



## APPLICATION OF DIGITAL IMAGING IN PERIODONTICS: A REVIEW

## Dental Science

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## ABSTRACT

The use of radiographic imaging as an aid in diagnosis and treatment planning of periodontal disease is widely accepted. Its main purpose is to assess the level of the alveolar bone including the pattern and extent of bone resorption. Radiographs can provide critical information for diagnosis and treatment planning, which can also serve as baseline information for the assessment of treatment outcomes. Computer based image acquisition and processing technique now increase the importance of radiography in periodontal diagnosis. This article reviews various imaging modalities along with an analysis of their clinical application.

## KEYWORDS

Periodontal disease, Digital radiography, Cone beam computed tomography

## Introduction

Progression of periodontal diseases and healing following therapy result in alveolar bone changes. Therefore, the diagnosis of subtle alveolar bone changes is of importance in the treatment and maintenance of periodontitis-susceptible patients and in periodontal research.<sup>1</sup> Treatment of patients with advanced periodontal diseases requires not only extensive clinical recording but also radiological examination. Radiography provides vital information on the amount and type of damage to the alveolar bone. Intraoral radiography is the most commonly used imaging technique for the diagnosis of periodontal bone defects.<sup>2</sup>

Requirements of an Imaging Modality<sup>3</sup>

Diagnostic imaging modality should ideally satisfy the following basic principles: It should be affordable for most patients. Adequate number and types of images should be obtainable in order to provide required anatomical information. The imaging technique selected should provide the accurate required information. It should be possible to accurately relate the images available to the anatomy of the patient. The images obtained should be with minimal distortion. If more than one imaging modality is feasible, the imaging information should be governed by the ALARA (As Low As Reasonably Achieved) principle.

## Digital Radiography

Digital detectors have been on market since 15yrs and the evolution of this technology has made digital imaging in dentistry a viable alternative to film based imaging. It offers a number of advantages compared to film. The elimination of chemical processing is considered one of the main benefits. Image processing can be used to enhance a selected region in the image for a specific diagnostic task.<sup>4</sup>

There are currently two competing technologies available for implementation of digital imaging. One uses solid state detectors and other photostimable phosphor. Both are available for intraoral and extraoral applications. Solid state detectors are based either on charge couple device technology (CCD) or on complimentary metal oxide semiconductor technology (CMOS). Both are rigid sensors that are directly linked to computers.

The dimensions of solid state sensors have improved dramatically since their first introduction. Active image areas are currently very similar to those of intraoral film and the sensors have become much thinner. They are still considerably thicker than film, which together with their rigidity and cable attachment, can make sensor placement more challenging and patient discomfort more likely. The key feature is immediate availability of the image and results in considerable time saving.

Digital imaging system based on photostimable phosphor (PSP) also called storage phosphor offer an indirect approach to digital image acquisition. The PSP plates are dimensionally comparable to film and handle quite similarly. Exposed plates are scanned in external laser

scanner, which generates the digital image data for storage and display on the computer. The plates are then erased and can be reused. Advantages and disadvantages of digital radiography:<sup>5,6</sup>

**Advantages** - The resultant image can be modified in various ways, such as grayscale, brightness, contrast and inversion. Computerised software programs allow for the calibration of magnified images, thus ensuring accurate measurement. Developing solutions and Conventional film developers Data storage and less radiation

**Disadvantages** - Cost of devices, Learning to use the concept, Thickness of the sensor, Rigidity of the sensor, Lack of standardization and Infection control

## Digital Subtraction Radiography (DSR)

In 1935 Zeides des Plantes first demonstrated this technique, who used a photographic technique. It is the technique by which images not of diagnostic value in a radiograph, are reduced so that the changes in the radiograph can be precisely detected. Digitalisation achieved by taking a picture of radiograph using video camera. This technique facilitates both qualitative & quantitative visualization of even minor density changes in bone by removing the unchanged anatomic structures from image. Digital subtraction radiography has been developed to enhance the visualization of mineral changes that have occurred overtime.<sup>7</sup>

## Computed Tomography (CT)

CT machine use a rotating fan beam to image one thin slice of the patient at the time, generally in axial rotation. Modern CT machines uses a continuous table motion during image acquisition, resulting in spiral or helical image formation pattern. Once the image volume has been generated, image slices can be reconstructed in various orientations through a process called multi-planar reformating (MPR).<sup>4</sup> Fuhrmann et al (1995) have shown that CT assessment of alveolar bone height and intrabony pockets is accurate and precise.<sup>8</sup>

## Cone-Beam Computed Tomography (CBCT)

The CBCT scanners work on volumetric tomography. The cone-beam technique involves a single 360° scan in which there is an x-ray source and a reciprocating area detector which synchronously moves around the patient's head (stabilized with a head holder). At certain degree intervals a single projection image which is known as "basis" image is acquired. This series of basis projection images are referred to as the projection data. Software programs incorporating sophisticated algorithms including back-filtered projection are applied to this image data to generate a 3D volumetric data set, which then can be used to provide primary reconstruction images which in axial, sagittal and coronal planes. The digital imaging has some distinct practical advantages including that in CBCT the collimation of the primary x-ray beam to the area of interest there is a reduction in the size of the irradiated area thereby minimizing the radiation dose and it has been seen that CBCT images can result in a low level of metal artifact,

particularly in the reconstruction of the jaw and teeth.<sup>9</sup>

Mol and Balasundaram<sup>10</sup> compared the image quality between CBCT and conventional radiography in the assessment of alveolar bone levels. They found that CBCT provided slightly better diagnostic and quantitative information on periodontal bone levels in three dimensions than conventional radiography. They found that the accuracy in the anterior aspect of the jaws is limited in both imaging techniques, obtained with traditional means.

Vandenbergh et al.<sup>11</sup> studied thirty periodontal bone defects of 2 adult human skulls using intraoral digital radiography and CBCT. Periodontal bone levels and defects on both imaging modalities were assessed and compared to the gold standard. The study concluded that the intraoral radiography was significantly better for contrast, bone quality, and delineation of lamina dura, but CBCT was superior for assessing crater defects and Furcation involvements.

Stavropoulos and Wenzel<sup>12</sup> evaluated the accuracy of CBCT scanning with intraoral periapical radiography for the detection of periapical bone defects. CBCT was found to have better sensitivity compared to intraoral radiography.

### Radiovisiography

RVG was invented by Dr. Frances Mouyens, manufactured by Trophy Radiologie (Vincennes, France) in 1984 and described in the U.S. dental literature in 1989. The RVG system is capable of rapidly displaying a digital radiographic image on a monitor which results in a lower patient radiation. The "Radio" component is the conventional x-ray generator with a timer, capable of very short exposure time, along with image receptor. The "Visio" portion converts the output signal from a Charge Coupled Device to a digital format and displays it on a monitor. The "Graphy" component consists of data storage unit connected to a video printer. The most significant advantages of digital imaging, therefore, are computer aided image interpretation and image enhancement, in addition to the obvious options of standardized image archiving and image retrieval.<sup>13</sup>

### Implant Site Imaging

The placement of dental implant requires thorough planing to optimize its success and to minimize morbidity. Once the optimal location and orientation of the implant has been established based on restorative criteria, the clinician needs to determine whether the recipient site can accommodate and support the implant in terms of length, width and angulation. Prior to the placement of dental implants the operating dentist needs to have a fairly good idea of the quality and quantity of bone available for implant placement, the precise location of the mandibular canal to avoid injury of any sorts to the neurovascular bundle, and location of the floor of the maxillary sinus to prevent sinus wall perforations thus minimizing chances of inadvertent oro-antral communications and consequent infections.<sup>4</sup>

The fabrication of a reference marker to account for horizontal and vertical magnification is an example of improving the reliability of panoramic radiography. When conventional or CT is method of choice, the fabrication of stent with radio-opaque markers provides a simple and effective means to identify the location of recipient site. The most reliable method of identifying the recipient site and correlating the image with surgical is the use of guiding tubes as radiographic markers. The use of CT has become more prevalent with the advent of MPR software specially for dental implant treatment planing.

Post operative imaging is usually performed for evaluation of peri-implant bone. While some bone loss is expected at the crestal bone around the implant, a followup radiograph can assist the practitioner that whether the loss is within the reasonable limits. Whether or not implant show osseointegration cannot be determined radiographically, although an increase in bone density near implant bone interface is usually a favourable sign. The application of digital subtraction radiography can be particularly useful to detect osseous changes around the implant at early stage.<sup>4</sup>

### Conclusion

Diagnostic imaging and techniques develop and implement a cohesive treatment plan. There are various imaging options available in the present day scenario; however, the choice of modality should be based on individual requirements of a particular case. The skill, knowledge

and ability of the clinician to interpret obtained data also play a crucial role in selection of the imaging modality. The cost of the procedure and radiation dose should also be weighed to the benefit of anticipated information.

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