ORIGINAL ARTICLE

Role of Radiographic Imaging and Interpretation in Periodontal Disease

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ABSTRACT

Background: **Prescribing the appropriate imaging modality and ensuring optimal imaging.**

Objective: **To give a brief account of Radiographic Interpretation of periodontal disease and to describe the various radiological features of periodontal disease.**

Materials and Methods: **This review was undertaken following the PRISMA protocol. Search was carried out through various engines and medical databases like Medline, PubMed, EMBASE, SCOPUS, etc.. Keywords "Radiographs", "Imaging", "Periodontal disease" were used to obtain the relevant data. An analysis of the imaging options, the reason behind the selection of a particular imaging modality, including advantages and disadvantages of each modality used was carried out.**

Results: **In many ways, the interpretation of the images created is the most important aspect of diagnostic imaging. Failure to ensure thorough and accurate interpretation denies the diagnostic benefit to the patient who has received ionizing radiation associated with the radiologic study.**

Conclusions: **Radiographs can be used to document periodontal disease and determine the success or failure of periodontal therapy.**

KEY WORDS

radiographs, imaging", periodontal disease

INTRODUCTION

Radiographic interpretation is an essential part of diagnostic process. The ability to recognize what is revealed by a radiograph enables a dental professional to play a vital role in the detection of diseases, lesions and condition that cannot be identified clinically. Interpretation refers to an explanation of what is viewed on the radiograph and diagnosis refers to the identification of disease by examination or analysis[1).

Periodontal disease refers to a group of diseases that affect the tissues found around the teeth. Thorough clinical and radiographic examinations are necessary to detect, evaluate, and diagnose periodontal disease. Radiographs aid the clinician in identifying of the extent of alveolar bone loss[2).

Number and type of Available Images

Conventional dental radiography produces images in only 2D, usually in the mesiodistal direction. In some cases a view at right angles to the plane of the original film is beneficial. Techniques such as tomography, sialography, nuclear imaging, CBCT, Conventional CT, and MRI may be required[3).

Diagnostic imaging should be completed before a biopsy procedure or treatment is provided. Clinical examination indicates the number and types of films required. The interpretation of these films in turn may suggest the need for additional imaging. Caution should be exercised in attempting to make an interpretation on the basis of a single film, especially if the only film is a panoramic view. Bitewing or periapical projection often can be supplemented[3).

Systematic Radiographic Examination

First, the bone is examined. All anatomic landmarks appropriate for the region are identified. Character of the trabecular bone should be examined in terms of Density and Size. Same areas should be compared on adjacent images & with corresponding area on images of the other side[4).

A second visual circuit should be made through all the images, examining the bone of the alveolar process. The height of the alveolar crest relative to the teeth and the cortication should be examined. Loss of height of the alveolar bone (more than 1.5 mm from the adjacent

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cementoenamel junctions) may indicate active or past periodontal disease[5].

All regions of the alveolar process should be examined to gain an overall appreciation for the extent and severity of alveolar bone loss. Any areas of erosion of the alveolar crest and the thickness of the overlying mucosa should be noted[5].

Finally, a third visual circuit should be made, examining the dentition and associated structures[5].

Radiographic Assessment of Periodontal Conditions

Anatomic Considerations include:

- Position of the maxillary sinus in relation to a periodontal deformity
- Missing, supernumerary, impacted, and tipped teeth

Pathologic Considerations:

- Caries
- Periapical lesions
- Root resorption

Normal Periodontal Tissues Anatomy

A thin layer of opaque cortical bone often covers the alveolar crest. The height of the crest lies at a level approximately 0.5 to 2.0 mm below the level of the CEJs of adjacent teeth. Between posterior teeth the alveolar crest also is parallel to a line connecting adjacent CEJs. Between anterior teeth the alveolar crest usually is pointed and may have a well-defined cortex and between the anterior teeth, the normal alveolar crest is pointed and well corticated, coming to within 0.5 to 2.0 mm of the adjacent CEJs. The normal alveolar crest lies 0.5 to 2.0 mm below the adjacent CEJ and forms a sharp angle with the lamina dura of the adjacent tooth[2].

The periodontal ligament (PDL) space is often slightly wider around the cervical portion of the tooth root, especially in adolescents with erupting teeth. In this situation, if the lamina dura still forms a sharp, well-defined angle with the alveolar crest, the condition is a variant of normal and is not an indication of disease[3].

The thickness of alveolar crests varies widely, and it may be very thin coronally. This may appear radiographically as an increase in radiolucency toward the crest. These sorts of variations in density alone are not an indication of disease and may be a variation of normal. 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[6].

The shape of the tooth creates the appearance of a double PDL space. When the x-ray beam is directed so that two convexities of a root surface appear on a film, the double PDL space is seen.

General Radiographic Features of Periodontal Disease

Changes in the morphology of the supporting alveolar bone

This include loss of the interproximal crestal bone and bone overlapping the buccal or lingual aspects of the tooth roots[7].

Changes to the internal density and trabecular pattern

Changes to the internal aspect of the alveolar bone reflect either a reduction or an increase in bone structure or a mixture of both[3].

Changes in Morphology Of The Alveolar Bone

Early Bone Changes[8-10]

- Appear as areas of localized erosion of the interproximal alveolar bone crest
- The anterior regions show blunting of the alveolar crests and slight loss of alveolar bone height.
- The posterior regions may also show a loss of the normally sharp angle between the lamina dura and alveolar crest.
- In early periodontal disease, this angle may lose its normal cortical surface (margin) and appear rounded off, having an irregular and diffuse border.
- The disease process may not be of recent onset because significant loss of attachment must be present for 6 to 8 months before radiographic evidence of bone loss appears
- 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*).
- More pronounced bone loss around the mandibular first molar and the generalized interproximal calculus.

If the periodontitis progresses, the destruction of alveolar bone extends beyond early changes in the alveolar crest and may induce a variety of defects in the morphology of the alveolar crest.

These patterns of bone loss have been divided into horizontal bone loss, vertical (angular) defects, interdental craters, buccal or lingual cortical plate loss, and furcation involvement of multirooted teeth[11].

Horizontal Bone Loss[7,10]

- Radiographic appearance of loss in height of the alveolar bone where the crest is still horizontal (i.e., parallel to an imagined line joining the CEJs of adjacent teeth) but is positioned apically more than a couple of millimeters from the CEJs.
- Horizontal bone loss may be mild, moderate, or severe, depending on its extent.
- Mild bone loss may be defined as approximately a 1- to 2-mm loss of the supporting bone.
- Moderate loss is anything greater than 2 mm up to loss of half the supporting bone height.
- Severe loss is anything beyond this point.
- Care must be taken in using the CEJ as a reference point in cases of overeruption and severe attrition.

Vertical (or angular) osseous defect[11]

- The term *vertical (or angular) osseous defect describes a bony lesion* that is localized to a single tooth, although an individual may have multiple vertical osseous defects.
- These defects develop when bone loss progresses down the root of the tooth, resulting in deepening of the clinical periodontal pocket.
- The radiographic presentation is a vertical deformity within the alveolus that extends apically along the root of the affected tooth from the alveolar crest.
- The outline of the remaining alveolar bone typically displays an oblique angulation to an imaginary line connecting the CEJ of the affected tooth to the neighboring tooth.
- In its early form, a vertical defect appears as abnormal widening of the PDL space at the alveolar crest.
- The vertical defect is described as three walled (surrounded by three bony walls) when both buccal and lingual cortical plates remain
- It is described as two walled when one of these plates has been resorbed
- One walled when both plates have been lost.
- *The distinctions among these* groups are important in designing the treatment plan.
- Often vertical defects are difficult or impossible to recognize on a radiograph because one or both of the cortical bony plates remain superimposed over the defect.
- Visualization of the depth of pockets may be aided by inserting a gutta-percha point.

Interdental Craters[12]

- Two-walled, trough like depression that forms in the crest of the interdental bone between adjacent teeth.
- Radiographically, bandlike or irregular region of bone with less density at the crest, immediately adjacent to the more dense normal bone apical to the base of the crater.

Buccal or Lingual Cortical Plate Loss[13]

- Loss of a cortical plate may occur alone or with another type of bone loss such as horizontal bone loss.
- Increase in the radiolucency of the root of the tooth near the alveolar crest.
- Semicircular shadow with the apex of the radiolucency directed apically in relation to the tooth.

Osseous Deformities in the Furcations of Multirooted Teeth

On plain 2D imaging, lucent and relatively well defined mandibular molar furcations are usually only seen when there is destruction of either the buccal or lingual cortical plates, or both. If both or one of cortices are preserved, the mandibular molar furcation defect appears as a focal region of varying hypodensity and definition[14)].

Very early furcation involvement of a mandibular molar is characterized by slight widening of the periodontal ligament space in the furcation region. Profound radiolucent lesion within the furcation region *resulting* from loss of bone in the furcation region and the buccal and lingual cortical plates[15)].

The bony defect may also involve only the buccal or lingual cortical plate and extend under the roof of the furcation. In such a case, if the defect does not extend through to the other cortical plate, it appears more irregular and radiolucent than does the adjacent normal bone[14)].

In the mandible, the external oblique ridge may mask furcation involvement of the third molars. Convergent roots may also obscure furcation defects in maxillary and mandibular second and third molars[16)].

The image of furcation involvement is not as sharply defined around maxillary molars as around mandibular molars because the palatal root is superimposed on the defect. It should also be noted that an inflammatory furcation lesion may also be of pulpal origin, related to accessory pulpal canals, root resorption or iatrogenic perforation. The precise location, extent, and morphology of periodontal defects, including furcation defects, is better appreciated with MCT and CBCT[14)].

Changes To Internal Density And Trabecular Pattern Of Bone

The peripheral bone may appear more radiolucent, or more sclerotic (radiopaque), or more commonly with a mixture of these patterns. A radiolucent change reflects loss of density and number of trabeculae. The trabeculae appear very faint, which is more commonly seen in early or acute lesions. The trabeculae toward the alveolar crest on the mesial and distal aspect of the tooth are barely perceptible and the marrow spaces are enlarged. Inflammatory products from a periodontal lesion can even extend through the cortex of the floor of the maxillary sinus to cause a regional mucositis[14-16)].

Periodontal Abscess[17)]

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:[15,18,19)]

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 radiographically.

Aggressive Periodontitis[20)]

Initially, there is bone loss in the maxillary and mandibular incisor or first molar areas, usually bilaterally, resulting in a vertical, *arclike destructive pattern*. As the disease progresses, loss of alveolar bone may become generalized but remains less pronounced in the premolar areas. Usually an Arc-shaped radiolucency at the 1st molar region in 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, density of the surrounding cancellous bone[21)].

When seen on radiographs, variations in PDL space width suggest that the tooth is being subjected to increased forces. Successful attempts to reinforce the periodontal structures by widening the PDL space can be accompanied by increased width of the lamina dura and sometimes by condensation of the perialveolar cancellous bone. Widened periodontal spaces may be seen. caused by trauma from occlusion. Increased density of the surrounding bone caused by new bone formation in response to increased occlusal forces[22)].

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[21)].

Perio- Endo Lesion

These defects may reflect contiguity of periodontal and periapical inflammatory lesions, where both lesions are sufficiently large that they essentially merge to form one larger lesion.

Radiologically, it can be difficult to distinguish between the various causes, although the morphology of the lesion may provide useful clues which can be correlated with the clinical findings[23)].

Fistula tracking

It is done by inserting a semirigid radiopaque material into the sinus track until resistance is met. A radiograph is then taken, which reveals the course of the sinus tract and the origin of the inflammatory process.

Radiographically, suspicion should be heightened if the bone destruction does not have the pattern or morphology normally associated with periodontal disease. Any lesion of bone destruction that has ill-defined borders and a lack of peripheral bone response (sclerosis) should be viewed with suspicion[24)].

Limitations of Radiographs in periodontal diseases[2,4,8,11,15,22)]

- Radiographs provide a 2D view of a 3D situation - bony defects overlapped by higher bony walls may be hidden.
- Typically show less severe bone destruction than is actually present
- Do not demonstrate the soft-tissue-to-hard-tissue relationships
- Bone level is often measured from the CEJ; not valid in situations of overeruption or severe attrition with passive eruption.

Role of CBCT in Periodontal Disease

CBCT is a new technology that provides 3D cross-sectional images dedicated to the maxillofacial region without superimposition or blurring and reduces the risk of radiation. CBCT technology has a substantial impact on maxillofacial imaging. It has been applied to diagnosis in all areas of dentistry and is now expanding into treatment applications. CBCT shouldn't be considered a replacement for panoramic or conventional projections but a complementary modality[8)]. CBCT could be advantageous for diagnosing periodontal pathologies, treatment planning and follow-up, due to minimum radiation dosage to the patient, enhanced spatial resolution, and smaller volumes to be interpreted. CBCT offers images with enhanced resolution which provide better diagnostic and quantitative data with regards to periodontal tissues. Compared to conventional radiographs, CBCT provides cross-sectional images of the alveolar bone height, width and angulations[25)].

It has been reported in the literature that found that CBCT is more precise in identifying the defects incomparison with intraoral radiographs. CBCT revealed an increased rate of accuracy in recognizing periodontal defects, especially, in the orovestibular orientation as compared to conventional radiograph[26,27)]. CBCT has also been proved to be advantageous and more precise in diagnosing the infra-bony defects and involvement of the furcation[28)].

CONCLUSION

Radiographs can be used to document periodontal disease and determine the success or failure of periodontal therapy. Interpretation of periodontal disease on dental radiographs should include an evaluation of the alveolar bone; bony changes can be described in terms of pattern (horizontal or vertical), distribution (localized or generalized), and severity (slight, moderate or severe). Radiographs can be used in the classification of periodontal disease based on the amount of bone loss. Bitewing Radiographs can also be used to detect interdental calculus and interdental bone loss.

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