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# Dental Imaging Techniques: A Review Article

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## ABSTRACT:-

For many years, radiographs have been a useful tool for identifying periodontal disease and assessing the efficacy of treatment. The importance of radiography in periodontal diagnostics is increasingly increased by computer-based image acquisition and processing techniques. In addition to serving as a baseline for the assessment of treatment outcomes, radiographs can offer crucial information for diagnosis and treatment planning. Traditional radiographic tools are ineffective for identifying the areas of ongoing tissue degradation, tracking the effectiveness of treatment, and assessing susceptibility to further periodontal disease. To get around these restrictions, different modalities have been developed, including graphic diagnostic methods used in periodontics.

## INTRODUCTION: -

Periodontology has faced significant challenges with diagnostic testing. It is mostly based on data gathered from the patient's medical and dental histories as well as findings from a comprehensive oral examination. Before making a diagnosis, the full set of signs and symptoms associated with a disease is taken into account, along with any extra information offered by radiographic imaging and laboratory tests (1).

Traditional radiographic tools are insufficient for identifying the areas of ongoing tissue degradation, monitoring the effectiveness of therapy, and assessing susceptibility to further periodontal disease. In dentistry, using radiographs as a diagnostic tool has become standard practice. The electronic age has led to the introduction of more specialized equipment into various stages of imaging techniques. (1)

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**Conventional Radiographs**

The configuration of the silver grains in the picture emulsion makes up a traditional radiographic image. The X-Ray beam's intensity affects the density of the silver granules. The pattern of the various silver grain densities is communicated to the eyes and seen as various shades of gray when a radiograph is examined on a light box using transmitted light. (2)

It is a common technique to evaluate the loss of alveolar bone brought on by periodontitis. It can be utilized to assess bone loss, regardless of angular patterns or intra-bony defects, root morphologies and topographies, furcation radiolucencies, endodontic diseases, endodontic misshapes, developmental anomalies, and surviving root length and shape in bone.

**Intra oral periodical radiographs**

Paralleling and bisecting angle procedures are two frequently used methods for taking conventional radiographs. When using bisecting techniques, the central ray of the x-ray beam is directed at right angles to a plane that bisects the angle between the long axis of the teeth and the film, which is placed parallel to the long axis of the tooth (3).

Advantages of intraoral periapical radiogrphs:

A detailed evaluation of apical cysts and other diseases in the alveolar bone is provided, together with information on periodontal state, apical infection, traumatized teeth and the condition of the alveolar bone.

**Conventional panoramic imaging**

Full mouth IOPA is replaced with oral pantomography. It can be utilized for follow-up care, pathological progress, post-operative bone healing, and before any surgical treatments (such the removal of impacted teeth or cyst enucleation) (4). Before inserting osseo-integrated implants, it is also used to view the alveolar bone levels and assess the vertical height of the alveolar bone.

Advantages of pantamography

Compared to full mouth IOPA, it has a lower exposure dose. This investigation creates images of a large anatomic region. The ability to identify anatomical structures, determine the correct orientation of surrounding structures, and spot generalized bone loss are all possible.

**Limitations of OPG**

OPG has restrictions on picture distortion and projection of lingual features above buccal surfaces. Less detail is obtained from screen film combinations than from intraoral pictures. Its limitations include artifact misinterpretation and tooth overlapping.

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## Advanced radiographic techniques

Our understanding of nearly all species of the periodontal disease process has changed as a result of advances in fundamental periodontal research. These advancements have improved periodontal disease prevention, diagnosis, and treatment through significant clinical applications. In contrast, the effect of radiographic imaging on periodontal care has largely remained unaltered for decades. (5)

Considerable dose reduction and increased image quality have been achieved as a result of significant advancements in X-ray generator and X-ray technology. However, there hasn't been much of a shift in the fundamental information that oral radiography images provide. Only a few number of innovative new technologies have been developed to meet the urgent needs in periodontal diagnosis. Many of the drawbacks connected with conventional film-based radiography have been attributed to them, and digital imaging has been lauded as the solution. The majority of these restrictions, though, have to do with how X-rays are transmitted and how images are interpreted, not with the type of image receptor.

## Radiovisiography (RVG)

Lower patient radiation is achieved via the RVG system's quick projection of a digital radiography image on a monitor. The "Radio" component consists of an image receptor and a typical x-ray generator with a timer that can produce very brief exposure times. The "Visio" component digitizes the CCD output signal before displaying it on a monitor. A data storage unit that is coupled to a video printer makes up the "Graphy" component(6). Using CCD, Duret F et al. (1988) described RVG. An environment without film enables quick image capture, less expensive storage, numerous viewing, and remote image interchange. The creation of a filmless atmosphere also makes the duties of teaching and conducting research in an academic setting easier.

The availability of electronic images enables electronic teaching materials, conferences, teleconsultations, and other communication activities. It can be used to find periapical diseases, intra bony abnormalities, and dental caries (7).

## Digital Image

The sensor generates an electrical signal that is a voltage that changes over time. The computer's frame grabber card, which has the specific job of sampling the signal at frequent intervals and converting it from analog to digital, is linked to the sensor. The computer stores the measuring results as numbers (8) The radiation intensities of a rectangular, two-dimensional grid of sensor elements known as pixels are monitored during the image capture and digitization process by an electronic sensor system. The numbers are read out and used to regulate the pixel intensities on the monitor screen in order to display the image. There are several ways to obtain a digital image. (9)

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(A) Conventional Radiograph Digitized, Using a Flat-Bed Scanner and Transparency Adapter Intra oral Detector

(B) Semi direct Digital Image, Acquired Using Photo stimulable Phosphor Plates

(C) Direct Digital Image, Acquired Using a Charge Coupled Device, Complementary Metal- Oxide Semiconductor, or Other Electronic Device

**Intra oral Detector**

Real-time imaging is possible with direct sensor systems; a picture appears on the monitor in a matter of seconds. The CCD sensor is the center of the systems. CCDs are collections of light- or x-ray-sensitive pixels. (10) The several thousand photoelectric cells that make up an ACCD produce voltage in response to the amount of light or x-rays that hit them. The accumulated charge from each pixel is serially sent to a read-out amplifier to read the CCD charge.

Disadvantages of CCD devices

Blooming is akin to letting too much light into a viewbox, which can dazzle the operator and obliterate radiographic details in the overly bright image.

The CCD's output has to be digitalized. The voltages produced by the various CCD elements are then rounded off by a specialized hardware converter (Analog-To-Digital converter [ADC]) into the various values that can be utilized to represent the image digitally.

**Complementary Metal Oxide Semiconductor**

Intraoral sensory stems are increasingly including CMOS-Based sensors. Design integration is the technology's first benefit. Integration, low power consumption, manufacturing ease, and affordability are the main benefits of CMOS image sensors. The ability to take advantage of the high-volume manufacturing capacity already in place to serve the CMOS semiconductor industry is another benefit of CMOS technology. (11) Every computer in the world is already equipped with a CMOS chip.

**Radiography using digital subtraction**

Zeidses des Plantes, who employed a photographic approach, originally exhibited this method in 1935. It is a method for reducing radiological pictures that are not diagnostically significant so that changes can be precisely identified.

By employing a video camera to take an image of a radiograph, digitalization is achieved. The development of digitalsubtractionradiography (DSR) has improved the ability to see how minerals have changed through time. The invention of the microcomputer, which made it possible to digitize and subtract conventional radiographs, made it easier to use substraction radiography in dentistry. The DSR's ability to neutralize the intricate anatomical background against these alterations is its main strength. (12)

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Advantages of DSR

It has the capacity to find tiny osseous lesions. A strong association exists between alterations in alveolar bone. Trabecular marrow gaps can be seen thanks to the augmentation of low- and high-density pictures, which improves the overall contrast.

Disadvantages of DSR

DSR is unable to provide a description that is objective. X-rays are present, they are highly standardized, there is no exposure decrease, and the process is expensive and time-consuming. Additionally, it requires equal projection alignment when exposing successive radiographs.

**Computer Assisted densitrometric image analysis system**

Urs Brägger and colleagues introduced it in 1988. A radiograph's light transmission is measured by a video camera, and the signals are subsequently transformed into images in grey scale. In order to save and mathematically manipulate images, cameras are placed in close proximity to computers and image processors. It provides a method that can be used objectively to measure changes in alveolar bone. High levels of sensitivity, precision, and reproducibility result from this. (13)

**Computer-Based Thermal Imaging**

It contrasts the rates of rewarming in healthy and inflamed human gingiva. Assist in measuring the gingival temperature. useful objective technique for periodontal disease diagnosis. A non-invasive method is provided by infrared thermography.

**Conventional tomography**

By obscuring the images that are outside the plane of interest, it is intended to image a slice or plane of tissue. It is made up of a permanently coupled x-ray tube and radiographic film that revolves around a fixed axis and fulcrum. Tube and film travel in opposite directions simultaneously as exposure starts. Within the fulcrum, objects stay in their fixed places and may be seen clearly. With the development of MRI, CT, and cone beam imaging, its utility has decreased.

**Computed tomography**

Allan MacLeod Cormack and Godfrey Hounsfield shared the Nobel Prize in 1979. It is made up of an x-ray tube that emits a finely collimated x-ray beam that is then directed through the patient and onto a number of scintillating detectors or ionizing chambers. A circle-shaped x-ray tube moves inside a continuous ring of detectors. Patients are still while the x-ray tube spins once. The table will then advance 1 to 5 millimeters to the following scan (14). The use of CT for measuring alveolar bone height has been investigated as a result of the three-dimensional information.

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**Helical CT**

As the patient's table moves through the gantry, which contains an x-ray tube and detectors, it continually revolves around the patient. As a result, a continuous helix of data is collected. The detectors are solid state cadmium tungstate detectors and gas filled xenon ion chambers. (15)

Advantages:

The superimposition of photos of structures outside the interest region is removed. Wide field of view, operator independence, strong soft tissue discrimination, sensitivity to soft tissue calcification, and bone involvement are some of its other features. It provides great contrast resolution variations between tissues with different densities. Sagittal and axial coronal planes are available for viewing images.

Disadvantages:

Expensive radiation dose, difficulty scanning in planes other than axial planes, need for intravenous contrast for optimum results, and high cost are the main drawbacks.

**Magnetic resonance imaging (MRI)**

Ionizing radiation is not used in any way. It deals with how protons behave in a magnetic field. The image itself is an additional instance of a tomograph or sectional image that initially seems similar to a CT.

used to image soft tissue lesions and cerebral lesions. For the examination of intracranial lesions in the head and neck region, particularly those affecting the posterior cranial fossa, the pituitary, and the spinal cord. Salivary gland examination, tumor staging, examination of the TMJ to reveal both the bone and soft tissue components, and implant evaluation.

Advantages of MRI:

It uses non-ionizing radiation. No biological effects exist. Higher soft tissue contrast is produced. Clearly visible blood vessels. In all planes, high resolution photographs can be created. It is helpful to compare an MRI before and after initial periodontal therapy.

Disadvantages of MRI

It is a time-consuming and expensive treatment. Artifacts are created by metallic objects in the mouth cavity.

**Bone scanning or Radionuclide imaging**

In contrast to X-rays, CT scans, and MRI, which evaluate structural or anatomical changes, this approach evaluates biochemical changes in the body. It is a nuclear scanning technique that reveals fresh bone development or bone breakdown locations. It is possible to assess

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alveolar bone deterioration and keep an eye on circumstances that can have an impact on the periodontium (including infection and trauma).

**DICOM Standard**

Digital communications and imaging in medicine. It makes it easier for imaging systems and devices to communicate. DICOM ensures that devices, especially those built by various manufacturers, to communicate with one another by defining certain data and interface criteria.

## SUMMARY AND CONCLUSION:-

When based on solid scientific data, the adoption of future radiography modality advancements has the potential to completely alter how we view the periodontal tissues. It is already possible to perform digital image standardization, subtraction radiography, 3D imaging, and quantitative picture analysis. The use of increasingly sophisticated imaging techniques by periodontists in the future is unquestionably going to increase, whether directly as a chairside treatment or indirectly with the assistance of an oral and maxillofacial radiologist. Dentists should be familiar with the functions, prerequisites, therapeutic advantages, and risk factors of these devices in order to use them properly.

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