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SUCCORING ROLE OF RADIOGRAPHS IN PERIODONTICS

Periodontics

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ABSTRACT

Periodontal disease is amongst the most prevalent diseases worldwide. Also its chronic and inflammatory nature has proved a significant relation with overall systemic health of an individual. So it's very crucial to diagnose its presence and severity at very early stage to protect periodontal health as well as overall wellbeing of a person. Modern technologies have provided clinicians with automated probes but the major drawback is their cost and technique sensitivity. Owing to these limitations of new diagnostic tools, the conventional tools of diagnosis such as clinical examination and radiographic evaluation (in combination) still got the upper hand. In this review article, we will discuss about basic consideration and new developments in radiographic evaluation in periodontal disease.

KEYWORDS

Lamina dura, periapical radiography, CBCT, 3-D radiography, digital radiography.

INTRODUCTION

Dental Radiography is a Radiographic procedure that is used or employed to take images of the teeth, bones, and soft tissues around them; in order to identify, diagnose, plan treatment and monitor disease progression. Also clinically evident periodontal conditions can become apparent on radiographs. So, Radiographs can provide important details of relevance to periodontal decision making which is not capable of being captured by clinical examination, such as length of root(s) with remaining bony support *(Corbet 2009),* pattern of bone loss, degree of furcation involvement, underlying lesion on root surface, etc. A better understanding of the periodontal disease process challenged usefulness of traditional clinical and radiographic methods for diagnosis and prompted revision of out-dated diagnostic aids. The first dental clinic was established by Dr.C.E.Kells in July 1896, using X-ray machine. With time new radiographic techniques and machines have been developed for more precision and accuracy. In the modern era, Cone Beam Computed Tomography is most widely accepted. In this review article we will discuss about significance of conventional and advanced radiographic techniques in Periodontics.

Conventional Dental Radiography

Conventional dental radiography involves the conventional X-ray machine consisting of x-ray tube, which is composed of a cathode and an anode and an image receptor i.e. x-ray film. The cathode serves as the source of electrons that flow to the anode. The cathode and anode lie within an evacuated glass envelope or tube. X-rays are produced when electrons generated from cathode travel and strike the anode end. For the x-ray tube to function, a power supply is necessary to:

(1) To generate electrons by heating filament, and
(2) To generate a high-voltage potential between the anode and cathode to accelerate the electrons.

Conventional Dental radiography is divided into two:

1) Intraoral radiography
a) Periapical radiography.
b) Bitewing radiography
c) Occlusal radiography
2) Extraoral radiography
a) Panoramic radiography
b) Oblique lateral radiography
c) Cephalometric radiography

Periapical radiography:

In periodontics, periapical radiography is indicated in:

- Apical pathology and other lesions situated within alveolar bone.
- Pre- and postoperative assessment of alveolar surgery.
- Following trauma to teeth and alveolar bone.
- Pre- and postoperative assessment of implants.

The quality of radiographic image is affected by image size and shape distortion. And this can be controlled conventionally by using different techniques. Accuracy in dental radiography is influenced by the technique used and the angulation *(Rao 2008)*. The two techniques commonly employed are:

- Bisecting angle technique
- Paralleling technique

Paralleling technique is more accurate one as it follows maximum principles of accurate image projection*(Bhatti 2012).*

Bitewing radiography:

Bitewing radiographs are more helpful in assessing the interdental bone region or alveolar crest as compared to periapical technique. It is indicated in:

- Detection of interdental caries.
- Crown (interproximal surfaces of premolars and molars).
- Assessment of the periodontal condition.
- Detection of interdental bone loss.

Based on film placement it can be of two types (figure 1&2)*(Carranza 2012):*

1) Horizontal bitewing radiography
2) Vertical bitewing radiography

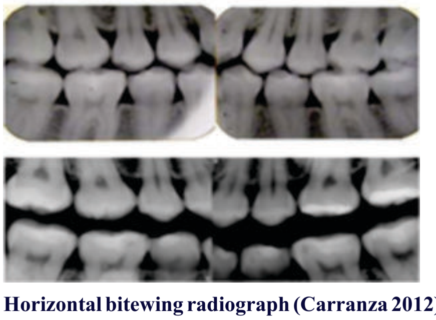

Figure1: Horizontal bitewing radiograph (Carranza 2012)

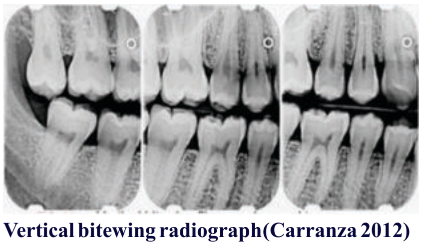

Figure2: Vertical bitewing radiograph(Carranza 2012)

Among the two, vertical bitewing radiography is more helpful in Periodontal diseases as it covers wider area of alveolar bone *(Carranza 2012).*

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Radiographic evaluation of bone changes in Periodontal diseases is reliant on appearance of interdental bone, because the relatively dense root structure veils the facial and lingual bony plates. The thin radiopaque border lining the PDL, alveolar crest is termed as Lamina Dura. Because the lamina dura represents the cortical bone lining of the tooth socket; the shape and position of the root and changes in the angulation of the x-ray beam will produce considerable variations in its appearance *(Manson1963).*

Criteria for adequate angulation of periapical radiographs *(Carranza 2012)***:**

- The radiograph should be showing the tips of molar cusps with little or none of the occlusal surface showing.
- Enamel caps and pulp chambers should be distinct.
- Interproximal spaces should be open.
- Proximal contacts should not be overlapping unless teeth are out of line anatomically.

In periodontal disease the earliest signs must be detected clinically. The radiographic image tends to underestimate the severity of bone loss. The discrepancy between the alveolar crest height and the radiographic appearance ranges from 0 to 1.6 mm, mostly accounted for x-ray angulation *(Carranza 2012).* Radiographs are an indirect method for determining the amount of bone loss in periodontal disease. The important thing to remember is that radiographs are like history books; they are updating us about what happened in the past rather than about present condition. Ironically, they image the amount of remaining bone rather than the amount lost.

Changes in periodontal disease can be visualized radiographically by variation in following structures *(Carranza 2012)***:**

- Lamina dura.
- Crestal radiodensity.
- Size and shape of the medullary spaces.
- Height and contour of the bone.

Limitations Of Conventional Radiographs

- Conventional radiographs are specific but lack sensitivity.
- More than 30% of bone mass at alveolar crest must be lost to be recognized on radiographs.
- Radiographs provide a 2-dimensional view of a 3 dimensional situation.
- Provides only information about interproximal bone level.
- Radiographs do not demonstrate soft tissue - to - hard tissue relationship, hence no information about depth of soft tissue pocket.

Advanced 2-d Radiography

The limitations of conventional 2D imaging techniques could be overcome with the evolution of advanced 2D imaging techniques. These are:

- Xeroradiography
- I125 absorptiometry
- Digital radiography
- Digital subtraction radiography
- Computer Assisted Densitometric Image Analysis system (CADIA)

Xeroradiography

Pioneer of this technique was Carlson in 1937. In 1963, Stronezak was the first to use it in dentistry. In xeroradiography, Edge enhancement effect is used for better visualization of small structures and areas of minimal density differences. It is an excellent aid in evaluating early osseous changes, assessment of osseous repair after periodontal therapy, and visualize crestal heights.

I125 Absorptiometry

It was introduced into dentistry by Hausmann et al. in 1962. As in conventional radiographs there must be bone loss of atleast 30% to be detected radiographically. But I125 Absorptiometry is able to demonstrate itsy-bitsy changes in alveolar bone mass. This method is based on the use of collimated monoenergetic radiation from I125 and replacement of the x-ray film by a non-image forming detector *(Henrikson 1979).* I125 is considered as most sensitive technique for analyzing periodontal bone changes and can be used as a standard for comparing the sensitivity of other techniques.

Other variants:

- Single photon absorptiometry that determines the total thickness of the alveolar ridge (hard and soft tissue).
- Dual photon absorptiometry that determines the bone mass.

Digital radiography

Digital radiography as the name suggests, it uses sensor and information which is presented and then stored as a digital image in a computer. Digital radiography in dentistry was first introduced in 1987 by Dr. Francis Mouyen who launched Radio Visio Graphy (RVG) with the help of physicist and charge couple image sensor design engineer Paul Suni *(Jayachandran 2017).*

Digital radiographic images can be direct, indirect or semi-direct. In Periodontal diagnosis, it provides high resolution which helps in visualizing supporting tissues including the finer details such as periodontal ligament space, alveolar bone crest, lamina dura and bony trabecularization *(Ahmadi2010).*

Digital subtraction radiography

Subtraction radiography provides greater visualization of radiographic changes between a pair or series of radiographs by subtracting out the background which is common in all *(Jeffcoat1993).* Digital subtraction radiography (DSR) can be used to ameliorate the detection of crestal or periapical bone density changes and to evaluate caries progression.

T Mera in 1989 had demonstrated that digital subtraction radiography is useful in monitoring alveolar bone changes associated with periodontal diseases *(Mera1989).*

In 1994 Ortmann stated that even 5% of bone loss can be detected in Digital Subtraction Radiography.

Computer Assisted Densitometric Image Analysis system (CADIA)

It was introduced by Urs Brägger et al 1988 *(Brägger1988).* This technology utilizes a video based computer assistance programme and then signals are converted to grey scale images.

It offers an objective method for studying alveolar bone changes quantitatively. This technique is highly sensitive and accurate.

Advanced 3-d Radiography

No doubt that the abovementioned advanced 2-D radiographic techniques are highly sensitive and more accurate than conventional radiographic methods but they are demonstrating structure in 2-D only. So, more advanced techniques having 3-D image visualization have been developed. These are:

- Computed Tomography (CT)
- Small volume CT
- Tuned Aperture CT (TACT)
- Cone Beam CT (CBCT)
- Cone Beam Volumetric tomography (CBVT)
- Quantitative CT (QCT)
- Optical Coherence Tomography (OCT)
- Nuclear medicine
- Magnetic Resonance Imaging (MRI)
- Ultrasonography

Computed Tomography(CT)

Computed tomography is very important diagnostic tool for diseases related to internal tissues. CT is X-ray based computer assisted technique which uses a series of X-rays projected from multiple angles through a gantry and then these multiple images are used to construct visualization of internal tissues of body (bone, muscles, fat, organs and blood vessels). In Periodontics Fuhrmann (1995) precisely evaluated alveolar bone height and intrabony pockets by using CT. Routine use of conventional CT in dentistry is not feasible because of high cost, unnecessary excessive radiation and general practicality. Computed tomography can be of two types:

- Fan beam CT
- Cone beam CT

Tuned Aperature CT(TACT)

It is designed to produce holographic images with 3-D views of teeth and pathology. In 1997 Webber used TACT to detect location of Periodontal bone gain/loss, alveolar bone contour and even recurrent caries.

Cone Beam Computed Tomography (CBCT)

Since its introduction for the maxillofacial region by Italian co-inventors Attilio Tacconi and Piero Mozzo in 1998, CBCT imaging has become an important and established diagnostic tool for the clinical assessment and treatment planning of patients needing dental implants. It is important for clinicians to have a full understanding of the technical principles of dental CBCT imaging to purchase the correct machine, and using it correctly and effectively to reap the full benefit, while minimizing radiation-related patient risk.

CBCT machine consists of:

- CBCT imaging hardware
- Image detector

CBCT imaging hardware

It is made up of three basic elements:

- X-ray source (X-ray generator)
- Image detector (sensor)
- Gantry (C-arm or rotating platform) that connects the X-ray source and the detector

CBCT generates 3D volumetric images and provides axial, coronal and sagittal multiplanar reconstructed images without magnification. These 3D images are imperative for the diagnosis of intrabony defects, furcation involvements and buccal/lingual bone destruction *(Acar 2014).*CBCT applications provide obvious benefits in periodontics, however; it should be used only in correct indications considering the necessity and the potential hazards of the examination.

Optical Coherence Tomography (OCT)

It is an optical signal acquisition and processing method which employs infrared rays and is useful in digital recording of Pocket morphology and attachment level. Optical Coherence Tomography provides quantitative details of character and thickness of gingiva, distribution of subgingival calculus and root surface irregularities. Optical coherence tomography is a dedicated method for determining attachment level. Xiangectal 2009 had evaluated that OCT offers 3-D imaging of periodontal soft tissues and provide a very high resolution.

Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging is the most advanced imaging technique as it uses non-ionizing radiation for visualization of soft tissues (dental pulp, gingiva, nerves). It has been employed for detection of inflammatory lesions in soft as well as hard tissues. It can detect Histopathological changes in gingiva at very early stages of periodontal disease.

Nuclear Medicine

With his invention of the first clinically successful radioisotope camera (the scintillation, or Anger gamma, camera) over 40 years ago, Hal O. Anger, BS, DSc (hon.), created the foundation for the sophisticated dedicated imaging systems available today[13]. Anger was quite influential in changing nuclear medicine from a static imaging technique to one that highlights its tomographic and functional capabilities *(Tapscott19981)* (Figure3) .

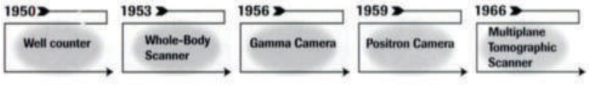

Figure3: Chronology of Hal O. Anger's Nuclear Medicine Invention.(Tapscott 1998)

Nuclear medicine vernacularly termed "bone scanning" is used to study alterations in bone metabolism using radio labeled bone seeking radiopharmaceutical molecule like 99 m- technetium. Nuclear medicine visualize changes that indicate bony metastases, primary bone tumors, metabolic bone diseases, and stress fractures. Nuclear medicine is useful in dentistry for the early detection of periapical pathologies and growth disorders.

Nuclear medicine can be employed in three categories of imaging devices:

- Planar nuclear imaging
- Single-photon emission computed tomography *(SPECT)*
- Positron emission tomography *(PET)*

Ultrasonography

The conventional periodontal examination using periodontal probe comes up with critical metrics like Clinical Attachment level, Gingival Recession and pocket depth, howbeit this is painful to patients and is time consuming for clinicians. New advanced imaging using ultrasound waves have been developed to overcome these hurdles in accurate diagnosis *(Moore 2022).* The pioneer of ultrasonography usage in Periodontics is *Spranger*. In this technique, different echoes from hard and soft tissues are recorded and then interpreted for diagnosis *(Lin 2018; Bains2008)*. Examples of ultrasonic diagnostic use is an ultrasound probe by *NASA (Joseph 1998) and ULTRADERM.*

The upper hand of Ultrasonic imaging in Periodontal Diagnosis as follow:

- Non-Invasive
- Portable
- Low cost alternative
- Free of ionizing radiations
- Lesser intra-examiner variations
- For imaging peri-implantitis
- For topography of edentulous crestal bone

Artificial intelligence in radiographic diagnosis

The literal meaning of Artificial Intelligence (AI) is making up of decisions by computer and its software based programmes without supervisions/inputs of any human resource. AI is next level imaging diagnostic tool without developing any new device or image delivery system *(King 2018)*. AI is a computerized technology to interpret images accurately. Recent and worldwide examples of AI in dental radiology are:

- DL (Deep Learning) tool in analyzing CBCT which is computerized and algorithm based programme.
- DiagnoCat (AI in Clinical Dentistry).

CONCLUSION

Periodontal diseases come under the most prevalent diseases in global population. Also, alveolar bone loss is irreversible phenomenon but it can be prevented by proper diagnosis at the very early stage. This can be done by thorough clinical examination and use of appropriate radiographic technique. No doubt advancement in radiography has made possible to see the minute details of Periodontal structure but it can never be a substitute to good clinical examination.

Table: A Summary Of Different Literal Evidences For Radiographic Technique Useful In Periodontal Diagnosis

RADIOGRAPHIC TECHNIQUES	INFERENCES	REFERENCES
Periapical radiography	Evaluate Interdental alveolar bone changes and appearance of Lamina Dura	Manson 1963 Corbet 2009
Xeroradiography	Excellent aid in evaluating early osseous changes. Assessment of osseous repair after periodontal therapy and visualization of crestal height	Lopez 1976
I125absorptiometry	Most sensitive for analyzing Periodontal bone changes and mineral content of alveolar bone	Hausmann 1962 Ortmann 1982
Digital radiography (RVG)	Provide finer details of periodontal ligament space, alveolar bone crest, Lamina Dura and bony trabecularization	Francis Mouyen 1987
Digital Subtraction Radiography	Detection of crestal or periapical bone density changes and can detect even 5% of bone loss	T Mera 1989
Computer Assisted Densitometric Image Analysis system (CADIA)	Quantitative alveolar bone changes can be studied	Bragger 1988
Computed Tomography (CT)	Evaluate bone height and intrabony pockets	Fuhrmann 1995
Tuned Aperture Computed Tomography (TACT)	Detect location of periodontal bone gain/loss, alveolar bone contour	Webber 1997

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Cone Beam Computed Tomography (CBCT)	Precisely and accurately evaluate the alveolar bone characteristics and considered as gold standard	Kelly 2006 Mol and Balasundaram 2008 Bezak 2010 Walter 2011 Mohan 2014 Elashiry 2018
Cone beam volumetric tomography(CBVT)	Offers high resolution and accuracy for assessment after regenerative therapy (bone fill/defect resolution)	Tyndall 2012
Quantitative Computed Tomography (QCT)	Provide detailed bone mineral density information with precise 3-D anatomic localization of bone density assessment	Cann 1988
Magnetic Resonance Imaging (MRI)	Histopathological changes of gingiva can be detected at very early stage of periodontal disease	Schara 2009 Gaudino 2011 Ruetters 2018
Optical Coherence Tomography (OCT)	Quantitative information of gingiva	Petra Surlin 2018 Luana 2019
Ultrasonography	Non-invasive , lesser intra-examiner variability	Moore C ,et al 2021 Lin et al 2018 Bains VK, 2008
Artificial Intelligence	DL (deep learning) tool in analyzing CBCT DiagnoCat	King, 2018

REFERENCES

1. Acar B, Kamburoğlu K(2014). Use of cone beam computed tomography in periodontology. *World J Radiol*, 28:6(5), 139-147.
2. Ahmadi RS(2010). Cementoenamel junction- alveolar bone crest distance in interproximal areas of intact primary molars in healthy 7-9 year old girls in Hamadan. *DJH*, 2(1),35-41.
3. Bains VK, Mohan R, Bains R(2008). Application of ultrasound in periodontics: Part I. *J Indian Soc Periodontol*, 12(2), 29-33.
4. Bhatti UD(2012). Common Radiographic Errors in Dentistry. *Acta sci dent sci*, 4(3), 14.
5. Brägger U, Pasquali L, Rylander H, Carnes D, Kornman KS (1988). Computer-assisted densitometric image ansalysis in periodontal radiography. A methodological study. *J Clin Periodontol,* 15(1), 27-37.
6. Carranza, F., Newman, M., Takei, H. and Klokkevold, P (2012). *Carranza's Clinical Periodontology*. 11th ed. St Louis, Mo: Elsevier saunders.
7. Corbet EF, Ho DKL and Lai SML (2009). Radiographs in periodontal disease diagnosis and management. *Aust Dent J*, 54(1), 27–43.
8. Henrikson CO (1979). Alveolar bone mass using 125I absorptiometry. *J Periodontol*, 50(4), 30-4.
9. Jayachandran S (2017). Digital imaging in dentistry: A review. *Contemp Clin Dent* , 8(2), 193-194.
10. Jeffcoat MK, Reddy MS(1993). Digital Subtraction Radiography for Longitudinal Assessment of Peri-Implant Bone Change: Method and Validation. *Adv Dent Res,* 7(2), 196-201.
11. King BF Jr (2018). Artificial Intelligence and Radiology: What Will the Future Hold? *J Am Coll Radiol*; 15(3 Pt B): 501-3.
12. Lin CY, et al(2018). Photoacoustic Imaging for Noninvasive Periodontal Probing Depth Measurements. *J Dent Res*, 97(1), 23-30.
13. Manson JD(1963). The Lamina Dura. *Oral Surg Oral Med Oral Pathol*, 16, 432-7.
14. Mera T(1989). Digital Subtraction Radiography for detection of periodontal bone changes. *Nihon Shishubyo Gakkai Kaishi*, 31(1), 129-146.
15. Moore CA, et al (2022). High-resolution ultrasonography of gingival biomarkers for periodontal diagnosis in healthy and diseased subjects. *Dentomaxillofac Radiol*, 51(6), 20220044.
16. Rao KD(2008). Conventional dental radiography vs. Advanced dental imageology. *J Indian Acad Oral Med Radiol*, 20(2), 77-80.
17. Tapscott E (1998). Nuclear Medicine Pioneer: Hal O. Anger.First scintillation camera is foundation for modern imaging system. *J Nucl Med*, 39(3):15N, 19N, 26N-27N.