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Role of Radiographic Evolution: An Aid to Diagnose Periodontal Disease

Krishna Kripal and Aiswarya Dileep

Abstract

In periodontics, the main purpose of radiography is to detect the level of the alveolar bone including the pattern and extent of loss of the bone. Measurements which are of linear from the cement-enamel junction to the crest of the alveolar bone and from the cement enamel junction to the bone defect base are commonly used to measure the bone height and bone defects. In radiographs, the periodontal ligament space, lamina dura and periapical region are seen and also helpful in identifying risk, such as calculus and dislodged restorations. Radiographs can provide information for proper diagnosis and treatment planning, which can provide information for the assessment of accurate treatment outcomes.

Keywords: computed tomography, cone beam computed tomography, tuned aperture computed tomography, magnetic resonance imaging, ultrasonography

1. Introduction

Ever since the discovery of X-rays by Wilhelm Conrad Roentgen in 1895, the diagnostic capabilities of medical and dental professions has been revolutionized and forever changed the practice of medicine and dentistry. Substantial advances in X-ray generator and X-ray detector technology have resulted in significant dose reductions and improved image quality. These advances in oral radiography have transformed into meaningful clinical applications improving the way we prevent, diagnose and treat periodontal disease [1–3].

In periodontics, the main purpose of radiography is to detect the level of the alveolar bone including the pattern and extent of bone loss. Measurements which are of linear from the cement enamel junction to the crest of alveolar bone and from the cement enamel junction to the osseous defect base are commonly used to measure crestal bone levels and osseous defects [4–7]. In radiographs, the periodontal ligament space, lamina dura and periapical region are evident and also useful in identifying risk factors, such as calculus and defective restorations [8].

Radiographs are valuable for diagnosis of periodontal disease, estimation of severity, determination of prognosis, and evaluation of treatment outcome. However, radiographs are an adjunct to the clinical examination, not a substitute for it. Radiographs demonstrate changes in calcified tissue; they do not reveal current cellular activity but rather reflect the effects of past cellular experience on the bone and roots.

Radiographs can provide critical information for diagnosis and treatment planning, which can also serve as baseline information for the assessment of treatment outcomes [9–11].

Periodontist need to understand the strength and weakness of diagnostic imaging and way the cost and benefits of the test before prescribing it. Prescribing the appropriate type and the number of radiographs is critical for optimizing the impact of radiographs on treatment out comes.

The adaption of imaging which is digital as a modality of radiographic assessment of the feature, according to scientific evidence, has the potential to change the way to see the periodontal tissues. There is a little doubt that future periodontist will be using as advanced imaging modalities, either directly or indirectly [12].

2. 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 bone which is present interdentally normally is seen as a radiopaque line beside the periodontal ligament (PDL) and at the bone margin, called as the lamina dura. Because this thin line represents the cortical bone which lining the socket, and change in the angulation of the beam produce changes in its appearance [13, 14].

Crest of the interdental bone 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 [15] (**Figure 1**).



Figure 1.

Crest of interdental bone normally parallel to a line drawn between the cementoenamel junction of adjacent teeth (arrow). Note also the radiopaque lamina dura around the roots and interdental bone.

3. Radiographic techniques

In conventional radiographs, periapical and bite-wing 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, 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. Standardized, reproducible techniques are required to obtain reliable radiographs for pretreatment and posttreatment comparisons. Prichard put forward the following four criteria for the determination of adequate angulation of periapical radiographs [16–18]:

1. The periapical radiograph should have the ability to show the cusps of molars with occlusal surface.
2. Enamel and pulp chambers should be seen and distinct.
3. Open interproximal spaces.
4. Contacts between the adjacent teeth should not overlap unless teeth are out of line. 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. 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 [19].

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. Bite-wing projections offer an alternative that better images periodontal bone levels. For bite-wing 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

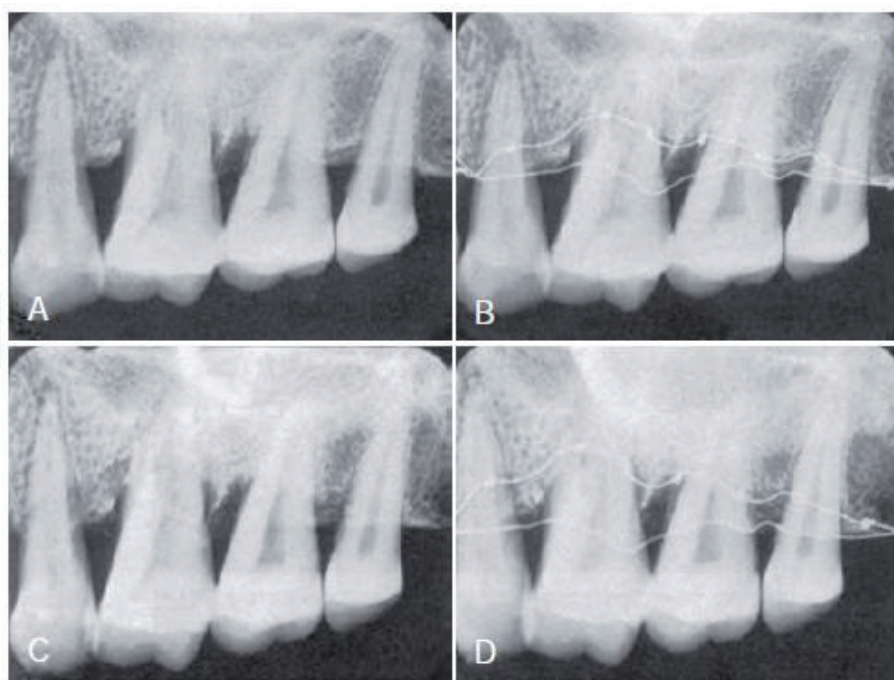


Figure 2.
Comparison of long-cone paralleling and bisection-of-the-angle techniques. (A) Long-cone paralleling technique, radiograph of dried specimen. (B) Long-cone paralleling technique, same specimen as A. Smooth wire is on margin of the facial plate and knotted wire is on the lingual plate to show their relative positions. (C) Bisection-of-the angle technique, same specimen as A and B. (D) Bisection of the-angle technique, same specimen. Both bone margins are shifted toward the crown, the facial margin (smooth wire) more than the lingual margin (knotted wire), creating the illusion that the lingual bone margin has shifted apically.

through the contact areas of the teeth and perpendicular to the film. Thus the projection geometry of the bite-wing 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 bite-wing radiographs, films can be placed vertically to cover a larger area of the jaws. More than two vertical bite-wing films might be necessary to cover all the interproximal spaces of the area of interest [20] (**Figure 2**).

4. 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 [16].

4.1 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 [21].

4.1.1 Amount

Radiographs are an indirect method for determining the amount of bone loss in periodontal disease; they image 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. The distance from the CEJ to the alveolar crest has been analyzed by several investigators. Most studies, conducted in adolescents, suggest a distance of 2 mm to reflect normal periodontium; this distance may be greater in older patients [22].

4.1.2 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 [23].

5. 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. 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 [24–26].

Radiographs do not indicate the internal morphology or depth of craterlike defects. Also, radiographs do not reveal the extent of involvement on the facial and lingual surfaces. Bone destruction of facial and lingual surfaces is masked by the dense root structure, and bone destruction on the mesial and distal root surfaces may be partially hidden by superimposed anatomy, such as a dense mylohyoid ridge. In most cases, it can be assumed that bone losses seen interdentally continue in either the facial or the lingual aspect, creating a troughlike lesion [27].

Dense cortical facial and lingual plates of interdental bone obscure destruction of the intervening cancellous bone. Thus a deep craterlike defect between the facial and lingual plates might not be depicted on conventional radiographs. To record the destruction of the cancellous bone which is present interproximally and radiographically, the cortical bone must be involved. A decrease of only 0.5–1.0 mm in the thickness of the cortical plate is sufficient to permit radiographic visualization of the destruction of the inner cancellous trabeculae. Interdental bone loss may continue facially and/or lingually to form a troughlike defect that could be difficult to appreciate radiographically. These lesions may terminate on the radicular surface or may communicate with the adjacent interdental area to form one continuous lesion [28].

6. Radiographic appearance of periodontal disease

6.1 Periodontitis

Radiographic changes in periodontitis follow the pathophysiology of periodontal tissue destruction and include the following [29]:

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. Depicting these early changes depends greatly on the radiographic technique, as well as on morphological changes. No correlation was found between

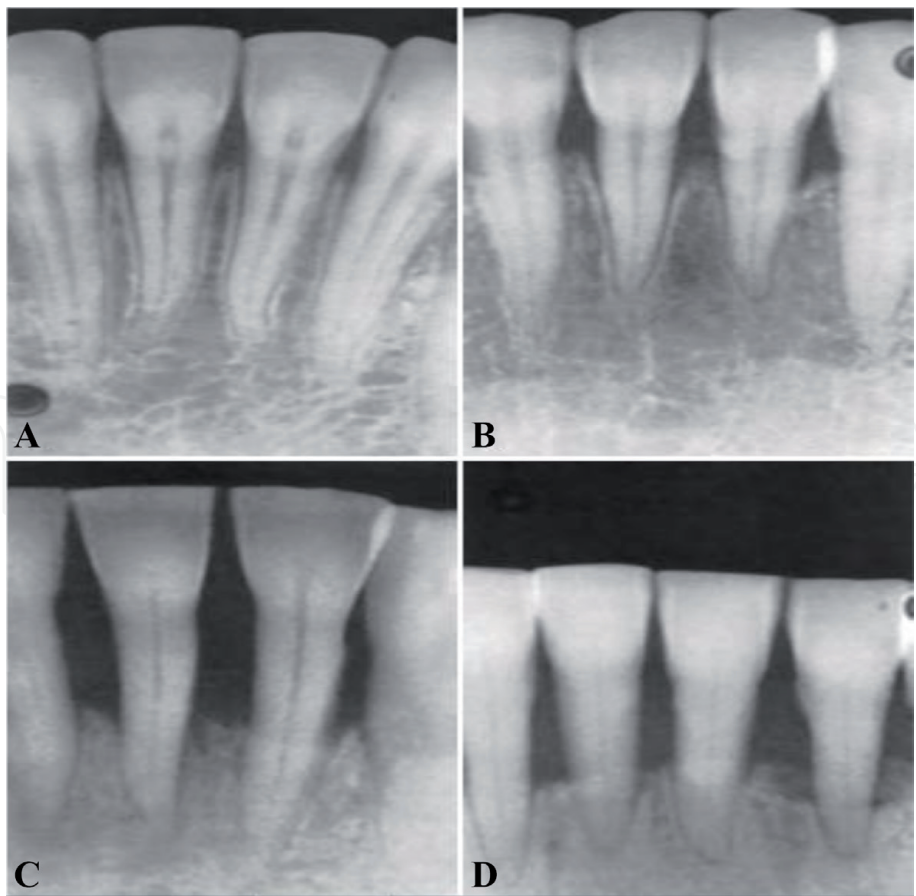


Figure 3. Radiographic changes in periodontitis. (A) Normal appearance of interdental bone. (B) Fuzziness and a break in the continuity of the lamina dura at the crest of the bone distal to the central incisor (left). There are wedge-shaped radiolucent areas at the crest of the other interdental bone. (C) Radiolucent projections from the crest into the interdental bone indicate extension of destructive processes. (D) Severe bone loss.

lamina dura in radiographs and the presence or absence of clinical inflammation, bleeding on probing, periodontal pockets, or clinical attachment loss. Therefore it can be concluded that the presence of an intact crestal lamina dura may be an indicator of periodontal health (**Figure 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. The apex of the area is pointed in the direction of the root.
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 [30–32].

7. Furcation involvement

Definitive diagnosis of furcation involvement is made by clinical examination, which includes careful probing with a specially designed probe (e.g., Nabers). Radiographs are helpful, but root superimposition, caused by anatomic variations and/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 [31].

The recognition of 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 [32]:

1. The radiographic change in the furcation area can be determined clinically, especially if there is bone loss on adjacent roots.
2. Reduced radiodensity in the furcation area in which bony trabeculae outlines are visible suggests furcation involvement of the teeth.
3. Whenever there is marked bone resorption in relation to a single molar root, it can be assumed that the furcation of it is also involved (**Figure 4**).

8. Trauma from occlusion

Trauma from occlusion can produce visible changes radiographically in the thickness of the lamina dura, morphology of the alveolar bone crest, width of the PDL space, and density of the surrounding cancellous bone [31].



Figure 4.
Early furcation involvement suggested by fuzziness in the bifurcation of the mandibular first molar, particularly when associated with bone loss on the roots.

Traumatic lesions manifest more clearly in faciolingual aspects because mesio-distally, the tooth has the 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 pathognomonic of 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 [32].

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 space. 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 [33].

9. Advanced procedures

9.1 Tomography

Tomography is a generic term formed by the Greek words “Tomo” (slice) and “Graph” (picture). So tomography refers to imaging by sections or sectioning, through the use of any kind of penetrating wave. A device used in tomography is called a tomography, while the image produced is a tomogram. Conventional film-based tomography, also called body section radiography is, a radiographic technique designed to image more clearly objects lying within a plane of interest. This is accomplished by blurring the images of structures lying outside the plane of interest through the process of motion “unsharpness.”

In conventional medical X-ray tomography, sectional image is taken through a body by moving an X-ray source and the film in opposite directions during the exposure.

9.1.1 Main indications

The main clinical indicated to examine various facial structures:

- When a pathology is strongly suspected clinically, but plain films are negative.
- Preoperative assessment of jaw height, thickness and texture before inserting implants.

- Postoperative evaluation of implants.
- Tomography of sinuses.
- Tomography of facial bones, to study facial fractures.
- Evaluation of grossly comminuted facial fractures to determine all the fracture sites.
- Assessment of the extent of orbital blow-out fractures.
- The most commonly used radiographic modality for demonstrating maxillo-facial.
- Fractures are conventional radiography and it is still believed to be the most reliable.
- Diagnostic tool.
- As an additional investigation of the TMJ and condylar head particularly useful if.
- Patients are unable to open their mouths.

9.1.2 Advantages

- It gives a more precise evaluation of sinus pathologies, which are poorly visualized on.
- Routine radiography.
- Assessment of the size, position and extent of antral tumors.
- Sphenoid and ethmoidal sinuses are more clearly visualized.
- Similar optimum definition is obtainable on each slice.

9.1.3 Disadvantages

- The radiation dose to the patient may be high.
- The technique is time-consuming.
- A high level of cooperation is required as the patient has to remain in the same position throughout the investigation.
- Images appeared to be blurred.

10. Computed tomography (CT)

10.1 Introduction

In April of 1972 Godfrey Hounsfield a senior research scientist at EMI limited in Middlesex, England announced the invention of a revolutionary imaging technique.

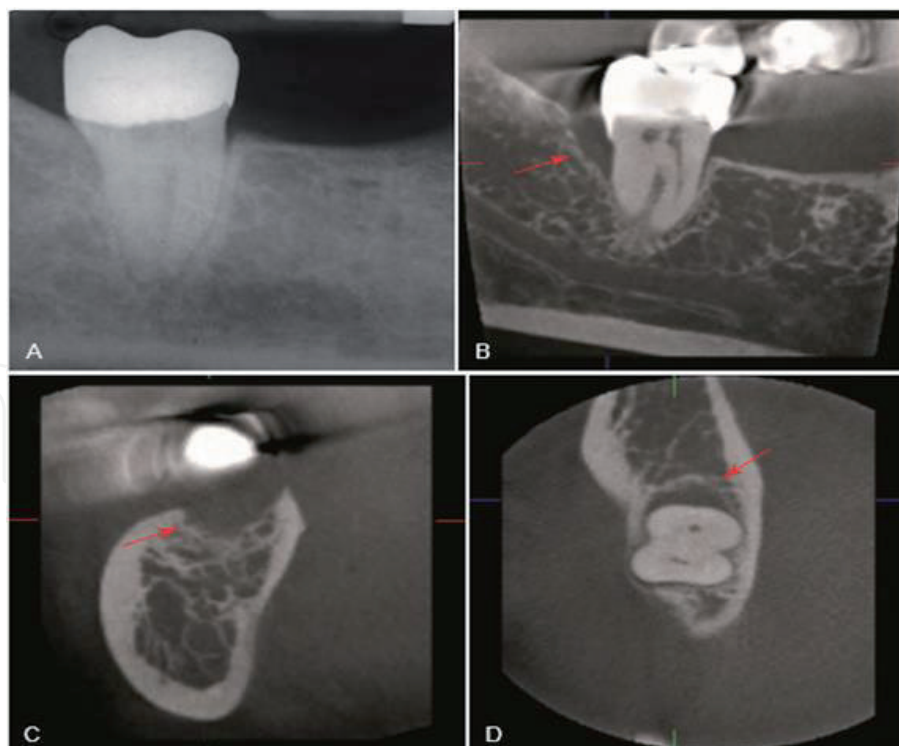


Figure 5.
 Periapical radiograph (A) and sagittal (B), cross-sectional (C), and axial (D) cone-beam computed tomography (CBCT) sections of the mandibular right second molar. No pathology is detected on the periapical radiograph. However, CBCT images clearly illustrate a deep, vertical, three-wall defect on the distal surface of the mandibular right second molar (red arrow).

He referred this technique as computerized axial transverse scanning for which he received a Nobel prize in 1979. With this technique he was able to produce an axial cross sectional image of the head using a narrowly collimated, moving beam of X-rays [33, 34].

10.2 Cone beam computed tomography

In the last decade, cone-beam computed tomography (CBCT) has revolutionized the field of oral and maxillofacial imaging. However, CBCT finds application in almost every diagnostic task of clinical dentistry, including evaluation of periodontal and periapical structures. CBCT offers many advantages over conventional radiography, including the accurate three-dimensional imaging of teeth and supporting structures. Although not recommended for every dental patient, CBCT avoids the problems of geometric superimposition and unpredictable magnification and can provide valuable diagnostic information in periodontal evaluation [35].

Periapical and bite-wing radiographs provide information mostly for the interdental bone. However, a three-wall defect that preserves the buccal and/or lingual cortices can be difficult to diagnose, and the buccal, lingual, and furcational periodontal bone levels are hard to evaluate in conventional radiographs. When clinical examination raises concerns for such areas, CBCT imaging can add diagnostic value [36–39] (Figure 5).

11. Advantages of CBCT in dentistry

Being considerably smaller, CBCT equipment has a greatly reduced physical footprint and is ~20–25% of the cost of conventional CT. CBCT provides images

of high contrasting structures and is therefore particularly well-suited towards the imaging of osseous structures of the craniofacial area. The use of CBCT technology in clinical dental practice provides a number of advantages for maxillofacial imaging [40]. These include:

11.1 Rapid scan time

Because CBCT acquires all projection images in a single rotation, scan time is comparable to panoramic radiography. This is desirable because artifact due to subject movement is reduced. Computer time for dataset reconstruction however is substantially longer and varies depending on FOV, the number of basis images acquired, resolution and reconstruction algorithm and may range from ~1 to 20 minutes [41, 43].

11.2 Beam limitation

Collimation of the CBCT primary X-ray beam enables limitation of the X-radiation to the area of interest. Therefore an optimum FOV can be selected for each patient based on suspected disease presentation and region of interest. While not available on all CBCT systems, this functionality is highly desirable as it provides dose savings by limiting the irradiated field to fit the FOV.

11.3 Image accuracy

CBCT imaging produces images with sub-millimeter isotropic voxel resolution ranging from 0.4 mm to as low as 0.09 mm. Because of this characteristic, subsequent secondary (axial, coronal and sagittal) and MPR images achieve a level of spatial resolution that is accurate enough for measurement in maxillofacial applications where precision in all dimensions is important such as implant site assessment and orthodontic analysis [42].

11.4 Reduced patient radiation dose compared to conventional CT

Published reports indicate that the effective dose (E) varies for various full field of view CBCT devices from 29 to 477 μSv depending on the type and model of CBCT equipment and FOV selected patient positioning modifications (tilting the chin) and use of additional personal protection (thyroid collar) can substantially reduce dose by up to 40%. These doses can be compared more meaningfully to dose from a single digital panoramic exposure, equivalent CT dose, or the average natural background radiation exposure for Australia (1500 μSv) in terms of background equivalent radiation time (BERT). CBCT provides an equivalent patient radiation dose of 5–80 times that of a single film-based panoramic radiograph, 1.3–22.7% of a comparable conventional CT exposure or 7–116 days of background radiation.

11.5 Limitations of CBCT imaging

While there has been enormous interest, current CBCT technology has some limitations related to the “cone beam” projection geometry, detector sensitivity and resolution which is contrast. These parameters create an inherent image “noise” that reduces image clarity such that current systems are unable to record soft tissue contrast at the relatively low dosages applied for maxillofacial imaging.

Another factor that impairs CBCT image quality is image artifact three types of cone-beam-related artifacts:

Partial volume averaging: it occurs when the selected voxel resolution of the scan is greater than the spatial or contrast resolution of the object to be imaged.

Under sampling: under sampling can occur when too few basis projections are provided for the reconstruction. A reduced data sample leads to misregistration and sharp edges and noisier images because of aliasing, where fine striations appear in the image.

Cone-beam effect: the cone-beam effect is the major source of error, especially in the parts which are outside of the scan volume. Because of the divergence of as it rotates around the patient in a horizontal plane. The amount of data corresponds to the total amount of attenuation along a specific beam projection angle as the scanner completes an arc. Because the outer row pixels record less attenuation, whereas more information is recorded for objects projected onto the more central detector pixels, which results in image distortion, streaking artifacts.

11.6 Advantages of CBCT

1. CBCT has a scanning time which rapid as in comparison with panoramic radiography.
2. It allows reconstruction with proper three dimensional and display from an angle.
3. Its beam collimation makes limitation of X radiation to the area of interest.
4. Images clarity produces images ranging from 0.4 mm to as low as 0.076 mm.
5. Radiation dosage of patient is reduced (29–477 μSv) in comparison with conventional CT (~ 2000 μSv). Patient radiation dose is six times lesser than normal CT, as the exposure time is ~ 18 seconds.
6. The units of CBCT reconstruct the projection data to provide inter relational images in three orthogonal planes (axial, sagittal, and coronal).
7. Reformation which is multiplanar is possible by sectioning volumetric datasets nonorthogonally.
8. Multiplanar image can be “thickened” by increasing the number of voxels.
9. Volume rendering which is 3D is processed by direct or indirect technique.
10. The three positioning beams make patient positioning easy.
11. Reduced image artifacts: CBCT projection geometry, together with fast acquisition time, results in a low level of metal artifact in primary and secondary reconstructions.

11.7 Disadvantages

The only disadvantage is its cost. But considering the enormous benefits, this cost effect can be overlooked.

Indications of cone-beam computed tomography:

1. Assessment of the jaw which includes:
 - Pathological lesions which are bone and soft tissue;

- Periodontal assessment;
- Endodontic assessment;
- Alveolar ridge loss;
- Recognition of fractures and structural maxillofacial deformities;
- Assessment of the inferior alveolar nerve before extraction of mandibular third molar impactions.

12. Ultrasonography

Ultrasound imaging is easy to use for the detection of noninvasive and soft tissue related diseases. Ultrasonography utilizes sound waves for image production. The first major attempt at a practical application was made in search for the sunken Titanic in the North Atlantic in 1912. A few early attempts at applying US in medical diagnosis. Successful medical application began shortly after the war in the late 1940s and early 1950s. The vital ingredients are transducer, ultrasonic beam, a cathode ray tube or television monitor. The evolution of sonic imaging began slowly from a static one dimensional base (A-mode or amplitude mode), improved somewhat when a component of motion was added (TM-mode), made a giant leap forward with two dimensional imaging (B mode or brightness mode) and reached its current zenith with gray scale imaging. The phenomenon sound which are perceived is the result of changes which are periodic in the pressure of air against the eardrum. The periodicity of these changes ranging from 1500 to 20,000 cycles per second (hertz [Hz]). By definition, ultrasound has a periodicity >20 kHz. Thus it is distinguished from other waveforms which are mechanical simply by having a vibratory frequency more than the human audible range. Diagnostic ultrasonography (sonography), uses vibratory frequencies in the range of 1–20 MHz. Scanners which are used for sonography generate impulses which is electrical that are converted into sound waves which is of high frequency help of a transducer.

Transducer is a device that transform one form of energy into another-in this case, electrical energy can be converted into sonic energy. The most important part of the transducer is a thin piezoelectric crystal or material which is made up of a great number of dipoles arranged in a pattern of geometric. A dipole may be thought of as a distorted molecule which has two ends that appears to have a positive charge on one end and a negative charge on the other.

Applications of ultrasound in periodontics:

1. As diagnostic aid: ultrasonography probe gives a system of mapping for noninvasive procedure and calculate as well as record various measurements of subject's periodontal ligaments relative to a fixed point such as cementoenamel junction. This probe uses ultrasound to detect periodontal ligament and cement-enamel junction. This ultrasound probe records a series of measurements which is painless.
2. Assessment of periodontium: an ultrasonic scanner that functions at a frequency of 29 MHz has been used to detect the dimensional relationship between hard and soft structures of periodontium. This device also used to assess the gingival thickness before and after mucogingival surgery for gingival recession and to calculate the thickness of masticatory mucosa.

3. Detection of subgingival calculus: there are large number of subgingival calculus detection systems available found that dental surfaces may be determined separately by the tip oscillations analysis of an ultrasonic instrument, which has features of subgingival calculus detection.
4. Complete removal of dental plaque or the biofilm: removal of the bacterial plaque by means of the acoustic micro-streaming and cavitation effects of ultrasound. Many studies have shown that there is no statistically significant difference in the effectiveness of plaque removal using hand or motor driven instruments. It can also used for scaling in cases of necrotizing ulcerative lesions as this possess an action of lavage.
5. Removal of supra and subgingival calculus: cavitation effect liberates energy that can be able to remove the deposits. It is effective on the both supra and subgingival calculus, a direct contact between the vibrating tip and the calculus is needed.
6. Clearance of endotoxin and detoxification: the endotoxins are known to be fragments of bacterial cells and toxic products of bacteria and can be found in the root cementum or dentine, saliva and gingival crevicular fluid. Endotoxins are cytotoxic substances and can affect the immune system of the host. It is suggested that, for the successful treatment outcome, the infected dentine and altered cementum have to be removed. Recent studies have shown that endotoxin is superficially associated with the cementum and calculus. They can be easily removed by rinsing, brushing, lightly scaling, or polishing the root surface. Heat generated from magnetostrictive units may helpful in endotoxin removal or detoxification.
7. Curettage: ultrasound is effective for the debridement of the epithelial lining of periodontal pockets. A Morse scaler-shaped or rod-shaped ultrasonic instrument can be used. Ultrasonic instruments are found to be as effective as curettage done by hand instruments.
8. Osseous surgery: ultrasonic bone cutting surgery has been recently introduced as an alternative to the conventional techniques. Piezosurgery® is a new and innovative method that uses piezoelectric ultrasonic vibrations to do precise and safe osteotomies. Piezoelectric surgery uses a specifically engineered surgical instrument characterized by a surgical power that is three-times higher than normal ultrasonic instruments. The unique feature of this technique is that the cutting action occurs when tool is employed on the mineralized tissue, but stops when soft tissue is encountered. This technique can be used for preprosthetic surgery, sinus elevation procedure, implant placement as well as alveolar crest expansion.

13. Conclusions

Periapical radiographic examination should be part of each patient's periodontal evaluation and should be coupled with a detailed recording of pocket depths, gingival margin location, and bleeding on probing. Radiographic evaluation should be updated every 2 years. Periapical radiographs often underestimate the amount of periodontal bone loss, and early changes are usually not detected. Significant interdental bone loss can occur and may not be detectable on periapical radiographs

because the density of the intact buccal and lingual or palatal bone plates obscure changes that occur as the result of periodontitis. Comparison of periapical radiographs of the same area taken at different times will only be reliable in documenting dramatic changes in bone levels since variations in angulation of the beam, placement of the film, and development of the image make accurate measurements taken over time very difficult and unreliable.

Recent use of three-dimensional radiographic techniques with CBCT gives a much more accurate picture of periodontal bone loss than do two-dimensional radiographs and will be more widely used as this technology becomes available in more clinics.

Conflict of interest

None.

Appendices and nomenclature

| | |
|---------|---|
| CEJ | cemento- enamel junction |
| PDL | periodontal ligament |
| TMJ | temperomandibular joint |
| CT | computed tomography |
| CBCT | cone beam computed tomography |
| FOV | field of view |
| MPR | multiplanar reformation |
| ARPANSA | australian radiation protection and nuclear safety agency |
| BERT | background equivalent radiation time |
| A MODE | amplitude mode |
| B MODE | brightness mode |

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