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Renaissance in Periodontal Imaging: A Systematic Review

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Abstract:
Dentistry has seen colossal advances in all its branches in the course of the last three decades. With these advances, the requirement for more exact analytic tools, specially imaging methods, have end up plainly obligatory.
These simple radiographic strategies experience the ill effects of characteristic confinements like: Two dimensional projection, superimposition, magnification, and distortion of anatomic structures.
The advancement of 3D imaging modalities has made enhanced elucidation of auxiliary and biophysical changes, guarantees densitometric evaluations of dentoalveolar structures incorporating varieties in alveolar bone thickness, a peri‐implant bone mending all the more definitely.
The aim of this review is to focus on the requirements, applications, advantages and disadvantages and artifacts of the currently available digital imaging techniques.

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I Introduction

It is for the most part broadly acknowledged that radiographs supplement clinical examination in setting up the conclusion and controlling the treatment get ready for a patient influenced by those periodontal ailments which have added to pulverization of the periodontal attachment. (**Fig.1**)

Simple two dimensional (2D) imaging modalities have been utilized as a part of dentistry since the main intraoral radiograph was gotten in 1896. From that point forward dental imaging systems have progressed with presentation of tomography and all encompassing imaging.

Simple 2D imaging utilized as an extra to periodontal appearances couldn't add to this totally. Novel imaging modalities, accessible to date uncovered the periodontium, three dimensionally in this way empowering periodontists for early determination and better intercession. Consistently, clinician ought to be guided by the standard of utilizing the slightest obtrusive procedure with the most minimal danger of radiation exposure [1].

This review is based on the different radiographic techniques used for the appraisal of patients with periodontal disease. The different radiographic views to assist periodontal treatment planning are as follows:

- Conventional 2d imaging modalities
- Advanced 2d imaging modalities
- Cross sectional imaging modalities
- Imaging modalities for placement of implants

Conventional 2D Imaging Modalities:

The different radiographic perspectives to help periodontal treatment planning are conventional and specialized radiographic methods (**Table 1**).

Periapical Radiographs

There are two intraoral periapical techniques that are utilized as a part of the dental radiography:

a.) The paralleling technique.

b.) The bisecting angle technique.

Full-mouth studies of paralleling periapical radiographs have been thought to be a "best quality level" for periodontal analysis and treatment planning [2]. The paralleling technique is preferred on the grounds that it delivers a more exact and less twisted radiographic picture than the bisecting angle technique.

Inconvenience of periapical picture is that it gives a parallel perspective of jaw and no cross-sectional data, does not give a quantitative picture to bone thickness and angulation, distortion can't be institutionalized in these radiograph.

In any case this radiographic methodology is the most helpful normally utilized as a part of guaranteeing the bone to implant relationship during post surgical and support period of the implant due to the simplicity with which it can be performed and least introduction to radiation.

Occlusal Radiographs

The Occlusal radiographs additionally are helpful when patients can't open mouth sufficiently wide for Periapical radiographs or for different reasons can't acknowledge Periapical radiography. These kinds of radiographs are brought in patients with trismus, impacted canines and third molars.

Ortho Pantomography (OPG)

Ortho Pantomography is utilized as substitute for full mouth IOPA. It can be utilized as a part of follow-up treatment, advance of pathology, postoperative bony healing and preceding any surgical strategies. **[3]** It is likewise used to perspective of the alveolar bone levels and assessment of vertical heights of alveolar bone. It has a low introduction dosage contrasted with full mouth IOPA. Anatomical structures are most identifiable and appropriate introduction of contiguous structures and generalized bone loss can be recognized.

Advanced 2d imaging modalities

The confinements of conventional 2D imaging modalities could be overwhelmed with the development of advanced 2D imaging modalities as delineated in **Table 2**.

Microradiography is fundamentally demonstrated for the quantitative evaluation of basic highlights in mineralized tissues. The two sorts of microradiography include: Conventional contact microradiography and parallel beam microradiography which examinations the level of mineralization of dental tissues like dentinal tubules. Be that as it may, their characteristic confinements like long exposure time and requirement for high power X-beam sources blocks its use [4].

Xeroradiography fulfills the property of edge upgrade by which little structures and areas of negligible thickness contrasts are better envisioned. Along these lines, it is a magnificent guide in assessing early bony changes, appraisal of osseous repair after periodontal treatment, and to plainly picture the crestal heights [5]. Disservices including Technical challenges, Transient picture maintenance, Slower speed, Technical confinements constrains its utilization.

Stereoscopy It is as of now utilized for looking at temporomandibular joint morphology, assessment of bony pockets, assurance of root configuration requiring endodontic treatment, appraisal of relationship of mandibular canals to roots of unerupted third molars, and to decide the bone form during dental implant conditions. Notwithstanding its wide applications, stereoscopy is ignored because of the requirement for long exposure time [6].

Scanography (soredex scanora) is a monetarily accessible X-beam unit. Scanography may be linear or rotational.. It is equipped for both posterioanterior and sidelong direct examining of the maxillofacial complex. The rotational scanography method was observed to be powerful in the evaluation of periodontal ailment and in location of periapical lesions[6].

I125 Absorptiometry It is the most sensitive strategy for dissecting periodontal bone changes and can be utilized as a standard for contrasting the affectability of different techniques. Different variations of this procedure incorporate single photon absorptiometry that measures the aggregate thickness of the alveolar edge and double photon absorptiometry that decides the bone mass [7].

Nuclear Medicine portrays changes that demonstrate bony metastases, bone tumors, metabolic bone illnesses, and stress fractures [8,9,10]. Nuclear medication is helpful in dentistry for the early identification of periapical pathologies and development disorders [11,12,13,14] . It has three classes of imaging devices: planar atomic imaging, single-photon outflow figured tomography (SPECT), and for positron emanation tomography (PET).

Planar nuclear imaging system proficiently pictures huge anatomical areas from a wide assortment of headings. It is utilized to see areas of the alveolar process in the research facility and clinical investigations of periodontitis [15,16,17,18,19] .

SPECT is an upgrade of planar imaging with improveded image resolution. PET: Clinical uses of PET examining incorporate cardiac imaging and tumor diagnosis[20].

Radiovisiography (RVG) framework is able to do quickly showing an advanced radiographic picture on a screen which brings about a lower radiation. A filmless domain permits fast picture securing, more affordable stockpiling, different review, and remote trade of pictures. Improvement of a filmless situation likewise encourages the educating and research obligations officeholder in a scholastic domain.[21].

Digital Subtraction Radiography (DSR) in periodontology helps in the recognition of initial changes in alveolar bone at the very early stage, which may somehow or another go undetected. It is valuable strategy to recognize crestal or periapical bone thickness changes [22]. Impediments of DSR are not skilled to give a goal description, no decrease in exposure, not an efficient and tedious process.

Cross sectional imaging modalities

The interest for getting cross-sectional data in all planes of intrigue has concentrated light towards novel cross-sectional imaging modalities as outlined in **Table 3.**

Computed Tomography (CT) is a specific radiographic strategy that depicts cross sectional picture of an object without superimposition of structures in the plane parallel to the X-beam bar. It shows contrasts between different delicate tissues. The capacity of CT framework to recognize objects of comparable thickness and catching the information in computerized shape for ensuing examination and reformatting blocks its utilization as a progressed demonstrative guide in periodontitis. Studies [23] have demonstrated that CT appraisal of height of alveolar bone and intrabony pockets is exact. Be that as it may, the expanded radiation presentation constrains its utilization in periodontics [24].

Cone-Beam Computed Tomography (CBCT) is an option imaging innovation presented for procuring three dimensional(3D) information for demonstrative errands. At present, five CBCT frameworks are utilized to be specific the Newtom 3G (quantitative radiology), I-CAT (Imaging Sciences International), CB Mercuray (Hitachi Medical Corporation), 3D Accuitomo (J. Morita Manufacturing), and the ILUMA (IMTEC Imaging). Cone-beam CT may give detailed data about furcation involvements in patients with chronic periodontitis [25] and furthermore help in treatment planning of dental implant procedures by measuring bone volume and quality precisely. It is as exact as direct measurements with a periodontal probe and as dependable as radiographs for interproximal regions, including buccal and lingual deformities. It likewise manages in finding the anatomic snags to be abstained during implant placement. Also, a reasonable perspective of TMJ complex, showing disintegration, osteophytic arrangement of the condyle or both is acquired without obstruction from surrounding dense temporal bone [26, 27].

Spiral Tomography is utilized as a significant aid in the treatment arranging of endosseous dental implants. In particular, it is valuable in cases requiring ideal implant angulation because of insignificant crestal width and high esthetic requests. Spiral tomography is analytically better than CT as far as diminishing artefacts, obscured pictures and diminishing the radiation exposure to imperative structures of head and neck [28].

Tuned Aperture Computed Tomography (TACT) can be utilized to create 3D perspectives of teeth, pathology, and different ranges of intrigue. TACT helps in diagnosing breaks of crowns and roots recognizes auxiliary canals. Also, it identifies the area of periodontal bone level, TMJ bony changes, and alveolar contours [29].

Cone Beam Volumetric Tomography(CBVT) in which 3D pictures are gotten. This forestalls the need for surgical reentry to evaluate the result of periodontal bone grafting. It produces pictures that have high resolution and exactness for measuring regenerative treatment results like direct bone fill and defect resolution [30].

Quantitative Computed Tomography (QCT) offers exact 3D anatomic location of bone thickness estimations[31]. This grants simple differentiation amongst cortical and cancellous bone and evades extra-osseous, however conceivably perplexing structures, for example, mineralized vessels walls. QCT is a built up technique for estimation of the trabecular bone mineral thickness in the alveolar procedure of edentulous regions in post-menopausal ladies. Moreover, it surveys the degree of mineralization following autologous alveolar ridge augmentation [32, 33].

Simplant is a PC program for surveying oral implant site .Uses crude information from CT alongside advanced computer graphics. The focal points are appraisal of bone volume, bone height & quality, Proper length of implant can be chosen and clear perception of inferior alveolar canal.

Digital Tomosynthesis (DTS) the guideline of tomosynthesis depends on selective focusing of an arbitrary slice cut through the object by moving and including an arrangement of premise projections. By this strategy Pocket morphology, and attachment level are carefully recorded. Quantitative data of thickness and character of the gingiva, root surface inconsistencies, and the distribution of subgingival calculus.

Magnetic Resonance Imaging (MRI) It includes the conduct of protons in an magnetic field. In head and neck region it is utilized for the evaluation of intracranial injuries including especially the back cranial fossa, the pituitary and the spinal cord. For examination of the salivary organs and Tumors, examination of the TMJ to indicate both the hard and soft tissue structures and implant appraisal. there is no organic impacts. It gives higher soft tissue differentiate. Veins unmistakably seen. High determination pictures can be built in all planes.

DICOM Standard is the Digital Imaging and Communications in Medicine. It encourages correspondences between imaging device and frameworks. By managing particular information and interface necessities, DICOM guarantee that devices, especially devices made by various providers, can speak with each other.

II Imaging Modalities For Placement Of Implants

An anatomic variety in jaw morphology makes imaging an essential part of implant planning [35] The decision of implant imaging ought to be founded on clinical requests like, the requirement for depiction of anatomic or topographic conditions, simplicity of image production data anticipated from the image, biologic hazard for the patient and monetary considerations [36].(Table 4)

With traditional tomography, it is conceivable to get cross sectional pictures that can be utilized to decide bone width. With both conventional and CT, it is conceivable to get data about the width, height, and inclination of the alveolar process anatomic and topographic structures.

For the most part, the radiographic assessment of implant patients ought to be completed by the accompanying 3 axioms:

General contemplations: Prior to placement of implant, it appears to be suitable to consider panoramic radiography as a standard radiographic examination for alluded patients, It gives an exact methods for deciding implant length in both the maxilla and mandible with low biologic hazard. Periapical radiographs might be shown in regions not strongly portrayed in the all panoramic radiograph.

Cross-sectional imaging: In the maxilla cross-sectional imaging ought to be exhorted:

(a) In patients with extreme bone loss in the alveolar process, for single implant in the incisor area or various implants in the incisor and canine region,

(b) In destinations with serious bone loss and closeness of the maxillary sinus and,

(c) In patients getting ready for fixed prosthesis in the totally edentulous maxilla. In the mandible, cross-sectional imaging ought to be utilized when planned for fixed prosthesis.

Ideal applications for cross sectional imaging in both the maxilla and mandible: Conventional or CT is exhorted in conditions where unfavorable soft tissues impede appraisal of bone volume. In the mandible, it can be utilized for patients with a pronounced mylohyoid line and submandibular fossa. From a radiobiologist perspective, conventional tomography ought to be favored at whatever point feasible for single tooth gaps and extended edentulous spaces up to a quadrant [37,38,39,40,41,42,43].

At present, conventional cross-sectional tomography is suggested by the American Academy of Oral and Maxillofacial Radiology for most patients getting implants. [44].

The direct laser positioning system (DLP system) presented by Naitoh et al. [45] was created using a panoramic X-ray machine with a linear tomographic function. The DLP system permits the adjustment of the angle of the objective plane to the angulation of each designed implant site by tilting the occlusal plate with the accessory tool. The DLP system is viewed as helpful, particularly for patients with a small number of implant sites [46].

The recently developed limited cone beam X-ray CT (LCBCT) [47] makes utilization of cone beam and a 2D X-ray sensor.

It is accounted for to be helpful in pre-operative treatment planning for dental implant placement (Ito et al. 2001). The indispensable assimilated dose of radiation utilizing LCBCT was roughly 1/fifteenth that of spiral CT (SCT). It is a reliable tool for pre-operative assessment before dental implant surgery as a result of its high determination and diminished radiation[48].

III Discussion

Diagnosis of periodontal pathologies relies upon clinical signs and indications. Be that as it may, radiographic imaging is fundamental in the determination of pathologies related with alveolar bone. Two dimensional imaging systems are routinely utilized for the appraisal of alveolar bone deformities in periodontology. Computed tomography is a tomographic technique that mixes the idea of thin layer (tomography) radiography with the PC combination of the image (computed)[49] . Studies **[50]** have demonstrated that CT evaluation of alveolar bone height and intrabony pockets is precise. Notwithstanding, the expanded radiation exposure confines its utilization in Periodontics [51].

CBCT has the capacity of imaging these zones without the confinements of two dimensional imaging strategies [52, 53]. Studies have assessed the part of CBCT in periodontal analysis. In vitro studies announced the helpfulness of CBCT in the imaging of periodontal deformities [54-55]. An examination investigated the analytic estimations of digital intraoral radiography and CBCT in the assurance of periodontal bone loss, infrabony craters and furcation involvements[56]. CBCT generates a higher radiation dose to the tissues than conventional radiographic techniques. The effective radiation dose should not be underestimated, especially in childrens, who are much more susceptible to stochastic biological effects [57].

Spiral computed tomography is a computed tomography technology involving movement in a helical pattern for the purpose of increasing resolution. Most modern hospitals currently use spiral CT scanners. Spiral tomography is diagnostically superior to CT in terms of reducing artefacts, blurred images and decreasing the radiation exposure to vital structures of head and neck by 47-71% compared to CT [58].

Artifacts associated with CT, such as starburst patterns seen with metallic restorations, do not exist with TACT. TACT has proved to be effective in the determination of root fractures, especially vertical fractures.

Nair et al [59] found that TACT was a more effective and accurate imaging modality for non- destructive quantification of osseous changes within the healing bony defects.

CBVT produces images that have high resolution and accuracy for measuring regenerative therapy outcomes like direct bone fill and defect resolution [60]

QCT is an established method for measurement of the trabecular bone mineral density in the alveolar process of edentulous regions in post-menopausal women. In addition, it assesses the extent of mineralization following autologous alveolar ridge augmentation [61]

Micro focus CT analysis enables highly quantitative and qualitative measurement of bone augmentation. Thus, it is a dynamic non-invasive method for measuring bone regeneration. Advantages of micro focus CT are ease of reconstruction of 3D images within a short time, minimizing the risk of artefacts. Kochi et al. in 2010 [62]

MRI can also detect joint effusions, synovitis, erosions and associated bone marrow oedema. Odontogenic cysts and tumors can be distinguished better on MRI than on CT. According to periodontal point of view it can also identifies soft tissue diseases, especially neoplasia, involving tongue, cheek, salivary glands, neck and lymph nodes [63]

Dentascan imaging provides programmed reformation, organization, and display of the imaging study. Limitation of Dentascan imaging includes images that are not true in size and require compensation for magnification.

Digital image standardization, subtraction radiography, 3D imaging and quantitative image analysis are already a reality. There is little doubt that periodontists of the future will be using more advanced imaging modalities, either directly as a chair side procedure, or indirectly through the services of an oral and maxillo facial radiologist. Dentists should have knowledge of the working principles, requirements, clinical benefits and hazardous effects of these systems for proper usage.

IV Summary

Recent advances in imaging sciences have enabled periodontists to visualize structural and biophysical changes in the periodontium more accurately.

The various radiographic views to assist periodontal treatment planning are conventional and specialized radiographic techniques. The conventional radiography incorporates intraoral, occlusal, bitewing and extraoral radiograph.

The limitations of traditional 2D imaging techniques could be overcome with the evolution of advanced 2D imaging techniques.

The well-known 2D approaches though cost effective have limitations like image distortion and decreased resolution. The paradigm shift from 2D to 3D imaging techniques like CBCT, QCT, CBVT, and microfocus CT enabled to overcome these limitations.These novel advances have periodontal ramifications both for analysis and for assessment of helpful results.

To abridge from an analytic perspective CBCT gives an identical representation of intrabony defects in every one of the three planes. TACT and DSR decisively finds bone loss or gain and helps in pre-surgical implant planing. QCT evaluates trabecular bone mineral thickness in edentulous area. Regenerative treatment and implantology are the two fields of periodontology that need consideration in this angle. CBVT evaluate the result of bone grafting techniques like bone fill. QCT distinguishes mineralization following autologous alveolar ridge augmentation.

Late advances in imaging sciences have empowered periodontists to picture auxiliary and biophysical changes in the periodontium all the more precisely. However the decision of the suitable methodology correlated to the case still remains a predicament.

V Conclusion

This review endeavors to abridge novel imaging propels regarding their standards, periodontal ramifications, improving the decision of fitting radiographic guide for early conclusion and better periodontal intercessions.

There is little uncertainty that periodontists without bounds will be utilizing further developed imaging modalities, either straightforwardly as a chair side methodology, or in a roundabout way through the

administrations of an oral and maxillo facial radiologist. Dental practitioners ought to know about the working standards, necessities, clinical advantages and dangerous impacts of these frameworks for legitimate use.

Refferences

[1]. Newmann TG, Kornmann KS, Newmann MG, Jeffcoat M. Imaging techniques for the periodontium. Advances in Periodontics. Qiuntessence Publication; 1992. p. 42-55.
[2]. Corbet EF, Ho DKL, Lai SML. Radiographs in periodontal disease diagnosis and management. Australian Dental Journal 2009;54:(1 Suppl):S27-43.
[3]. Stuart C. White , Michael J Pharoah . Oral Radiology Principles and Interpretation 2009; 6 : 109 – 244
[4]. Takagi S, Chow LC, Brown WE, Dobbyn RC, Kuriyama M. Application of an x-ray image magnifier to the microradiography of dental specimens. J Dent Res 1985;64:866-9.
[5]. Lopez J Jr. Xeroradiography in dentistry. J Am Dent Assoc 1976;92:106-10.
[6]. White SC, Pharaoh MJ. Oral Radiology Principles and Interpretation. 5th ed. St. Louis, Missouri: Mosby Publication; 2004. p. 248-50.
[7]. Hausmann E, Ortman LF, McHenry K, Fallon J. Relationship between alveolar bone measured by 125I absorptiometry with analysis of standardized radiographs: 1. Magiscan. J Periodontol 1982;53:307-10.
[8]. Bell EG. Nuclear medicine and skeletal disease. Hosp Pract 1972;8:49-60.
[9]. Jacobsson S, Hollender L, Lindberg S, Larsson A. Chronic sclerosing osteomyelitis of the mandible. Scintigraphic and radiographic findings. Oral Surg Oral Med Oral Pathol 1978;45:167-74.
[10]. Mettler FA, Guiberteau MJ. Essentials of Nuclear Medicine Imaging. New York: Grune and Stratton; 1983. p. 214-47.
[11]. Garcia DA, Jansons D, Kapur KK. Bone-imaging and semiconductor probe measurements of technetium-99m-polyphosphate in the detection of periapical pathology in the dog. Arch Oral Biol 1976;21:167-74.
[12]. Donoff RB, Jeffcoat MK, Kaplan ML. Use of a miniaturized detector in facial bone scanning. Int J Oral Surg 1978;7:482-7.
[13]. Kaban LB, Cisneros GJ, Heyman S, Treves S. Assessment of mandibular growth by skeletal scintigraphy. J Oral Maxillofac Surg 1982;40:18-22.
[14]. Cisneros GJ, Jeffcoat MK, Kaban LB. Bone-seeking radiopharmaceutical uptake as an indicator of mandibular growth in rats. Angle Orthod 1985;55:336-44.
[15]. Garcia DA, Entine G, Tow DE. Detection of small bone abscesses with a high-resolution cadmium telluride probe. J Nucl Med 1974;15:892-5.
[16]. Garcia DA, Sullivan TM, Jungman C, O'Neil DM. An experimental evaluation of endodontic procedures and filling materials. Oral Surg Oral Med Oral Pathol 1981;52:641-7.
[17]. Jeffcoat MK, Kaplan ML, Weinstein M, Goldhaber P. Semiconductor probe measurements in beagle pups during deciduous tooth development. J Dent Res 1978;57:743-7.
[18]. Kaplan ML, Garcia DA, Goldhaber P, Davis MA, Adelstein SJ. Uptake of 99mTe-Sn-EHDP in beagles with advanced periodontal disease. Calcif Tissue Res 1975;19:91-8.
[19]. Kaplan ML, Davis MA, Aschaffenburg PH, Adelstein SJ, Goldhaber P. Clinical, radiographic and scintigraphic findings in experimental periodontal disease in dogs. Arch Oral Biol 1978;23:273-8.
[20]. Matteson SR, Deahl ST, Alder ME, Nummikoski PV. Advanced imaging methods. Crit Rev Oral Biol Med 1996;7:346-95.
[21]. Weathers K. RadioVisioGraphy Comes of Age. Practical Endodontics 1993; January: 1.
[22]. Gröndahl HG, Gröndahl K. Subtraction radiography for the diagnosis of periodontal bone lesions. Oral Surg Oral Med Oral Pathol 1983;55:208-13.
[23]. Fuhrmann RA, Bücker A, Diedrich PR. Assessment of alveolar bone loss with high resolution computed tomography. J Periodontal Res 1995;30:258-63.
[24]. Scarfe WC, Farman AG. What is cone-beam CT and how does it work? Dent Clin North Am 2008;52:707-30,v.
[25]. Walter C, Kaner D, Berndt DC, Weiger R, Zitzmann NU. Three-dimensional imaging as a pre-operative tool in decision making for furcation surgery. J Clin Periodontol 2009;36:250–257.
[26]. Honda K, Arai Y, Kashima M, Takano Y, Sawada K, Ejima K, et al. Evaluation of the usefulness of the limited cone-beam CT (3DX) in the assessment of the thickness of the roof of the glenoid fossa of the temporomandibular joint. Dentomaxillofac Radiol 2004;33:391-5.
[27]. Vandenberghe B, Jacobs R, Yang J. Diagnostic validity (or acuity) of 2D CCD versus 3D CBCT-images for assessing periodontal breakdown. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;104:395-401.
[28]. Bianchi J, Goggins W, Rudolph M. In vivo, thyroid and lens surface exposure with spiral and conventional computed tomography in dental implant radiography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;90:249-53.
[29]. Webber RL, Horton RA, Tyndall DA, Ludlow JB. Tuned-aperture computed tomography (TACT). Theory and application for three-dimensional dento-alveolar imaging. Dentomaxillofac Radiol 1997;26:53-62.
[30]. Grimard BA, Hoidal MJ, Mills MP, Mellonig JT, Nummikoski PV, Mealey BL. Comparison of clinical, periapical radiograph, and cone-beam volume tomography measurement techniques for assessing bone level changes following regenerative periodontal therapy. J Periodontol 2009;80:48-55.
[31]. Shahlaie M, Gantes B, Schulz E, Riggs M, Crigger M. Bone density assessments of dental implant sites: 1. Quantitative computed tomography. Int J Oral Maxillofac Implants 2003;18:224-31.
[32]. Genant HK, Steiger P, Block JE, Glueer CC, Ettinger B, Harris ST. Quantitative computed tomography: Update 1987. Calcif Tissue Int 1987;41:179-86.
[33]. Cann CE. Quantitative CT for determination of bone mineral density: A review. Radiology 1988;166:509-22.
[34]. Stuart C. White , Michael J Pharoah . Oral Radiology Principles and Interpretation 2009; 6: 109 – 244.
[35]. Aranyarachkul P, Caruso J, Gantes B, Schulz E, Riggs M, Dus I, et al. Bone density assessments of dental implant sites: 2. Quantitative cone-beam computerized tomography. Int J Oral Maxillofac Implants 2005;20:416-24.
[36]. Dula K, Mini R, van der Stelt PF, Buser D. The radiographic assessment of implant patients: Decision-making criteria. Int J Oral Maxillofac Implants 2001;16:80-9.
[37]. Rothman SL, Chaftez N, Rhodes ML, Schwarz MS. CT in the preoperative assessment of the mandible and maxilla for endosseous implant surgery. Work in progress. Radiology 1988;168:171-5.
[38]. Wishan MS, Bahat O, Krane M. Computed tomography as an adjunct in dental implant surgery. Int J Periodontics Restorative Dent 1988;8:30-47.

[39]. Tal H, Moses O. A comparison of panoramic radiography with computed tomography in the planning of implant surgery. Dentomaxillofac Radiol 1991;20:40-2.
[40]. Dandrau JP, Pharaboz G, Bellavoir A. Dentascan in dental implantation. Rev Stomatol Chir Maxillofac 1992;93:263-6.
[41]. Abrahams JJ. The role of diagnostic imaging in dental implantology. Radiol Clin North Am 1993;31:163-80.
[42]. DelBalso AM, Greiner FG, Licata M. Role of diagnostic imaging in evaluation of the dental implant patient. Radiographics 1994;14:699-719.
[43]. Cawood JI, Howell RA. A classification of the edentulous jaws. Int J Oral Maxillofac Surg 1988;17:232-6.
[44]. Almog DM, Benson BW, Wolfgang L, Frederiksen NL, Brooks SL. Computerized tomography-based imaging and surgical guidance in oral implantology. J Oral Implantol 2006;32:14-8.
[45]. Naitoh M, Kawamata A, Takouchi K, Ohsaki C, Ariji E. Improvements of tomography for implant treatment using panoramic X-ray machine: Development of direct laser positioning system. J Soc Oral Implantol 2000;13:59-68.
[46]. Tyndall DA, Brooks SL. Selection criteria for dental implant site imaging: A position paper of the American Academy of Oral and Maxillofacial radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;89:630-7.
[47]. Arai Y, Tammisalo E, Iwai K, Hashimoto K, Shinoda K. Development of a compact computed tomographic apparatus for dental use. Dentomaxillofac Radiol 1999;28:245-8.
[48]. Ito K, Gomi Y, Sato S, Arai Y, Shinoda K. Clinical application of a new compact CT system to assess 3-D images for the preoperative treatment planning of implants in the posterior mandible A case report. Clin Oral Implants Res 2001;12:539-42.
[49]. Fuhrmann RA, Bücker A, Diedrich PR. Assessment of alveolar bone loss with high Resolution computed tomography. J Periodontal Res 1995; 30:258-63.
[50]. Scarfe WC, Farman AG. What is cone-beam CT and how does it work.Dent Clin North Am 2008; 52:707-30,v.
[51]. http://en.wikipedia.org/wiki/Computed_tomography.
[52]. Acar B, Kamburoğlu K. Use of Cone Beam Computed Tomography in Periodontology. World Journal of Radiology 2014; 28;6(5):139-147.
[53]. Corbet, EF Ho DK, Lai SM. Radiographs in Periodontal Disease Diagnosis and Management. Australian Dental Journal 2009;54(1): S27–S43.
[54]. Mengel R, Candir M, Shiratori K, Flores-De-Jacoby L. Digital Volume Tomography in the Diagnosis of Periodontal Defects: An In Vitro Study on Native Pig and Human Mandibles. Journal of Periodontology 2005;76(5):665–673.
[55]. Misch KA, Yi ES, Sarment DP. Accuracy of Cone Beam Computed Tomography for Periodontal Defect Measurements. Journal of Periodontology 2006;77(7):1261–1266.
[56]. Mol A, Balasundaram A. In Vitro Cone Beam Computed Tomography Imaging of Periodontal Bone. Dentomaxillofacial Radiology 2008;37(6):319–324.
[57]. Vandenberghe B, Jacobs R, Yang J. Detection of Periodontal Bone Loss Using Digital Intraoral and Cone Beam Computed Tomography Images: An In Vitro Assessment of Bony and/or Infrabony Defects. Dentomaxillofacial Radiology 2008;37(5):252-260.
[58]. Bianchi J, Goggins W, Rudolph M. In vivo, thyroid and lens surface exposure with spiral and conventional computed tomography in dental implant radiography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;90:249-53.
[59]. Nair MK, Seyedain A, Agarwal S, Webber RL, Nair UP, Piesco NP, Mooney MP, Grondahl HG. Tuned aperture computed tomography to evaluate osseous healing. J Dent Res. 2001; 80:1621–1624.
[60]. Grimard BA, Hoidal MJ, Mills MP, Mellonig JT, Nummikoski PV, Mealey BL. Comparison of clinical, periapical radiograph, and cone-beam volume tomography measurement techniques for assessing bone level changes following regenerative periodontal therapy. J Periodontol 2009;80:48-55.
[61]. Genant HK, Steiger P, Block JE, Glueer CC, Ettinger B, Harris ST. Quantitative computed tomography: Update 1987. Calcif Tissue Int 1987;41:179-86.
[62]. http://www.emedicinehealth - MRI Introduction.htm.
[63]. Boeddinghaus R, Whyte A. Current concepts in maxillofacial imaging. Eur J Radiol. 2008;66:396–418

FIGURE 1: PERIODONTAL DISEASES

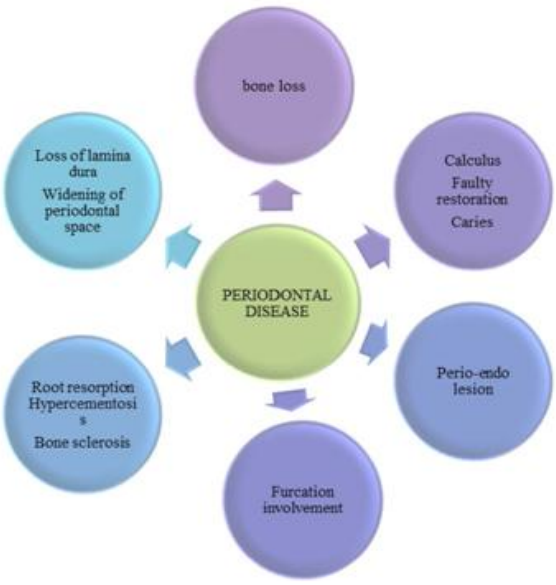

TABLE 1: CONVENTIONAL 2D IMAGING MODALITIES

Technique	Implications
Periapical Radiographs	Appraise root apex, bone loss
Occlusal radiographs	Perceive bone height as well as the tooth root
Oral pantomography	Perspective of the alveolar bone levels and assessment of vertical heights of alveolar bone

TABLE 2: ADVANCED 2D IMAGING MODALITIES

Technique	Implications
Microradiography	Evaluate the level of mineralization of dental tissues like dentinal tubules
Xeroradiography	Assessing early bony changes, appraisal of osseous repair after periodontal treatment, and to plainly picture the crestal heights.
Stereoscopy	TMJ morphology, bony pockets, appraisal of relationship of mandibular canals to roots of unerupted third molars
Scanography (soredex scanora)	Evaluation of periodontal ailment and in location of periapical lesions
I125 absorptiometry	Measures the alveolar thickness of the alveolar edge and decides the bone mass.
Nuclear medicine	Demonstrate bony metastases, bone tumors, metabolic bone illnesses, and stress fractures, periapical pathologies and development disorders.
Radiovisiography(RVG)	Dental caries identification, intra bony defects and periapical pathologies recognition
Digital subtraction radiography	Recognition of initial changes in alveolar bone, crestal or periapical bone thickness changes

TABLE 3: CROSS SECTIONAL IMAGING MODALITIES

Technique	Implications
Computed tomography (CT)	Appraisal of height of alveolar bone and intrabony pockets
Cone-beam computed tomography (CBCT)-	Pre-surgical implant planning by measuring bone volume and quality TMJ complex, showing disintegration, osteophytic arrangement of the condyle Maxillary sinus-extension of root apices, sinus floor
Spiral tomography	Endosseous dental implant cases
Tuned aperture computed tomography (TACT)	Diagnosing breaks of crowns and roots Recognizes auxillary canals Precise identification of bone loss/gain Detect recurrent caries
Cone beam volumetric tomography(CBVT)	Assess periodontal bone grafting procedures including treatment outcomes like direct bone fill and defect resolution
Quantitative computed tomography (QCT)	Assess trabecular bone mineral density in edentulous ridge Assess mineralization following autologous alveolar ridge augmentation
Simplant	Appraisal of bone volume, bone height & quality, Proper length of implant can be chosen and clear perception of inferior alveolar canal
Digital tomosynthesis (DTS)	Pocket morphology, and connection level are carefully recorded quantitative data of thickness and character of the gingiva, root surface inconsistencies, and the conveyance of subgingival calculus
Magnetic resonance imaging (MRI)	Evaluation of intracranial injuries examination of the salivary organs and Tumors, examination of the TMJ to indicate both the hard and soft tissue structures and implant appraisal. Veins unmistakably seen
DICOM Standard	Encourages correspondences between imaging device and frameworks

TABLE 4: IMAGING MODALITIES FOR PLACEMENT OF IMPLANTS

Technique	Implications
Spiral tomography	Endosseous dental implant cases
Cone beam computerized tomography	Pre-surgical implant planning by measuring bone volume and quality TMJ complex, showing disintegration, osteophytic arrangement of the condyle Maxillary sinus-extension of root apices, sinus floor
Direct laser positioning	Patients with less number of implant sites

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