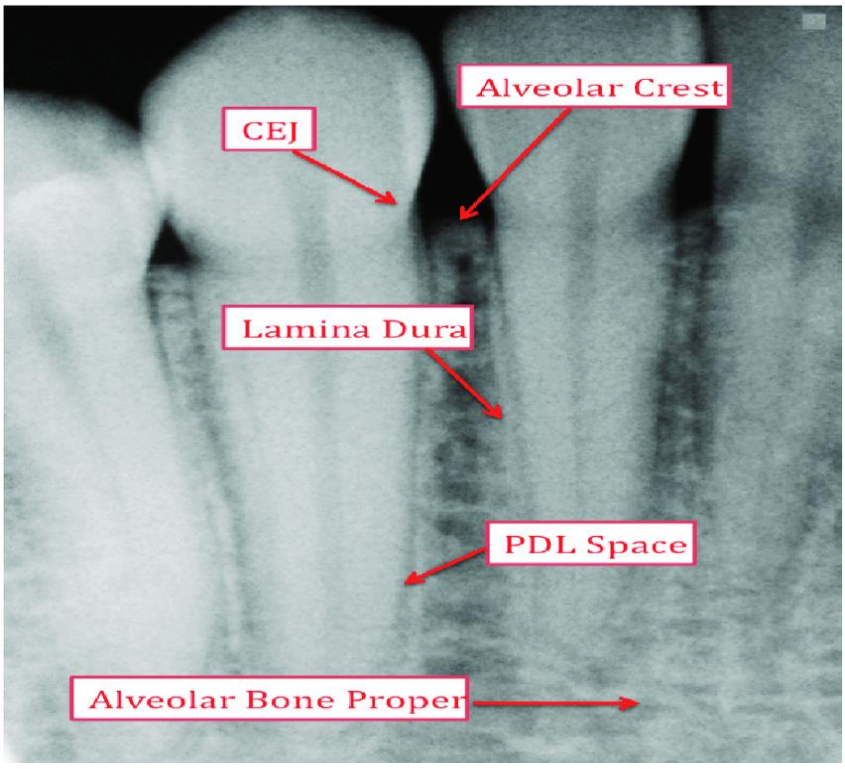
Radiographic aids in the diagnosis of periodontal disease

Radiographs are valuable for the diagnosis of periodontal disease, estimation of severity, determination of prognosis, and evaluation of treatment outcome.

Normal Interdental Bone

Evaluation of bone changes in periodontal disease is **based on** the appearance of the interdental bone, **because** the relatively dense root structure obscures the facial and lingual bony plates. The interdental bone normally is outlined by a thin, radiopaque line adjacent to the periodontal ligament (PDL) and at the alveolar crest, referred to as **the lamina dura**. Because the lamina dura represents the cortical bone lining the tooth socket, the shape and position of the root and changes in the angulation of the x-ray beam produce considerable variations in its appearance.

The width and shape of the interdental bone and the angle of the crest normally vary according to the convexity of the proximal tooth surfaces and the level of the cementoenamel junction (CEJ) of the approximating teeth.



Location of periodontal components on a periapical radiograph.

Radiographic Techniques

In conventional radiographs, **periapical and bitewing** projections offer the most diagnostic information and are most commonly used in the evaluation of periodontal disease. To properly and accurately depict periodontal bone status, proper techniques of exposure and processing are required. The bone level, pattern of bone destruction, and PDL space width, as well as the radiodensity, trabecular pattern, and marginal contour of the interdental bone, **vary by modifying exposure and development time, type of film, and x-ray angulation**.

Prichard established the following four criteria to determine adequate angulation of periapical radiographs:

1. The radiograph should show the tips of molar cusps with little or none of the occlusal surface showing.

2. Enamel caps and pulp chambers should be distinct.

3. Interproximal spaces should be open.

4. Proximal contacts should not overlap unless teeth are out of line anatomically.

For periapical radiographs, the **long-cone paralleling technique** most accurately projects the alveolar bone level. **The bisection-of-the-angle technique** elongates the projected image, making the bone margin appear closer to the crown; the level of the facial bone is distorted more than that of the lingual.

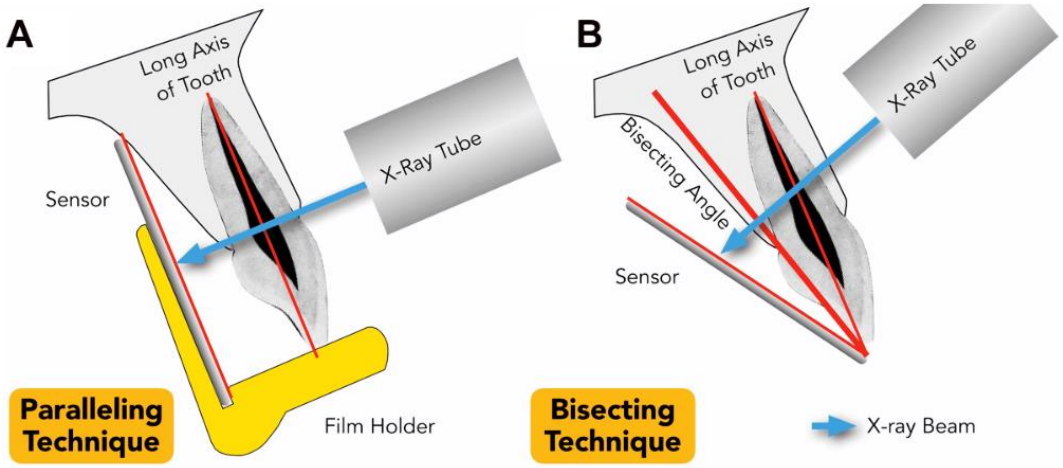
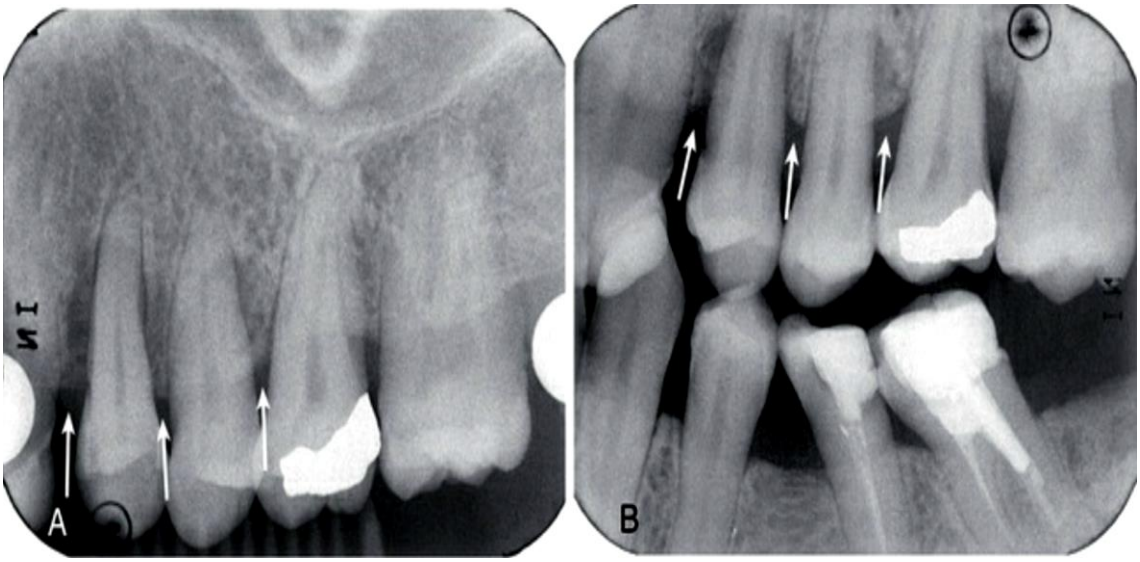


Fig. 1
(*A*) Paralleling technique, and (*B*) bisecting technique.

Inappropriate horizontal angulation results in tooth overlap, changes the shape of the interdental bone image, alters the radiographic width of the PDL space and the appearance of the lamina dura, and may distort the extent of furcation involvement.

In cases in which a shallow palate or floor of the mouth does not allow ideal placement of the periapical film. Periapical radiographs frequently **do not** reveal the correct relationship between the alveolar bone and the CEJ. **Bitewing** projections offer an alternative method that better images periodontal bone levels.

For bitewing radiographs, the film is placed behind the crowns of the upper and lower teeth parallel to the long axis of the teeth. The x-ray beam is directed through the contact areas of the teeth and perpendicular to the film. Thus the projection geometry of the bitewing films allows the evaluation of the relationship between the interproximal alveolar crest and the CEJ without distortion. If the periodontal bone loss is severe and the bone level cannot be visualized on regular bitewing radiographs, films can be placed vertically to cover a larger area of the jaws. More than two vertical bitewing films might be necessary to cover all of the interproximal spaces in the area of interest.



(A) Periapical and (B) bitewing radiographs from a patient with periodontitis. The periapical film clearly underestimates the amount of bone.

Bitewing radiography is the preferred imaging technique to depict periodontal bone levels in the posterior dentition.

Bone Destruction in Periodontal Disease

Early destructive changes of bone that do not remove sufficient mineralized tissue **cannot** be captured on radiographs. Therefore slight radiographic changes of the periodontal tissues suggest that the disease has progressed beyond its earliest stages.**The earliest signs of periodontal disease must be detected clinically.**

Bone Loss

The radiographic image tends to underestimate the severity of bone loss. The difference between the alveolar crest height and the radiographic appearance ranges from **0 to 1.6 mm**, mostly accounted for by x-ray angulation.

Amount

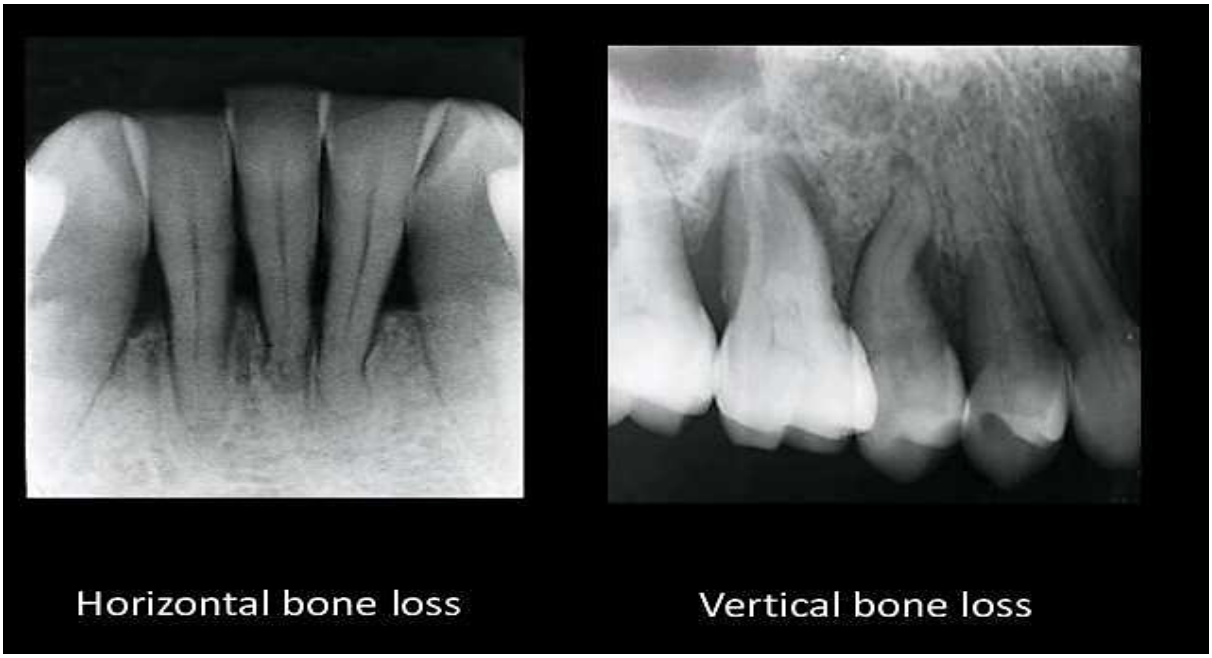
Radiographs are an indirect method for determining the amount of bone loss in periodontal disease; they show the amount of remaining bone rather than the amount lost. The amount of bone lost is estimated to be the difference between the physiologic bone level and the height of the remaining bone. Several investigators have analyzed **the distance from the CEJ to the alveolar crest**. Most studies, conducted in adolescents, suggest a distance of **2 mm** to reflect normal periodontium; this distance may be greater in older patients.

Distribution

The distribution of bone loss is an important diagnostic sign. It points to the location of destructive local factors in different areas of the mouth and in relation to different surfaces of the same tooth.

Pattern of Bone Destruction

In periodontal disease the interdental bone undergoes changes that affect the lamina dura, crestal radiodensity, size and shape of the medullary spaces, and height and contour of the bone. The height of interdental bone may be reduced, with the crest perpendicular to the long axis of the adjacent teeth **(horizontal bone loss)**, or angular or arcuate defects **(angular, or vertical bone loss)** could form.



Periodontal bone loss should be differentiated from normal anatomy or anatomic variants that can resemble disease. For example, **nutrient canals** in the alveolar bone can appear as linear and circular radiolucent areas. These canals can be seen more frequently in the anterior mandible, although they can be present throughout the alveolar ridge.

Nutrient canals.

Radiographic Appearance of Periodontal Disease

Periodontitis

Radiographic changes in periodontitis follow the pathophysiology of periodontal tissue destruction and include the following:

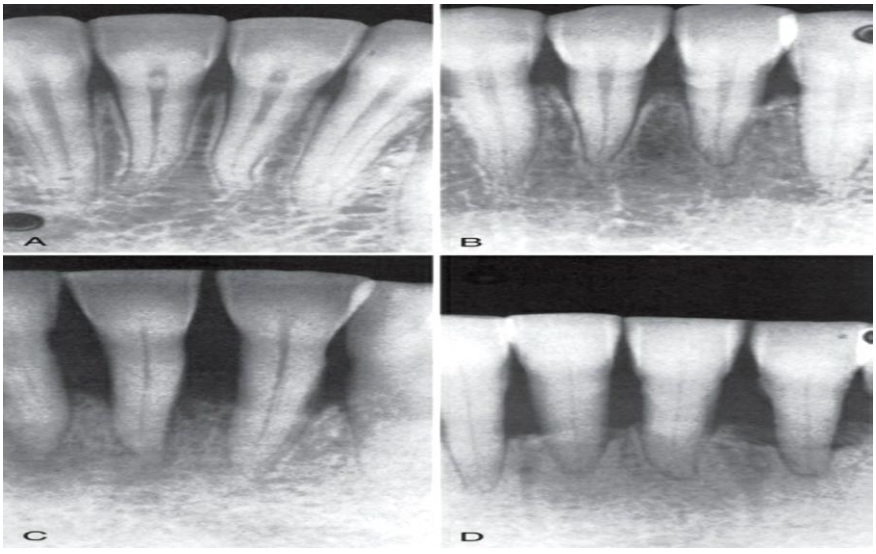
1. Fuzziness and disruption of lamina dura crestal cortication continuity is the earliest radiographic change in periodontitis and results from bone resorption activated by extension of gingival inflammation into the periodontal bone.

2. Continued periodontal bone loss and widening of the periodontal space results in a wedge-shaped radiolucency at the mesial or distal aspect of the crest.

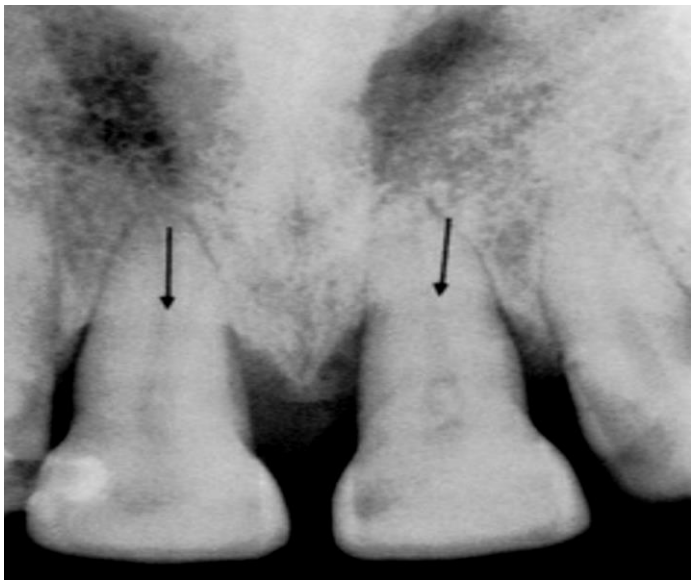
3. Subsequently, the destructive process extends across the alveolar crest, thus reducing the height of the interdental bone. As increased osteoclastic activity results in increased bone resorption along the endosteal margins of the medullary spaces, the remaining interdental bone can appear partially eroded.

4. The height of the interdental septum is progressively reduced by the extension of inflammation and the resorption of bone.

5. Frequently a radiopaque horizontal line can be observed across the roots of a tooth. This opaque line demarcates the portion of the root where the labial or lingual bony plate has been partially or completely destroyed from the remaining bone-supported portion.



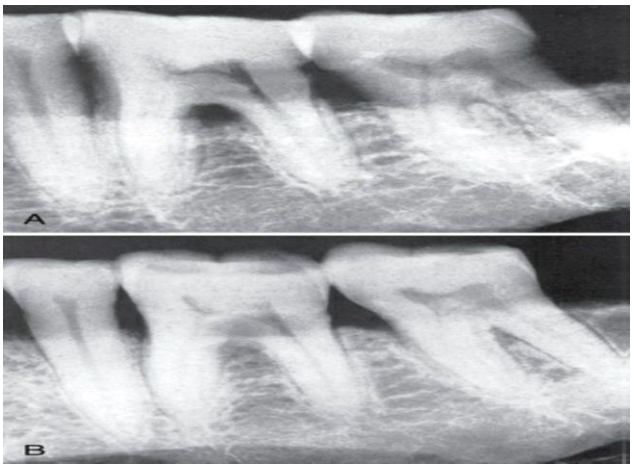
Radiographic changes in periodontitis.



Horizontal lines across the roots of the central incisors

Furcation Involvement

Definitive diagnosis of furcation involvement is made by clinical examination, which includes careful probing with a specially designed probe (**Nabers**). Radiographs are helpful, but root superimposition, caused by anatomic variations or improper technique, can obscure radiographic representation of furcation involvement. As a general rule, bone loss is greater than it appears in the radiograph. A tooth may present marked bifurcation involvement in one film but appear to be uninvolved in another.



(A) Furcation involvement indicated by triangular radiolucency in the bifurcation area of mandibular first molar. The second molar presents only a slight thickening of the periodontal space in the bifurcation area. (B) Same area as in A with different angulation.

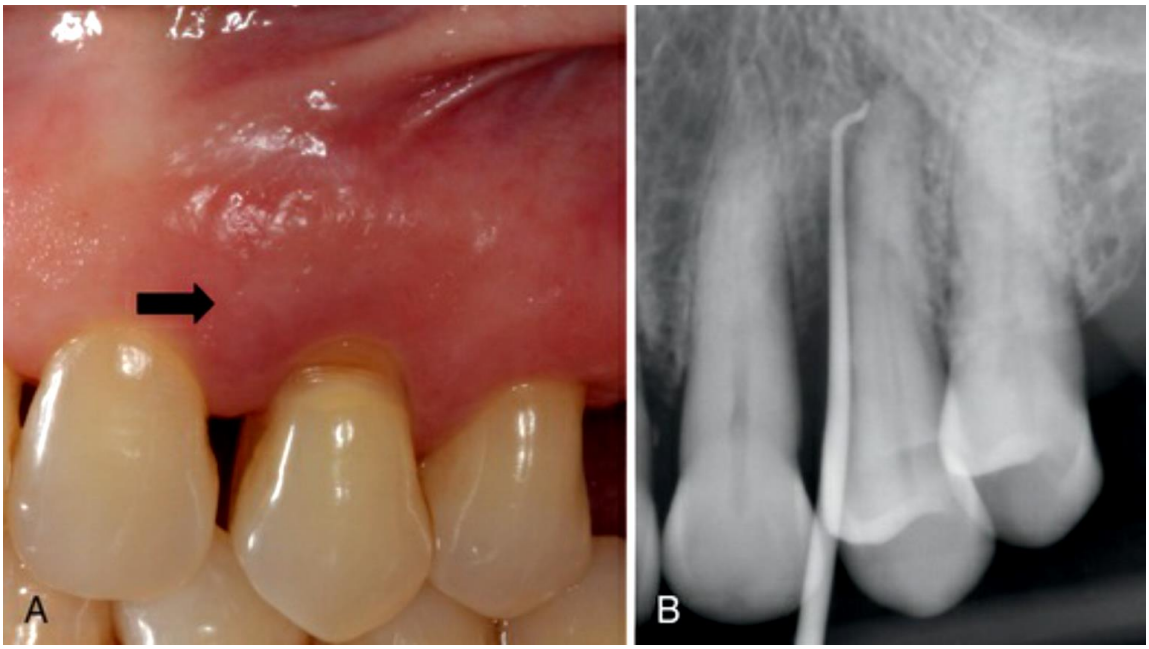
Periodontal Abscess

The typical radiographic appearance of a periodontal abscess is a discrete area of radiolucency along the lateral aspect of the root. However, the radiographic picture is often not characteristic. This can be due to the following:

1. The stage of the lesion:- In the early stages an acute periodontal abscess is extremely painful but presents no radiographic changes.

2. The extent of bone destruction and the morphologic changes of the bone.

3. The location of the abscess:- Lesions in the soft tissue wall of a periodontal pocket are less likely to produce radiographic changes than those deep in the supporting tissues.



Chronic periodontal abscess. (A) Periodontal abscess in the left maxillary first premolar area. (B) Extensive bone destruction on the mesial surface of the first premolar. Gutta-percha point traces to the root apex.

Abscesses on the facial or lingual surface are obscured by the radiopacity of the root; interproximal lesions are more likely to be visualized radiographically. Therefore **radiographs alone cannot** provide a final diagnosis of a periodontal abscess but need to be accompanied by careful clinical examination.

Localized Aggressive Periodontitis

Characterized by the following:

1. Initially, there is bone loss in the maxillary and mandibular incisor or first molar areas, usually bilaterally, resulting in a vertical, arclike destructive pattern

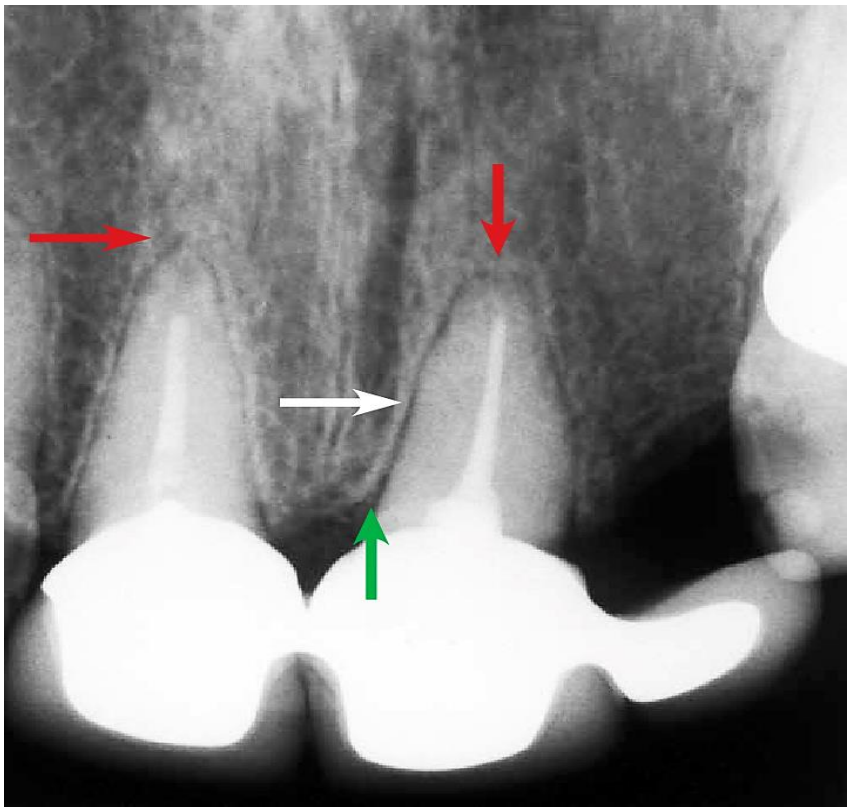
2. As the disease progresses, loss of alveolar bone may become generalized but remains less pronounced in the premolar areas.

Localized aggressive periodontitis.

Trauma From Occlusion

Trauma from occlusion can produce radiographically detectable changes in the thickness of the lamina dura, morphology of the alveolar crest, width of the PDL space, and density of the surrounding cancellous bone. Traumatic lesions manifest more clearly in faciolingual aspects because mesiodistally, the tooth has added stability provided by the contact areas with adjacent teeth. Therefore slight variations in the proximal surfaces may indicate greater changes in the facial and lingual aspects.

The injury phase of trauma from occlusion produces a loss of the lamina dura that may be noted in apex, furcations, and marginal areas. This loss of lamina dura results in widening of the PDL space. The repair phase of trauma from occlusion results in an attempt to strengthen the periodontal structures to better support the increased loads. More advanced traumatic lesions may result in deep angular bone loss, when combined with marginal inflammation, may lead to intrabony pocket formation.



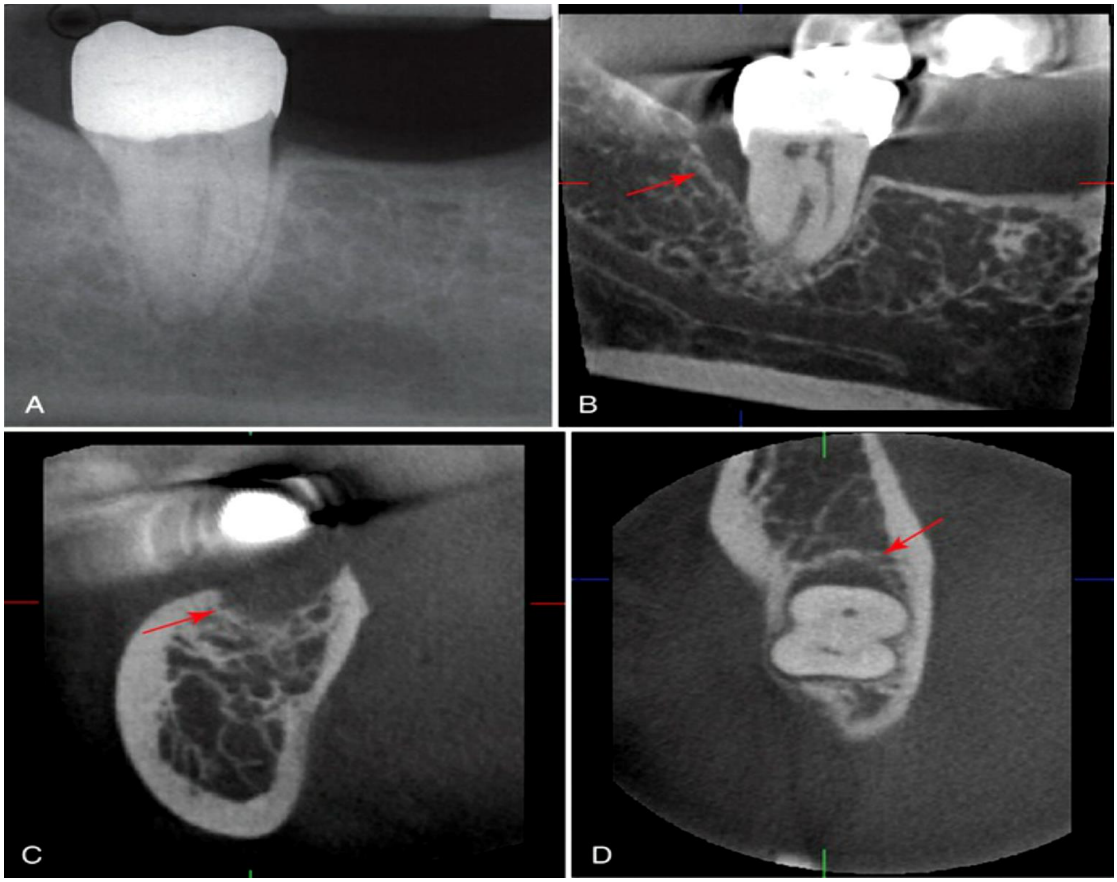
Radiographical change due to trauma from occlusion.

Digital Intraoral Radiography

Advances in digital imaging technology have driven rapid growth of digital intraoral radiography as a convenient alternative to conventional film-based radiography. Digital intraoral radiographic systems use either solid-state detectors or photostimulable phosphor (PSP) plates.

Advanced Imaging Modalities

Cone-beam computed tomography (CBCT) has revolutionized the field of oral and maxillofacial imaging. CBCT technology and its use in evaluating the implant patient. CBCT imaging provides three-dimensional information and overcomes many of the limitations of conventional two dimensional (2D) radiography. However, CBCT imaging is a higher-dose procedure relative to bitewing radiography, and is also more expensive. CBCT imaging for periodontal bone evaluation should be considered only for select cases where 2D information is insufficient for diagnostic or treatment planning needs, and it is not recommended for routine evaluation of periodontal bone loss.



(A) Periapical radiograph . (B) Sagittal. (C) Cross-sectional. (D) axial CBCT sections of the mandibular right second molar. No pathology is detected on the periapical radiograph. However, CBCT images clearly illustrate a deep, vertical, three-wall defect on the distal surface of the mandibular right second molar