Radiographic aids in the diagnosis of periodontal disease

Normal Interdental Bone

Evaluation of bone changes in periodontal disease is based mainly 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. (Fig. 1).

(Fig. 1)

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. The faciolingual diameter of the bone is related to the width of the proximal root surface. The angulation of the crest of the interdental septum is generally parallel to a line between the CEJs of the approximating teeth . When there is a difference in the level of the CEJs, the crest of the interdental bone appears angulated rather than horizontal.

Radiographic Techniques

The most diagnostic information and the most commonly used in the evaluation of periodontal disease are conventional radiographs, periapical and bitewing projections offer. Proper techniques of exposure and processing are required to properly and accurately describe periodontal bone status. The bone level, pattern of bone destruction, and PDL space width, the radio density, trabecular pattern, and marginal contour of the interdental bone,

vary by modifying exposure and development time, type of film, and x-ray angulation. Standardized, reproducible techniques are required to obtain reliable radiographs for pre-treatment and post-treatment comparisons.

The following four criteria established by Prichard 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.

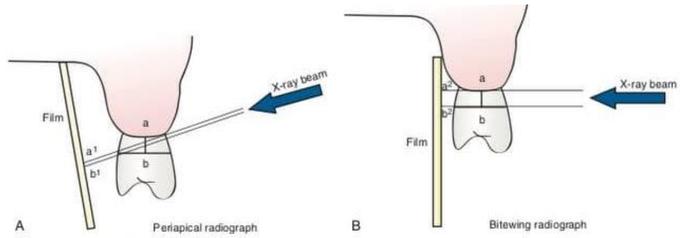
<u>For periapical radiographs</u>

-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.

In appropriate 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 .Periapical radiographs frequently do not reveal the correct relationship between the alveolar bone and the CEJ. This is particularly true in cases in which a shallow palate or floor of the mouth does not allow ideal placement of the periapical film.

<u>For bitewing radiographs</u>, Bitewing projections offer an alternative method that better images periodontal bone levels. 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. (fig 2)



(Fig. 2) Comparison between periapical (A) and bitewing (B) radiographs.

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.

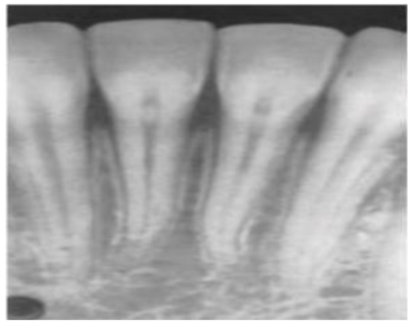
Amount: Radiographs are an indirect method for determining the amount of bone loss in periodontal disease; they show the amount of remaining bone rather than the amount lost. The amount of bone lost is estimated to be the difference between the physiologic bone level and the height of the remaining bone.

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.

Radiographic Appearance of Periodontal Disease

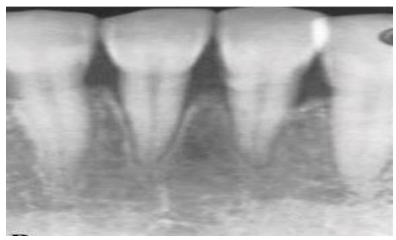
Periodontitis: Radiographic changes in periodontitis follow the pathophysiology of periodontal tissue destruction and include the following:

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. No correlation has been found between crestal lamina dura in radiographs and the presence or absence of clinical inflammation, bleeding on probing, periodontal pockets, or loss of attachment.Therefore it can be concluded that the presence of an intact crestal lamina dura may be an indicator of periodontal health, whereas its absence lacks diagnostic relevance. (Fig. 3)**



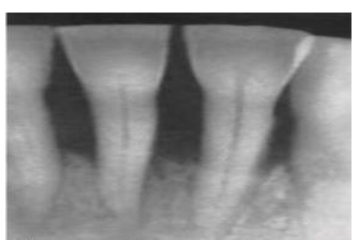
(Fig. 3)

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 (Fig.4). The apex of the area is pointed in the direction of the root.



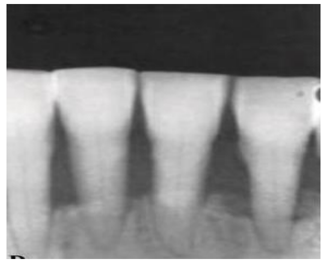
(Fig. 4)

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 (Fig. 5)**



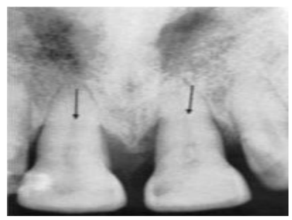
(Fig. 5)

4. **The height of the interdental septum is progressively reduced by the extensionof inflammation and the resorption of bone (Fig. 6).**



(Fig. 6)

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 (Fig. 7)**



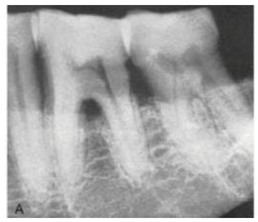
(Fig. 7)

Interdental Craters: **Interdental craters are seen as irregular areas of reduced density on the alveolar bone crests. Craters are generally not sharply demarcated but gradually blend with the rest of the bone. Conventional radiographs do not accurately depict the morphology or depth of interdental craters, which sometimes appear as vertical defects. (Fig. 8)**

(Fig. 8)

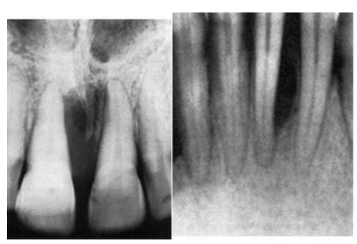
Furcation Involvement**: careful probing with a specially designed probe (e.g., Nabers) made definitive diagnosis of furcation involvement . Radiographs are helpful, but root superimposition, caused by anatomic variations or improper technique, can obscure radiographic representation of furcation involvement. 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 . Radiographs should be taken at different angles to reduce the risk of missing furcation involvement. A large, clearly defined**

radiolucency in the furcation area is easy to identify, but less clearly defined radiographic changes are often overlooked. To assist in the radiographic detection of furcation involvement, the following diagnostic criteria are suggested: 1. The slightest radiographic change in the furcation area should be investigated clinically, especially if there is bone loss on adjacent roots . 2. Diminished radiodensity in the furcation area in which outlines of bony trabeculae are visible suggests furcation involvement.3. Whenever there is marked bone loss in relation to a single molar root, it may be assumed that furcation is also involved. (Fig. 9)



(Fig. 9)

Periodontal Abscess: **The typical radiographic appearance of a periodontal abscess is a separate 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. Abscesses on the facial or lingual surface are obscured by the radiopacity of the root; interproximal lesions are more likely to be visualized radiographical .Therefore radiographs alone cannot provide a final diagnosis of a periodontal abscess but need to be accompanied by careful clinical examination. (Fig. 10)**



(Fig. 10)

Clinical Probing: **Regenerative and resective lap designs and incisions require prior knowledge of the underlying osseous topography. Careful probing of these pocket areas after**

scaling and root planing often requires local anesthesia and deinitive radiographic evaluation of the osseous lesions. Radiographs taken with periodontal probes, gutta-percha points, or other indicators (e.g., Hirschfeld pointers) placed into the anesthetized pocket show the true extent of the bone lesion. As indicated previously, the attachment level on the radicular surface or interdental lesions with thick facial or lingual bone cannot be visualized in the radiograph. The use of radiopaque indicators is an eficient and necessary diagnostic aid (Fig. 11).

(Fig. 11)

***<u>Trauma From Occlusion</u>*:** **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 radiographic changes listed next are not path gnomonic for trauma from occlusion and must be interpreted in combination with clinical findings, particularly tooth mobility, presence of wear facets, pocket depth, and analysis of occlusal contacts and habits.**

The injury phase of trauma from occlusion **produces a loss of the lamina dura that may be noted in apices, furcations, and marginal areas. This loss of lamina dura results in widening of the PDL .**

The repair phase of trauma from occlusion **results in an attempt to strengthen the periodontal structures to better support the increased loads.**

Radiographically, this is manifested by a widening of the PDL space, which may be generalized or localized. Although microscopic measurements have determined normal variations in the PDL space width along the root surface, these are generally not detected radiographically. Thus, when seen on radiographs, variations in PDL space width suggest that the tooth is being subjected to increased forces.

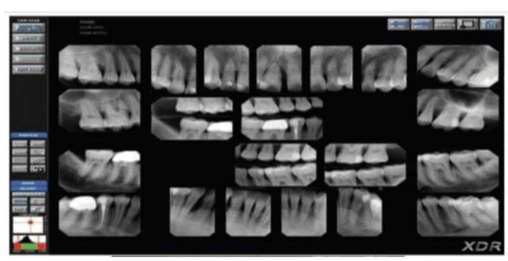
More advanced traumatic lesions **may result in deep angular bone loss, which, when combined with marginal inflammation, may lead to intrabony pocket formation.**

***In terminal stages*, these lesions extend around the root apex, producing a wide, radiolucent periapical image (cavernous lesions). Root resorption may also result from excessive forces on the periodontium, particularly those caused by orthodontic appliances. Although trauma from occlusion produces many areas of root resorption, these areas are usually of a magnitude insufficient to be detected radiographically. (Fig. 12)**

(Fig. 12).

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. These technologies have been integrated into patient management systems, enabling dental offices to maintain fully electronic patient records (Fig. 13).



(Fig. 13).

The digital records can be easily shared among dentists and other health care providers, enabling telediagnosis and facilitating transmission to third parties for reimbursement. Digital intraoral radiographic systems use either

1-solid-state detectors or

2-photostimulable phosphor (PSP) plates.

Systems with solid-state detectors use either *charge-coupled devices (CCDs)* or *complementary metal oxide semiconductor (CMOS)* chips as image receptors. These receptors are typically wired and connected to a computer using a Universal Serial Bus (USB)

connection. Wireless sensors are also available and require the use of disposable batteries. With CCD/CMOS-based receptors, images are recorded and displayed on a computer monitor virtually in real time. These sensors are bulkier than film, and the active image-recording area is slightly smaller than that of film.

A second technology for intraoral radiography is PSP plates. These receptors are the same size as intraoral radiographic film. Unlike CCD/CMOS receptors, PSP plates do not provide a real-time display of the radiographic image. On interaction with x-ray photons, PSP crystals in the plate store energy, creating a latent radiographic image. The stored energy is then released by stimulating the plate with an appropriate wavelength of light. Following radiographic exposure, the PSP plate is scanned by a laser beam, converting the latent radiographic image into a digital image. Following capture, digital radiographic images can be enhanced to augment radiographic diagnosis.

The brightness and contrast of the image can be altered to highlight specific anatomic regions, depending on the diagnostic task. The images can be magnified to allow closer examination of a specific area of interest. Importantly, a variety of image enhancement filters can be applied—for example, to sharpen images (enhance edges). Some software programs have preprogrammed algorithms that can be applied for specific diagnostic tasks—for example, to enhance interproximal caries, periodontal bone, pulp canals. However, it is important to recognize that such image manipulations can produce artifacts that may be misinterpreted as disease. Clinicians should be aware of such artifacts produced by digital image manipulation. In addition to the image manipulation features, digital radiographic images facilitate patient education, allow for easy storage and sharing with other health care providers, and can be easily integrated into electronic patient records.