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# Diagnostic Imaging As An Aid To Diagnose Periodontal Diseases (From Traditional To Advance)

A Project Submitted to

The College of Dentistry, University of Baghdad, Department of Oral Diagnosis Clinic in Partial Fulfillment for the Bachelor of Dental Surgery

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# Certification of the Supervisor

I certify that this project entitled " **Diagnostic Imaging As An Aid To Diagnose Periodontal Diseases From Traditional To Advanced** " was prepared by the fifth-year students Hussein Ahmed Mohammed under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirements for the Bachelor Degree in Dentistry.

Supervisor’s name

Date

# Certification of the Discussion Committee

We, the members of the discussion committee, certify that we have read and examined this graduation project and that in our opinion it of a graduation project. meets the standard.

**Signature** **Signature** **Signature**

Approved by the head of oral diagnosis department at the college of dentistry, University of Baghdad.

**Signature**

## List of abbreviation

| Symbol | Abbreviation |
|---|---|
| CT | Computed Tomography |
| CBCT | Cone Beam Computed Tomography |
| PA | Periapicl radiograph |
| PDL | Periodontal Ligament |
| HIV | Human immunodeficiency virus |
| DM | Diabetes mellitus |

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# Introduction

Periodontal diseases are the result of a complex interaction between bacterial plaque, the host's immune response, Microbial plaque and its byproducts are the main etiologic factors initiating the disease while the modifying factors that may impact the course of the disease is diabetes, smoking, obesity, and genetic predisposition may exacerbate the progression of periodontal disease **(white&Pharoah,2009).**

In general, we have gingivitis which is inflammation of gingiva and Periodontitis in particular represents a chronic inflammatory disease typically resulting in the apical migration of the junctional epithelium along with destruction of connective tissue attachment and alveolar bone **(Suárez.,2021).**

The diagnosis of periodontal disease is greatly facilitated by the use of radiographs. Radiographs are helpful in the assessment of treatment effects and the prognosis of disease progress because essential information is provided about the bony tissues covered by the gingiva that cannot be diagnosed by clinical inspection alone.Traditional radiographic image formation is based on the principle of projecting a three-dimensional object onto a two-dimensional image plane, and therefore this technique also has limitations. The radiographic image, lacks information about the third dimension, Consequently, a single radiograph is inappropriate for obtaining information about this third dimensional structures so More projections are needed for this purpose **(Stelt,1993).**

In the medical field, the 3D imaging using computed tomography (CT) has been available now for many years, but in the dental specialty, its application is restricted to the use in cases of maxillofacial trauma and diagnosis of head and neck diseases. Routine use of CT in dentistry is not accepted due to its cost, excessive radiation, and general practicality. In recent years, a new technology of cone-beam CT (CBCT) for acquiring 3D images of oral structures is now available to the dental clinics and hospitals. In its various dental applications, images of jaws and teeth can be visualized accurately with excellent resolution, can be restructured three dimensionally, and can be viewed from any angle. Most significantly, patient radiation dose is five times lower than normal CT. Today, CBCT scanning has become a valuable imaging modality in periodontology as well as implantology. For the detection of smallest osseous defects, CBCT can display the image in all its three dimensions by removing the disturbing anatomical structures and making it possible to evaluate each root and surrounding bone. In implant treatment, appropriate site or size can be chosen before placement, and osseous integration can be studied over a period of time **(Mohan et al., 2011)**

## Aims of the study

This review study is designed to provide foundation of knowledge on the most important diagnostic imaging modalities used for the assessment of periodontal disease & present an overall review about the imaging features of them & effect of systemic disease on periodontium.

# Chapter 1

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## Review of Literature

# Chapter one: Review of Literature

## 1.1. Periodontal diseases (definition & classification)

Periodontal diseases they are a set of conditions characterized by an inflammatory host response in the periodontal tissues that may lead to localized or generalized alterations in the soft tissues around the teeth, loss of supporting bone, and ultimately, loss of the teeth **(white &Pharoah, 2009).**

Periodontal diseases are classified as gingivitis and periodontitis. Gingival diseases may be dental plaque-induced or non – plaque-induced. Bacterial plaque-associated gingivitis is much more common than non – plaque-induced inflammatory diseases affecting the gingiva such as viral or fungal infections. Gingivitis presents as inflammation of the soft tissue surrounding the teeth with gingival swelling, edema, and erythema Periodontitis is classified, primarily by the clinical presentation, as chronic, aggressive, and periodontitis as a manifestation of a systemic disease. Other subtypes of periodontal conditions include necrotizing periodontal diseases, periodontal abscesses, and periodontitis associated with endodontic lesions. Periodontitis is distinguished from gingivitis by the clinically detectable destruction of host tissues seen as the loss of soft tissue attachment and supporting bone of the involved teeth (**Herrera et al.,2000).**

## 1.2. Anatomy of periodontium

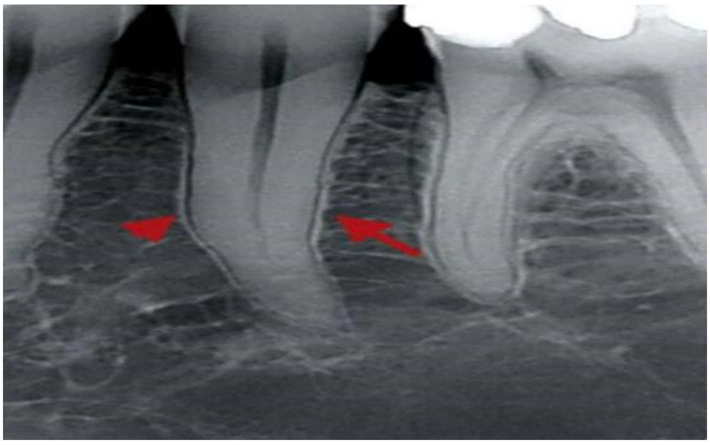
The periodontium comprises the supporting structures of the dentition. It is composed of four main elements: gingiva, cementum, periodontal ligament (PDL), and bone. Understanding this dynamic network of tissues is pivotal for the proper performance of the many procedures related to periodontal therapy **(Suárez,2021).**

### 1.2.1. Cementum

Cementum is the second mineralized tissue of the attachment apparatus. It is an avascular mineralized connective tissue that surrounds the dentin at the level of the dental root. Its primary function is to allow for the anchorage of Sharpey's fibers that will keep the tooth in the alveolus as well as to adapt and protect during tooth wear and movement It is having same radiopacity as that of dentine. It contains 50% of mineral content. Because of the thin layer of cementum and decreased contrast between cementum and dentine radiographically, it is not apparent **(Suárez, 2021).**

### 1.2.2. Lamina Dura

Lamina dura is a dense cortical bone of tooth socket that surrounds the teeth. It is thin white or radiopaque shadow which is continuous with the shadow of cortical bone at the alveolar crest. It represents a thin layer of dense bone, the so-called cribriform plate or alveolar bone proper. The presence of intact lamina dura indicates vital pulp. The radiographic appearance of lamina dura is caused by X-ray beam passing tangentially through the thickness of thin bony wall which results in observed attenuation. It appears (Fig.1-1) as radiopaque and well defined if X-ray beam passes directly through relatively larger area and if X-ray beam passes obliquely, it appears diffuse **(Ghom & Ghom, 2016).**



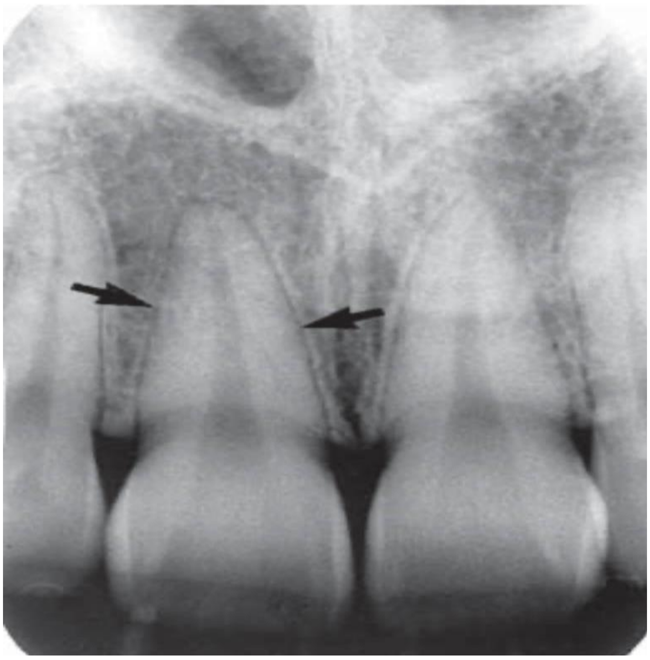
**(Fig. 1-1)** Lamina dura (red arrow) seen as dense radiopaque line surrounding the teeth **(Ghom & Ghom, 2016).**

The thickness and density of the lamina dura on the radiograph varies with the amount of occlusal stress to which the tooth is subjected. The lamina dura is wider and denser around the teeth that are under heavy occlusion, and thinner and less dense or even indiscernible around the teeth that are not subjected to occlusal function. Double lamina dura: The image of double lamina dura appears, when mesial and distal surface of root lie behind one another (Fig. 1-2). Due to this, rays will face two elevations in the path of X-ray beam. **(Ghom & Ghom, 2016).**

**(Fig. 1-2)** Double lamina dura appearance (red arrow) can be seen on the radiograph due to presence of two convexities of the root surface. **(Ghom & Ghom, 2016).**

## 1.2.3. Periodontal ligament space

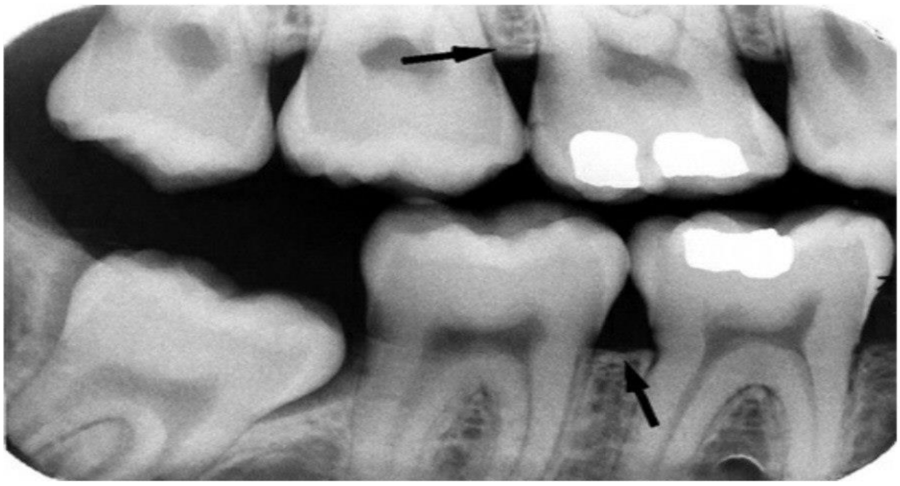
Periodontal ligament (PDL) is composed primarily of collagen, it appears as a radiolucent space between the tooth root and the lamina dura. This space begins at the alveolar crest, extends around the portions of the tooth roots within the alveolus, and returns to the alveolar crest on the opposite side of the tooth (Fig. 1-3). The PDL varies in width from patient to patient, from tooth to tooth in the individual, and even from location to location around one tooth. Usually, it is thinner in the middle of the root and slightly wider near the alveolar crest and root apex, suggesting that the fulcrum of physiologic movement is in the region where the PDL is thinnest. The thickness of the ligament relates to the degree of function because the PDL is thinnest around the roots of embedded teeth and those that have lost their antagonists. The reverse is not necessarily true, however, because an appreciably wider space is not regularly observed in persons with especially heavy occlusion or bruxism **(white &Pharoah,2009).**



**(Fig. 1-3)** The periodontal ligament space (arrows) is seen as a narrow radiolucency between the tooth root and lamina dura **(white &Pharoah,2009).**

### 1.2.4. Alveolar Crest

The gingival margin of the alveolar process that extends between the teeth is apparent on radiographs as a radiopaque line—the alveolar crest (Fig. 1-4). The level of this bony crest is considered normal when it is 0.5 to 2 mm apical to the cementoenamel junction of the adjacent teeth. The alveolar crest may recede apically with age and show marked resorption with periodontal disease. Radiographs can demonstrate only the position of the crest; determining the significance of its level is primarily a clinical decision **(Berkovitzet et al.,2009).**



**(Fig.1-4)** The alveolar crests (arrows) are seen as cortical borders of the alveolar bone. The alveolar crest is continuous with the lamina dura (**Moxham et al.,2009).**

## 1.3. Assessment of Periodontal Disease (Contributions of Diagnostic Imaging)

In the diagnosis of the periodontal diseases, the clinical and radiologic examinations are complementary. In the assessment of the periodontal status of a patient, the clinical examination is completed first in order to determine what further testing, including acquisition of diagnostic images, is required, radiologic images are an adjunct to this examination, and the prescription of imaging is indicated when the clinical examination suggests periodontitis **(Canton et al.,2018).**

## 1.3.1 Radiographic Assessment of Periodontal Conditions as mentioned by (Canton et al.,2018)

Radiographs are especially helpful in the evaluation of the following features:

- Amount of bone present
- Condition of the alveolar crests
- Bone loss in the furcation areas
- Width of the periodontal ligament space
- Local irritating factors that increase the risk of periodontal disease
- Calculus
- Poorly contoured or overextended restorations
- Root length and morphology and crown-to-root ratio
- Open interproximal contacts, which may be sites for food impaction
- Anatomic considerations
- Position of the maxillary sinus in relation to a periodontal deformity
- Missing, supernumerary, impacted, and tipped teeth
- Pathologic considerations
- Caries
- Periapical lesions
- Root resorption

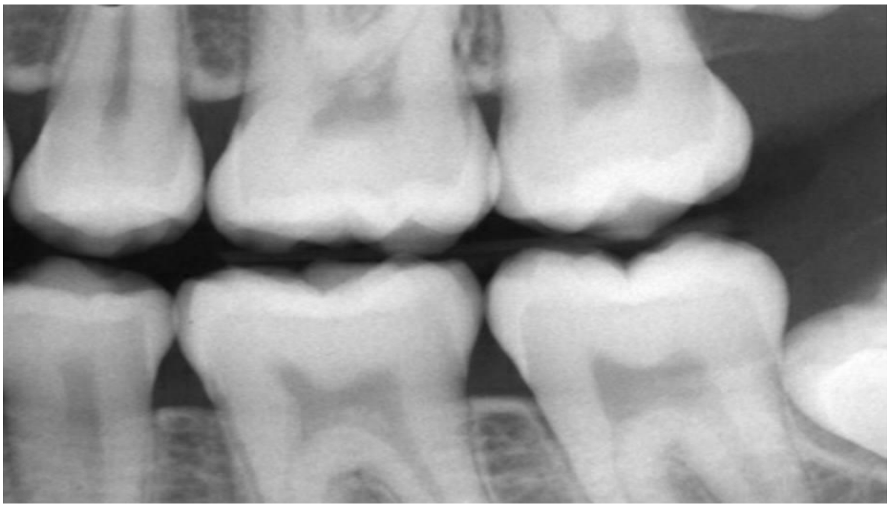
## 1.4. Imaging Modalities for the Assessment of Periodontal Disease

### 1.4.1. Traditional Modalities

#### 1.4.1.1. Intraoral images

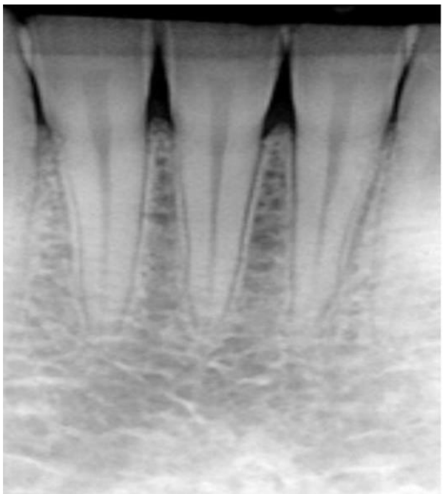
Provide the highest spatial resolution of any imaging modality, which allows the dentist to detect fine details of the periodontium and many of the radiologic signs of periodontal disease are subtle, including early loss of bone, and changes to the PDL space and lamina dura. Intraoral imaging modalities used for the assessment of periodontal disease include bitewing (interproximal) and periapical images **(scarfe et al.,2017)**.

Bitewing images should be considered the primary imaging choice for characterizing the periodontal diseases. These images most accurately depict the distance between the cementoenamel junction (CEJ) and the crest of the interradicular alveolar process because the incident x-ray beam is oriented at almost right angles to the long axes of the teeth (Fig. 1-5) **(Canton et al.,2018).**



**(Fig. 1-5)** The normal alveolar crest lies 0.5 to 2.0 mm apical to the adjacent cementoenamel junctions and forms a sharp angle with the lamina dura of the adjacent tooth. The crests may not always appear with a well-defined outer cortex **(Canton et al.,2018).**

Periapical images have the benefit of demonstrating the full length of the tooth and the surrounding bone, which allows for the evaluation of the percentage of root affected by bone loss. However, periapical images may provide a distorted view of the relationship between the teeth and the location of the alveolar crest because of greater variations in the obliquity of the primary x-ray beam (Fig.1-6) **(Canton et al.,2018).**



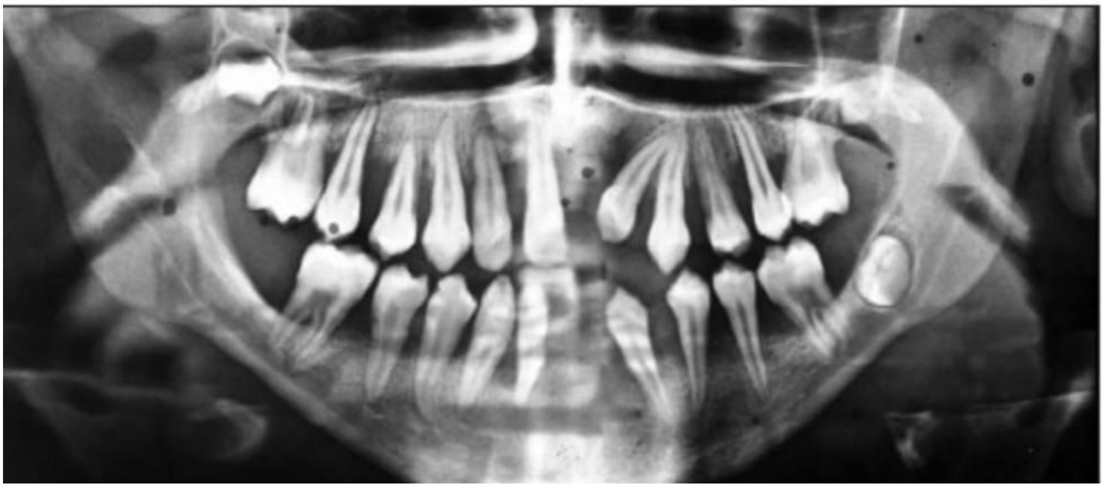
**(Fig.1-6)** Between the anterior teeth, the normal alveolar crest is pointed and well corticated, and is located within 0.5 to 2.0 mm of the adjacent cementoenamel junctions**. (Canton et al.,2018).**

### 1.4.1.2. Extra 0ral image

**Panoramic images** are relatively providing an overview of the teeth and jaws in a single image. High-quality panoramic images can demonstrate changes to the periodontal structures, and some studies have shown that they can provide comparable diagnostic information to intraoral images. Some authors suggest that a panoramic image supplemented with selected intraoral images may be adequate for periodontal assessment (Fig.1-7) **(khan et al.,2012).**

This extra oral imaging procedure creates images with superimpositions and distortions that do not arise in intraoral images, and their lower resolution relative to intraoral images makes detailed investigations difficult, particularly in the anterior areas of the jaws.

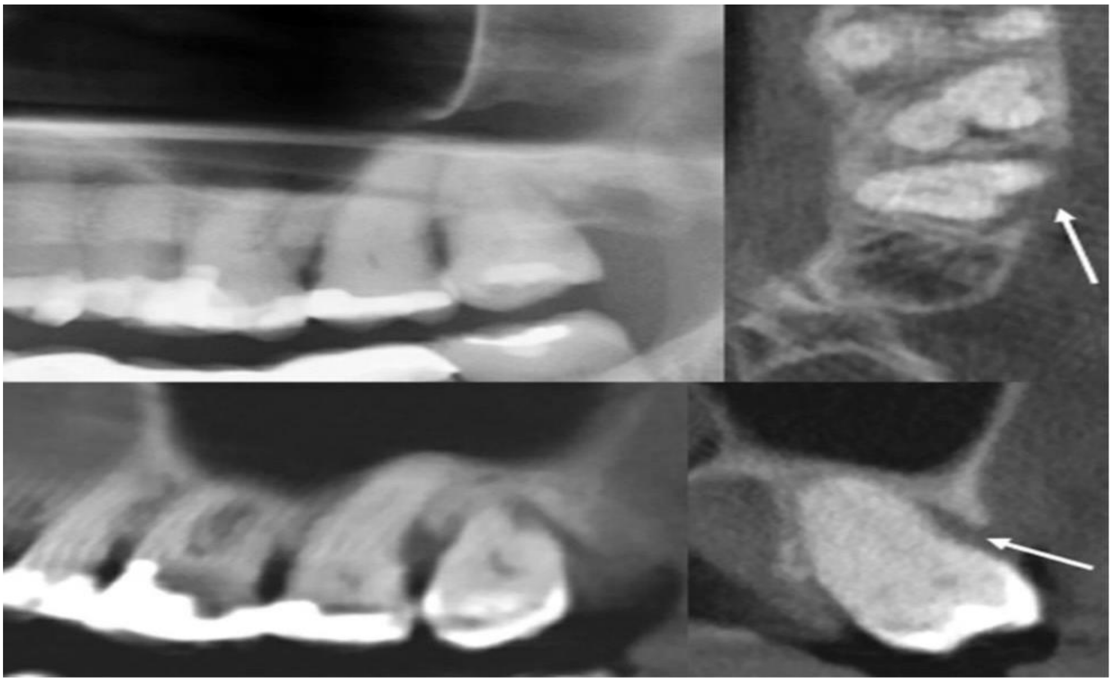
However, unless a panoramic system is already available or prescribed for another diagnostic query, the use of panoramic imaging as a primary imaging tool for characterizing periodontal disease is discouraged. The selection of imaging modalities must always be based on optimizing patient benefit for diagnosis, while minimizing risk. And, certainly, carefully selected intraoral images best achieve these goals **(scarfe et al.,2017).**



**(Fig.1-7**) OPG showing severe generalized destruction of alveolar bone. The mandibular right first molar was almost entirely out of its socket with not much bone support **(khan et al.,2012)**

## 1.4.2. Advance image

**Cone Beam Computed Tomography (CBCT)** has, as one powerful advantage, the ability to visualize the osseous supporting structures of the teeth from any angle, without anatomical superimpositions. This feature overcomes many of the limitations associated with intraoral and panoramic imaging techniques CBCT imaging allows better visualization of some periodontal defects that are not well depicted on conventional two-dimensional images. For example, CBCT imaging may permit a more complete assessment of the architecture of complex vertical defects and craters, furcations, and buccal and lingual cortical plate loss (Fig. 1-8). In addition, anatomic features, such as root morphology or cortical fenestration, and coexistent periapical pathosis, which may be pertinent to diagnosis, treatment planning, and prognosis, may also be better visualized **(Walter et al.,2010).**



**(Fig1-8)** Cropped panoramic image (top left) demonstrates moderate bone loss between the second and third molars. Axial (top right), coronal (bottom right), and parasagittal (bottom left) cone beam computed tomography images demonstrate the bone defects in this region more clearly. Periodontal bone loss around the buccal surface of the third molar is well visualized (arrows), which could not be appreciated on the panoramic image **(Walter et al.,2010).**

## 1.5. Imaging features of periodontal diseases

Because gingivitis is an inflammatory condition confined to the gingiva, there are no changes to the underlying bone. Therefore the appearance of the bone in a diagnostic image is normal. For all types of periodontal disease, the changes seen in diagnostic images reflect changes seen with any inflammatory condition of bone. These changes can be divided into changes in the morphology of bone, and changes to the trabecular density and pattern of supporting bone **(Jeffcoat et al.,1995).**

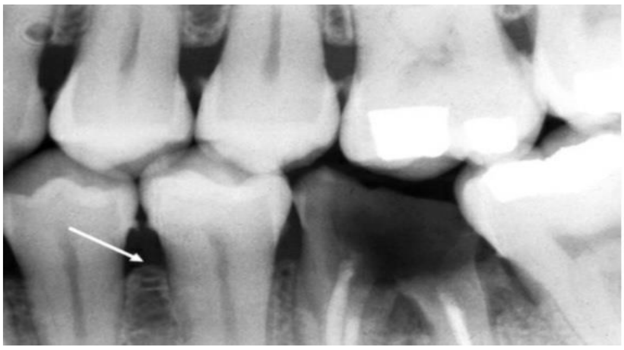
Alterations to the trabecular pattern of the alveolar processes reflect either a reduction or an increase in bone structure, or a combination of both. A reduction is seen as an increase in radiolucency because of decrease in either the number or density of existing trabeculae, or both.

An increase in bone is seen as an increase in radiopacity (sclerosis) as the result of an increase in the thickness and/or density of trabecula, and/or their number. As with all inflammatory lesions of bone, periodontal disease usually involves a combination of both bone loss and bone formation. However, acute early lesions predominantly display bone loss, whereas chronic lesions have a greater component of bone sclerosis. The following patterns of bone loss may be seen in the diagnostic image as the result of periodontitis **(Jeffcoat et al.,1995).**

### 1.5.1. Changes in Morphology of Alveolar Processes

Changes in morphology become apparent by observing a loss of the interproximal crestal bone, and the bone overlapping the buccal or lingual surfaces of the tooth roots**.**

The early bone changes that occur in periodontitis appear as areas of localized erosion of the interproximal alveolar crest (Fig.1-9). In the anterior regions of the jaws, there is blunting of the alveolar crests and slight loss of alveolar crestal bone height. In the posterior regions of the jaws, there may be loss of the normally acute angle between the lamina dura and alveolar crest. In early stages of periodontal disease, this angle may lose its normal cortical surface (margin) and appear “rounded off,” with an irregular and diffuse border **(Rams et al.,1994).**

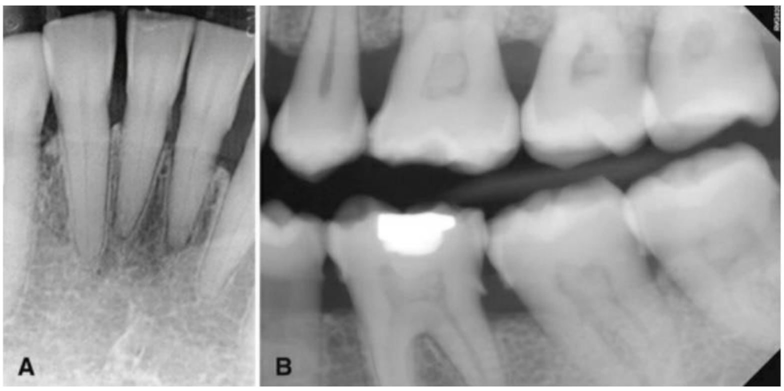


**(Fig.1-9)** Initial periodontal disease is seen as a loss of cortical density and a rounding of the junction between the alveolar crest and the lamina dura (arrow). **(Rams et al.,1994)**

Defects in the morphology of the alveolar process and crest may be described as being horizontal or vertical (angular) in nature, as interdental craters and furcation defects, and as a loss of the buccal or lingual cortical plate loss. The presence and severity of these bone defects may, of course, vary regionally within a patient, and certainly among different patients.

**1.5.1.1. Horizontal Bone Loss**

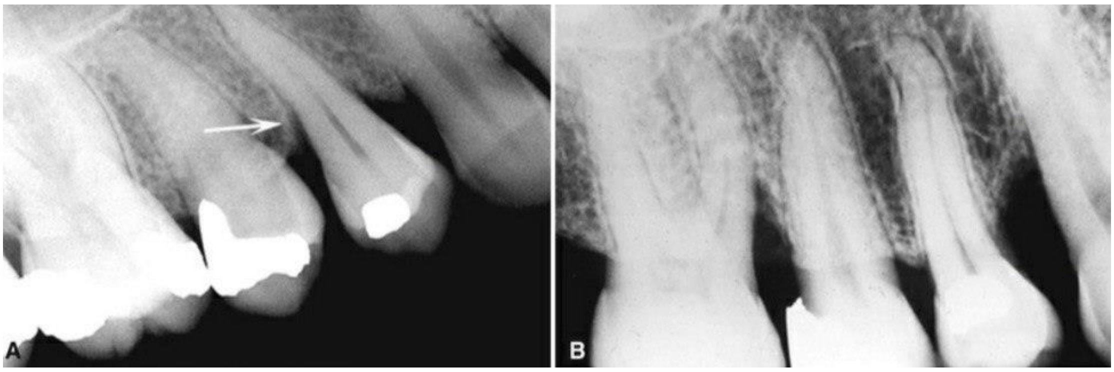
Horizontal bone loss describes the appearance of a loss in height of the alveolar process where the crest is still horizontal (i.e., parallel to an imaginary line joining the CEJs of adjacent teeth). The normal crest of the alveolar process can be up to as much as 2 mm apical to the CEJ, and therefore assessment of the quantity of bone loss must be considered from this point and not from the CEJ itself. In horizontal bone loss, the crest of the buccal and lingual cortical plates and the intervening interdental bone have been resorbed (Fig.1-10). Early stage (I) bone loss may be defined as loss of up to 15% of the tooth root length, or a probing depth of 4 mm or less. Stage II periodontitis is defined as bone loss between 15% and 33% of the root length, and probing depths of up to 5 mm. More severe Stages III and IV periodontal disease are defined as bone loss extending to the middle-third of the tooth root and beyond, with probing depths of 6 mm or more **(Khocht et al.,1996).**




**(Fig.1-10)** Horizontal bone loss is seen in the anterior region (A) and the posterior region (B) as a loss of the buccal and lingual cortical plates and interdental alveolar bone. **( Khocht et al.,1996)**

### 1.5.1.2. Vertical Bone Defects

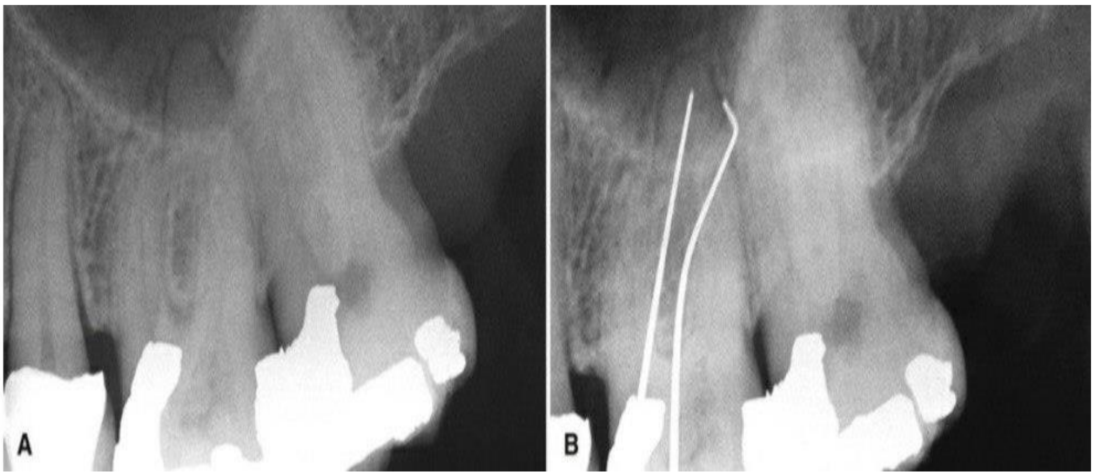
A vertical or angular, infra bony defect describes the appearance of bone loss that is localized at one or both root surfaces of a single tooth, although an individual may have multiple vertical osseous defects. These defects are associated with Stages III and IV periodontitis, and develop when bone loss progresses down the root of the tooth, resulting in a deepening of the periodontal pocket. This manifests as a V- or triangular-shaped defect within the bone that extends apically along the root of the affected tooth from the alveolar crest. Radiologically, the outline of the remaining alveolar process typically displays an angulation that is oblique to an imaginary line connecting the CEJ of the affected tooth to the adjacent tooth. In its early form, a vertical defect appears as abnormal widening of the PDL space at the alveolar crest **(Fig.1-11) (Papapanou,2018)**




**(Fig.1-11) (A)** A developing vertical defect. Note the abnormal widening of the periodontal ligament space close to the crest (arrow). **(B)** Maxillary periapical image reveals two examples of more severe vertical defects affecting the mesial surface of the first molar and the distal surface of the canine **(Papapanou,2018).**

The vertical defect is described as three-walled (surrounded by three bony walls) when both the buccal and lingual cortical plates remain intact. It is described as two-walled when one of these plates has been resorbed, and as one-walled when both plates have been lost (Fig.1-11). Depending on the amount of bone loss, vertical bitewing images may be required to show the entire extent of the loss (Fig.1-12). The distinctions among these groups are important in designing the treatment plan. The number of walls associated with a vertical defect is difficult or impossible to recognize on intraoral images, because one or both of the cortical bony plates may remain superimposed over the defect. Visualization of the depth of pockets may be aided by inserting a gutta-percha point before making the intraoral image. The point appears to follow the defect, because gutta-percha is relatively inflexible and radiopaque (Fig.1-13) **(Khocht et al.,1996).**

**(Fig.1-12)** Typical Vertical Bone Loss in Stage IV Periodontitis. Note the bone loss is confined to the region of the first molars **(Khocht et al.,1996).**

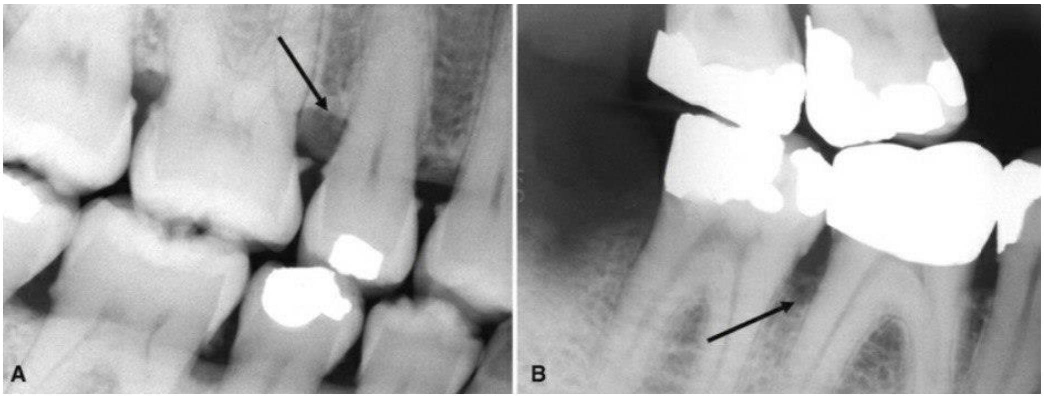



**(Fig.1-13)** Gutta-Percha may be used to visualize the depth of infrabony defects. **(A)** The image fails to show the osseous defect without the use of the gutta-percha points. **(B)** The image reveals an osseous defect extending to the region of the apex. **(Khocht et al.,1996).**

**(Fig.1-14)** Cone beam computed tomography images demonstrating details of the architecture of two three-walled vertical defects (white arrows). Axial (upper left) and parasagittal (upper right) reconstructions show a deep vertical defect on the distal surface of the mandibular left second molar. Calculus is seen on the root surface. Coronal (lower left) and axial (lower right) images of another case show a three-walled defect on the palatal aspect of the mesiobuccal root of a maxillary molar. Early furcation involvement is also detected on this tooth (black arrow) **(Papapanou,2018).**

### 1.5.1.3. Interdental Craters

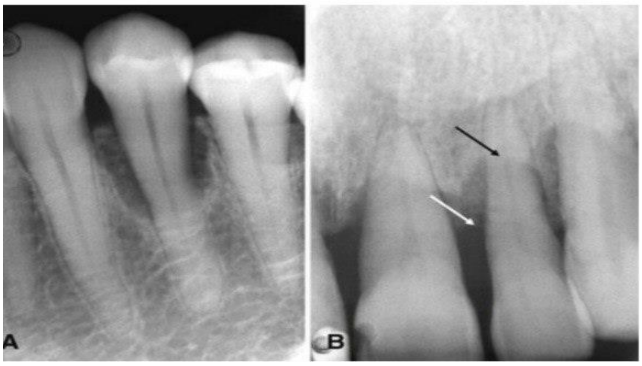
The interproximal crater is a two-walled, trough-like depression that develops in the crest of the alveolar process between adjacent teeth. The buccal and lingual outer cortical walls of the interproximal bone extend further coronally than the cancellous bone between them, which has been resorbed. In an image, this appears as a band-like or irregular region of bone with less density at the crest, immediately adjacent to the denser normal bone apical to the base of the crater (Fig.1-15). These defects are more common in the posterior segments of the jaws as a result of the broader buccal-lingual dimension of the alveolar crest in these regions **(page et al.,1997).**



**(Fig.1-15)** Interproximal craters, existing between the buccal and lingual as defects cortical plates, seen as a radiolucent band (A) or trough (B) apical to the level of the crestal edges. The arrows indicate the base of the craters. **(page et al.,1997)**

### 1.5.1.4. Buccal or Lingual Cortical Plate Loss

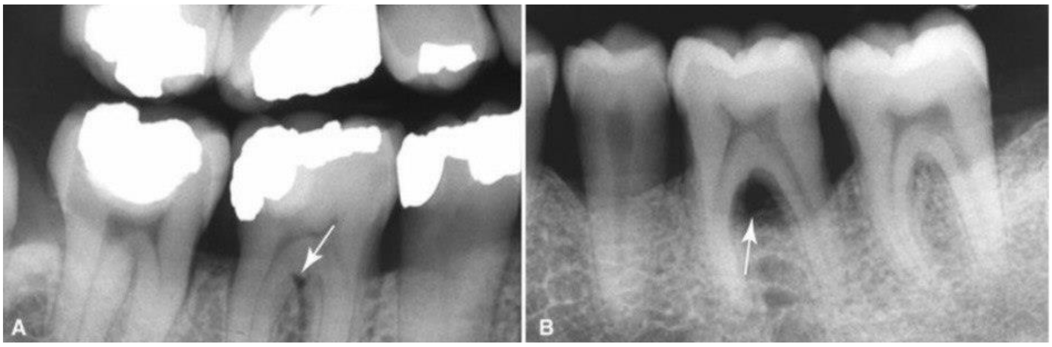
Buccal or Lingual Cortical Plate Loss The buccal or lingual cortical plate adjacent to the teeth may resorb. Loss of a cortical plate may occur alone or with another type of bone loss, such as horizontal bone loss. This type of bone loss is seen as an increase in the radiolucency of the tooth root near the alveolar crest. The shape seen is usually semicircular, with the depth of the radiolucency directed apically in relation to the tooth (Fig.1-16). Lack of bone loss at the interproximal region of the tooth may make this kind of defect difficult to detect on conventional images **(page et al.,1997).**



**(Fig.1-16) (A)** Loss of the lingual alveolar crest adjacent to this mandibular first premolar without associated interproximal bone loss. **(B)** Loss of the buccal cortical bone adjacent to the maxillary central and lateral incisors. The black arrow indicates the level of the buccal alveolar crest, which demonstrates more profound loss relative to the lingual alveolar crest (white arrow) **(page et al.,1997).**

### 1.5.1.5. Osseous Deformities in the Furcations of Multirooted Teeth

Progressive periodontal disease and the associated bone loss may extend into the furcations of multirooted teeth. As bone loss extends apically along the surface of a multirooted tooth, the bone covering the root can reach the level of the furcation or beyond. Widening of the PDL space at the apex of the interradicular bony crest of the furcation is strong evidence that the periodontal disease process involves the furcation (Fig.1-17A). The furcation defect may also involve only the buccal or lingual cortical plate, and extend into and apical to the roof of the furcation (Fig.1-17B). Use of the buccal object rule with images made at different angulations may enable the dentist to determine whether the buccal or the lingual cortical plate has been lost. If the bone crest is located apical to the furcation but the disease process has not extended into the interradicular bone, the width of the periodontal ligament space appears normal. In addition, the septal bone may appear more radiolucent but otherwise be normal **(Schwartz et al.,1997).**




**(Fig.1-17) (A)** Periapical image revealing very early furcation involvement of a mandibular molar characterized by slight widening of the periodontal ligament (PDL) space in the furcation region (arrow). (B) Periapical image revealing a profound radiolucent lesion within the furcation region (arrow) resulting from loss of bone in the furcation region and the buccal and lingual cortical plates **(Schwartz et al.,1997).**

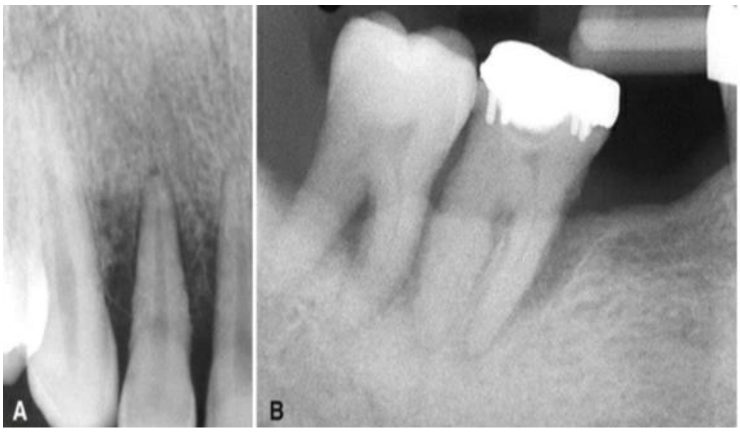
In the mandible, the external oblique ridge may mask furcation involvement of the third molars (Fig.1-17C). Convergent roots may also obscure furcation defects in maxillary and mandibular second and third molars. The loss of interradicular bone in the furcation of a maxillary molar may originate from the buccal, mesial, or distal surfaces of the tooth. The most common route for furcation involvement of the maxillary permanent first molar is from the mesial surface of the tooth The image of furcation involvement is not as sharply defined around maxillary molars as it is around mandibular molars, because the palatal root is superimposed over the defect (Fig.1-17D). However, this pattern of bone destruction is occasionally prominent and appears as an inverted "J-shape" radiolucency, with the hook of the "J" extending into the trifurcation (Fig.1-17E) or as a radiolucent triangle superimposed over the roots of the involved tooth with its apex pointing toward the furcation (Fig.1-12) **(Schwartz et al.,1997)**


**(Fig.1-17C)** Large furcation defect associated with the mandibular right third molar, which is less easily visualized due to superimposition by the external oblique ridge. There is also a combined periodontic-endodontic lesion of the first molar (arrow). (D) Angulation of this periapical view of a maxillary first molar projected the palatal root away from the trifurcation region revealing early widening of the furcation PDL space (arrow). (E) Example of an inverted "J-shape" radiolucent lesion (arrow) resulting from bone destruction extending into the trifurcation region of a three-rooted maxillary first bicuspid **(Schwartz et al.,1997).**

A definitive diagnosis of complex furcation deformities requires careful clinical examination and sometimes surgical exploration. Intraoral images are an important tool in identifying potentially involved sites as well as providing information about root morphology and length, which is of significance to treatment planning and prognosis. CBCT imaging can also be used to confirm involvement of a tooth and allow more detailed characterization of osseous furcation defects in cases where this information is necessary for treatment planning purposes **(Trombelli et al., 2018).**

### 1.5.2. Changes to the Internal Density and Trabecular Pattern of Bone

As with all other inflammatory lesions, the periodontal diseases may stimulate a reaction in the adjacent surrounding bone. The peripheral bone may appear more radiolucent or radiopaque, or more commonly, display a mixture of these patterns. A radiolucent change reflects a loss of density and number of trabeculae. The trabeculae appear very faint, which is more commonly seen in early or acute lesions (Fig.1-18A). If the trabeculae are sufficiently decalcified, they may not clearly appear in the image, The radiopaque or sclerotic bone reaction appears because of the deposition of bone on existing trabeculae at the expense of the marrow, resulting in thicker trabeculae that may eventually be so dense so as to appear as an amorphous radiopaque mass (see Fig.1-18B) **(Gutteridge., 1995).**




**(Fig.1-18)** **(A)** Example of a primarily radiolucent reaction around this maxillary lateral incisor. The trabeculae toward the alveolar crest on the mesial and distal aspect of the tooth are barely perceptible, and the marrow spaces are enlarged. **(B)** Periapical image revealing a predominantly sclerotic bone reaction resulting from the periodontal disease involving the mandibular molars. The trabeculae are thickened, and the marrow spaces are barely perceptible **(Gutteridge.,1995).**

## 1.6. Other Conditions Affecting the Periodontium

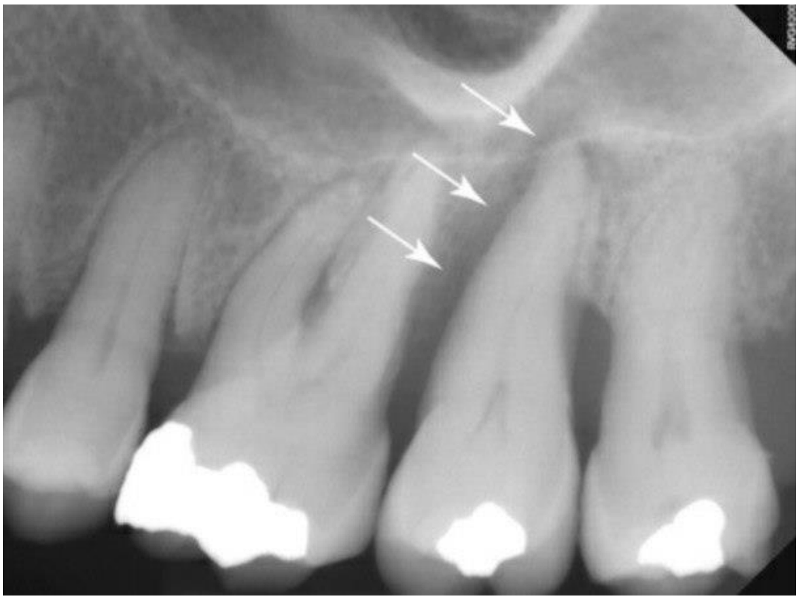
### 1.6.1. Periodontal Abscess

A periodontal abscess is a rapidly progressing, destructive lesion that usually originates in a deep soft tissue periodontal pocket. It occurs when the coronal portion of the pocket becomes occluded or when foreign material becomes lodged between a tooth and the gingiva. Clinically, pain and swelling, and sometimes a draining fistula, are present in the region. If the lesion is acute, there may be no visible changes in the image. If the lesion persists, a radiolucent region appears, often superimposed over the root of a tooth. The radiolucency may be a focal, round area of rarefaction, with loss of the lamina dura on the involved root surface, and a bridge of bone may be present over the coronal aspect of the lesion, separating it from the crest of the alveolar ridge (Fig.1-19). After treatment, some of the lost bone may regenerate **(Nelson et al.,1990).**

**(Fig.1-19)** Example of a periodontal abscess related to the maxillary canine; note the well-defined area of bone loss over the midroot region of the tooth and extending in a mesial direction toward the lateral incisor. There appears to be a layer of bone (arrow) separating the area of bone destruction from the crest of the alveolar process **(Nelson et al.,1990).**

### 1.6.2. Endodontic periodontal lesions

A periodontal lesion may extend to the apex of a tooth root causing secondary pulpitis, or periapical inflammatory disease may extend coronally to the crestal bone, causing a retrograde periodontitis. A combined periodontic-endodontic lesion appears as a deep angular bone defect on imaging, extending to the apex of a tooth and communicating with a concomitant focus of periapical rarefying osteitis (Fig.1-20). The bone defect usually has a relatively uniform width or widens slightly at the alveolar crest, creating a funnel-like shape (Fig.1-16A). Periodontic-endodontic lesions may affect one or multiple surfaces of the tooth, or they may be circumferential around the entire root. Treatment of these defects is complicated and involves both endodontic and periodontal therapy **(Nelson et al.,1990).**



**(Fig.1-20)** Combined Endodontic-Periodontic Lesion. There is an angular bone defect extending the whole length of the mesial surface of the second molar, from the crest to the apex (arrows) **(Nelson et al.,1990).**

### 1.6.3. Aggressive periodontitis

This rapidly progressing disease usually affects individuals younger than 30 years Aggressive periodontitis is now subclassified into localized aggressive periodontitis and generalized aggressive periodontitis. e radiographic appearance of the bone loss in localized aggressive periodontitis typically consists of deep vertical defects. Maxillary teeth are involved slightly more often than mandibular teeth, and strong left-right symmetry is common. The generalized form of aggressive periodontitis can involve several teeth or all the dentition and the rapid bone loss may be of the vertical or horizontal pattern. Early identification and treatment of aggressive periodontitis is important because of the rapid progression of this condition and the associated tooth loss. Treatment often consists of scaling, curettage, and administration of antibiotics and may also include surgical and regenerative therapies (**Fine et al.,2018).**

## 1.7. Periodontitis as a Manifestation of Systemic Disease

### 1.7.1. Diabetes mellitus

DM is a common disease and known risk factor for periodontitis, and glycemic control in diabetes is impaired by periodontal inflammation. There is thus is a two-way systemic relationship between these diseases. Uncontrolled diabetes may result in protein breakdown, degenerative vascular changes, lowered resistance to infection, and increased severity of infections. Consequently, patients with uncontrolled diabetes are more disposed to the development of periodontal disease than individuals with normal glucose metabolism. Patients with uncontrolled diabetes and periodontal disease also show more severe and rapid resorption of the alveolar processes, and are more prone to the development of periodontal abscesses. In patients whose diabetes is under control, periodontal disease responds normally to traditional treatment **(Emrich et al.,1991).**

### 1.7.2. Human immunodeficiency infection

HIV infection and acquired immunodeficiency syndrome (AIDS) is another modifier of periodontal disease. The incidence and severity of periodontal disease is high in patients with HIV/AIDS. In these individuals, the disease process is characterized by a rapid progression that leads to bone sequestration and loss of several teeth. These patients may not respond to standard periodontal therapy **(Knight et al.,2016).**

## 1.8. Other Modifiers of Periodontal Disease.

### 1.8.1. Head and neck radiation

High-dose irradiation to the oral tissues as a treatment for malignant conditions in the head and neck may have a detrimental effect on the periodontium. Radiation therapy to the jaws results in bone that is hypovascular, hypocellular, and hypoxic. This bone may be less able to remodel and be more susceptible to infections, resulting in rapid bone loss that is indistinguishable from the characteristics of periodontal disease seen on imaging. Teeth that have been exposed to high-dose radiation fields have been shown to demonstrate greater recession, attachment loss, and mobility than teeth in the same mouth that were not within the field **(Epstein et al.,1998).**

## 1.9. Limitation of radiographs

1.Radiographs provide a two-dimensional view of a three-dimensional situation. Because the radiographic image fails to reveal the three-dimensional structure, bony defects overlapped by higher bony walls may be hidden. Also, because of overlapping tooth structure, only the interproximal bone is seen clearly. However, subtle changes in the density of the root structure (which is more radiolucent) may indicate bone loss on the buccal or lingual aspect of the tooth. Furthermore, use of multiple images made at different angulations, as in a full-mouth set, allows the viewer to use the buccal object rule to obtain three-dimensional information such as whether cortical plate loss has occurred on the buccal or lingual aspects **( Pepelassi et al.,1997).**

2.Radiographs typically show less severe bone destruction than is actually present.

3. Radiographs do not demonstrate the soft-tissue-to-hard-tissue relationships and thus provide no information about the depth of soft tissue pockets **(Pepelassi et al.,1997).**

4. Bone level is often measured from the cementoenamel junction; however, this reference point is not valid in situations where there is overeruption or where there is severe attrition with passive eruption.

This extra oral imaging procedure creates images with superimpositions and distortions that do not arise in intraoral images, and their lower resolution relative to intraoral images makes detailed investigations difficult, particularly in the anterior areas of the jaws.

The vertical defect is described as three-walled (surrounded by three bony walls) when both the buccal and lingual cortical plates remain intact. It is described as two-walled when one of these plates has been resorbed, and as one-walled when both plates have been lost (Fig.1-11). Depending on the amount of bone loss, vertical bitewing images may be required to show the entire extent of the loss (Fig.1-12). The distinctions among these groups are important in designing the treatment plan. The number of walls associated with a vertical defect is difficult or impossible to recognize on intraoral images, because one or both of the cortical bony plates may remain superimposed over the defect. Visualization of the depth of pockets may be aided by inserting a gutta-percha point before making the intraoral image. The point appears to follow the defect, because gutta-percha is relatively inflexible and radiopaque

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Early stage (I) bone loss may be defined as loss of up to 15% of the tooth root length, or a probing depth of 4 mm or less. Stage II periodontitis is defined as bone loss between 15% and 33% of the root length, and probing depths of up to 5 mm. More severe Stages III and IV periodontal disease are defined as bone loss extending to the middle-third of the tooth root and beyond, with probing depths of 6 mm or more

Because gingivitis is an inflammatory condition confined to the gingiva, there are no changes to the underlying bone. Therefore the appearance of the bone in a diagnostic image is normal. For all types of periodontal disease, the changes seen in diagnostic images reflect changes seen with any inflammatory condition of bone. These changes can be divided into changes in the morphology of bone, and changes to the trabecular density and pattern of supporting bone is relatively inflexible and radiopaque

# Chapter 2

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## Previous studies

# Chapter two: Previous studies

## 2.1. Accuracy of Panoramic Radiograph for Diagnosing Periodontitis Comparing to Clinical Examination

**Machado et al. (2020)** concluded the diagnostic accuracy of a Radiographic-based Periodontal Bone Loss (R-PBL) method as a screening tool for periodontitis, in the form of radiographic bone loss, under the 2018 case definition in comparison to the 2012 case definition. The analysis was based on 456 patients (253 females and 203 males), screened for periodontal status in the Study of Periodontal Health in Almada-Seixal (SoPHiAS) project and subjected to a panoramic dental X-ray. Patients were diagnosed for the presence of periodontitis following the 2018 and 2012 case definition. R-PBL classification was defined by alveolar bone loss and diagnosed as no periodontitis (≥80% remaining alveolar bone), mild to moderate periodontitis (66% to 79%), or severe periodontitis (<66%).They appraise the X-ray quality to look for the influence on the performance of R-PBL. Sensitivity, specificity, accuracy, and precision, through several indicators, were determined. Performance measurement was assessed through binary and multiclass Receiver operating characteristic/are under the curve (ROC/AUC) analyses. Their results show that the tested R-PBL method under the 2018 case definition is a reliable tool in periodontitis cases screening. This method does not replace clinical periodontal evaluation, but rather, it screens patients towards a definitive periodontitis diagnosis. These results will contribute to support the development of automated prediction systems towards periodontitis surveillance.

## 2.2. Diagnostic Accuracy of CBCT for Aggressive Periodontitis

**Mohan et al in (2014)** studied the case of 27-year-old male patient reported to the department of periodontology with a 2-year history of his teeth slowly becoming loose. Clinical and radiological examinations were carried out. On clinical examination, generalized periodontal pockets with severe loss of attachment was observed. Grade III mobility of mandibular anterior teeth and left maxillary second premolar, Grade II mobility of right mandibular first molar, Grade II furcation involvement of maxillary and mandibular molars were recorded.

Phase I therapy performed consisted of scaling and root planning and the patient was evaluated after strict maintenance of oral hygiene for a month. Patient did not present any significant medical history that contraindicated surgery.

phase II Full mouth quadrant wise flap surgery (phase II) was planned. Mucoperiosteal flap on each quadrant was raised. Debridement of the periodontal osseous defects was performed in order to visualize the entire osseous defect at each tooth surface, which is considered as a Gold standard in study of these defects. Measurements of the osseous defects were carried out with UNC15 probe taking CEJ (cemento-enamel junction) as a reference point and measuring till the base of the defect. Flap was then sutured and periodontal dressing (Coe-Pak, USA) was applied to cover the surgical wound. The measurements obtained during surgical exposure of the defects were then compared with that obtained from digital and CBCT reconstructive images. CBCT images of periodontal osseous defects were identical to the measurements of osseous defects that were obtained during surgery. While digital radiography failed to reveal the extent of the osseous defects.

# Chapter 3

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## Conclusion

# Chapter 3

## 3.1. Conclusion

- Although the clinical examination is the most important step in the diagnosis of periodontal disease, special radiographic techniques are needed to show anatomy and pathology in periodontal apparatus and alveolar bone.
- The clinician should properly decide which patients would need special imaging techniques depending on the clinical examination, the amount of diagnostic information available from a particular imaging modality, the cost of the examination, and the radiation dose.
- Understanding as simple as possible the relation between the some systemic disease like diabetes mellitus and HIV with periodontal disease.

# References


- Anil Govindrao Ghom, Savita Anil Ghom(2016), Text book of oral radiology, second edition, INDIA. P;237-238.
- Berkovitz BKB, Holland GR, Moxham BL.(2009) Oral Anatomy, Histology and Embryology. 4th edition. Mosby: London.
- Canton JG, Armitage G, Berglundh T,(2018) A new classification scheme for periodontal and peri-implant diseases and conditions—Introduction and key changes from the 1999 classification. J Periodontol. 89(suppl 1):S1–S8.
- Emrich LJ, Shlossman M, Genco RJ.(1991) Periodontal disease in non-insulin-dependent diabetes mellitus. J Periodontol.;62:123–124.
- Epstein JB, Lunn R, Le N,(1998) Periodontal attachment loss in patients after head and neck radiation therapy. Oral Surgery Oral Medicine Oral Pathology Oral Radio Endod.;86:673–674.
- Fayiza Yaqoob Khan,Suhail Majd Jan,Mubashir Mushtaq,(2012)Papillon-Lefevre sundrome:case report&review of the literature. *Jornal of Indian society of periodontology,16(2),261.*
- Fine DH, Patil AG, Loos BG.(2018) Classification and diagnosis of aggressive periodontitis. Periodontol;89(suppl 1):S103–S119.
- Fernando Suárez, dds, ms. (2021) Periodontics: the complete summary. USA. Quintessence Publishing Co. Inc, pp. 93-95.
- Gutteridge DL.(1995) The use of radiographic techniques in the diagnosis and management of periodontal diseases. Dentomaxillofac Radiol.;24:107–113.
- Herrera C, González I, Sanz M.(2000) The periodontal abscess (I): clinical and microbiological findings. J Clin Periodontol;27:387–394.
- Jeffcoat MK, Wang IC, Reddy MS.(1995) Radiographic diagnosis in periodontics. Periodontol.;7:54–68.
- Khocht A, Zohn H, Deasy M,(1996) Screening for periodontal disease: radiographs vs PSR. J Am Dent Assoc.;127:749– 756.

- Knight ET, Liu J, Seymour GJ,(2016) Risk factors that may modify the innate and adaptive immune responses in periodontal diseases.;71:22–51.
- Mohan, R., Singh, A. and Gundappa, M.,( 2011). Three-dimensional imaging in periodontal diagnosis–Utilization of cone beam computed tomography. *Journal of Indian Society of Periodontology, 15(1), p.11.*
- Nelson RG, Schlossman M, Budding LM,(1990) Periodontal diseases and NIDDM in Pima Indians. Diabetes;13:836–840.
- Papapanou PN.,(1996). Periodontal diseases: epidemiology. Ann Periodontol.;1:1–36.
- Page RC, Offenbacher S, Schroeder HE,(1997) Advances in the pathogenesis of periodontitis: summary of developments, clinical implications and future directions.;14:216–248.
- Pepelassi EA, Diamanti-Kipioti A,(1997).Selection of the most accurate method of conventional radiography for the assessment of periodontal osseous destruction. J Clin Periodontol.;24:557–567.
- Rams TE, Listgarten MA, Slots J,(1994) Utility of radiographic crestal lamina dura for predicting periodontitis disease activity. J Clin Periodontol.;21:571–576.
- Ranjana Mohan, Ruhi Mark, Ipsa Sing and Ankita Jain (2014), Diagnostic accuracy of CBCT for aggressive Periodontitis. *Journal of Clinical Imaging Science*
- Schwartz Z, Goultschin J, Dean DD,(1997) Mechanisms of alveolar bone destruction in periodontitis.;14:158.
- Scarfe WC, Azevedo B, Pinheiro LR,(2017) The emerging role of maxillofacial radiology in the diagnosis and management of patients with complex periodontitis.;74:116–139.
- Stuart C. White, Michael J. Pharoah,(2009) oral radiology, principles and interpretation,USA&Canada,p;282-284.
- Trombelli L, Farina R, Silva CO, Tatakis DN.(2018) Plaque-induced gingivitis: Case definition and diagnostic considerations. J Periodontol;89(suppl 1):S46–S73.

- Van der Stelt, P.F.,(1993). Modern radiographic methods in the diagnosis of periodontal disease. *Advances in Dental Research, 7(2), pp.158-162.*
- Vanessa Machado, Luís Proença, Mariana Morgado, José João Mendes and João Botelho (2020),Accuracy of panoramic radiograph for diagnosing periodontitis comparing to clinical examination.
- Walter C, Weiger R, Zitzmann NU.(2010) Accuracy of three dimensional imaging in assessing maxillary molar furcation involvement. J Clinical Periodontol.;37:436–441.