e-ISSN:2320-7949
p-ISSN:2322-0090
RESEARCH AND REVIEWS: JOURNAL OF DENTAL SCIENCES

Radiographic Aids in Implantology: A Review.

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Review Article

Received: 06/02/2014
Revised: 01/03/2014
Accepted: 13/03/2014

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Keywords: dental implant, diagnostic image, implant planning, implant site, radiography

ABSTRACT

The use of dental implants has increased dramatically over the last decade and is becoming the preferred choice of replacing missing teeth over conventional fixed and removable prosthesis. There are many factors that play a role in success of implant. One important factor is the presurgical determination of the alveolar ridge. This review has been done with the objective of evaluating different radiographic aids available for implant planning and implant placement. Radiographic aids used to assess the suitability of implant placement and appropriate sites for implant placement, size of the implant that can be placed and need for any ridge surgery before placement. Ideal imaging techniques should have the following objectives (i) cross sectional view of the dental arch for visualization of jaw size. (ii) Accuracy of measurements. (iii) Bone quality. (iv) Presence or absence of pathoses. (v) Transfer of radiographic and clinical information. (vi) Should be in reasonable cost. (vii) Minimal radiation exposure Advanced techniques helps to assess the postoperative failure, improper placement of implant and violation of important structures.

INTRODUCTION

Selection of ideal implant site as well as optimal implant for a particular site is the first step in achieving functionally and esthetically successful implant prosthesis. Numerous dental imaging are available to predict the optimal implant site [1]. Implants have become an accepted form of permanent tooth replacement. It consists of a fixture, an abutment and screw or threaded rod [2]. Success of implant procedure depends on patient related and procedure dependent parameters, which includes general health conditions, biocompatibility of implant material, the feature of the implant surface, the surgical procedure, and the quality and quantity of the local bone [3]. The following factors determine the objectives of diagnostic imaging which includes, amount and type of information required and the period of treatment rendered. Decision to image the patient depends on the patient clinical needs [3].

Ideal Requirements of Diagnostic Imaging

Ideal diagnostic imaging depend on a number of factors, which includes ability to visualize the implant site in mesiolingual and buccolingual dimensions; the ability to allow reliable, accurate measurements; a capacity to evaluate trabecular bone density and cortical thickness; reasonable access and cost to the patient and minimal radiation risk [3]. It has the following characteristics, includes the ability to visualize the implant site in the mesiodistal, buccolingual and superioinferior [4].

Diagnostic Imaging Techniques

Imaging techniques for implant placement include: periapical, panaromic, occlusal, cephalometric and tomographic radiography, computed tomography, magnetic resonance imaging and cone beam computed tomography.

Periapical Radiographs

Periapical radiographs are images of limited region of mandibular or maxillary alveolus.[4] Periapical radiographs are used to plan implant placement.[3] it provides two dimensional information regarding the implant

e-ISSN:2320-7949
p-ISSN:2322-0090

site. These are produced with higher resolution [5]. Used for rulling out local bone or dental disease, bone density or mineralization and identify critical structures. It is produced by placing the film intraorally parallel to the body of the alveolus at the region of interest, producing the lateral view of the alveolus [5]. periapical radiographs have following advantages; in preprosthetic phase these films are used for single tooth implants in regions of abutment bone width, helps to assess periimplant bone support during follow up [6]. cost effective, less radiation. Periapical radiographs helps to locate the adjacent roots and any opaque foreign bodies that may be in the area being considered for implant placement [7].

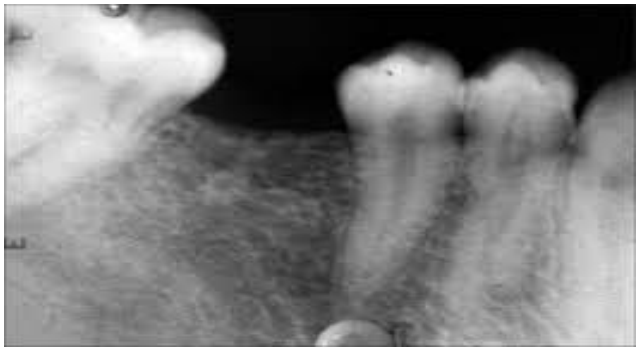

Figure 1: Intra Oral Periapical radiograph

Occlusal radiography

Occlusal radiographs are planar radiographs, produced by placing the film intraorally parallel to the occlusal plane with the central beam perpendicular to the filmfor mandibular image and oblique (45°) to the film for maxillary image. It is used to determine the faciolingual measurements of mandibular alveolar ridge [2,8].

Orthopantomogram (OPG)

Orthopantomogram is widely used in preimplant evaluation and treatment protocols [3]. Orthopantomogram is used nowadays because of adequate information it conveys, less radiation exposure and cost [7]. Panaromic radiography is a curved plane tomographic radiograph used to depict the body of the mandible, maxilla, lower half of maxillary sinus, inferior alveolar nerve and nasal fossa [2,3]. OPG has following advantages; vertical height of bone initially assessed, useful in making preliminary estimations of crestal alveolar bone and cortical boundaries. These procedures can be be performed with convenience, ease and speed. Gross anatomy of the jaws and related pathologic findings can be evaluated [1,6]. A study conducted by CE Sakakura et al in the year of 2003, among 69 dentists analysed that 63.8% of dentists prescribe panaromic radiograph for dental implant assessment [9].

Figure 2: Orthopantomogram

Lateral Cephalometric radiographs

Cephalometric radiographs are oriented planar radiographs of the skull. Skull is oriented with respect to the x-ray device and the image receptor using a cephalometer. The geometry of cephalometric imaging device result in 10% magnification of the image with a 60 inch focal object and 6 inch object to film distance. Cross-sectional image of the alveolus in the midsagittal plane is demonstrated by this lateral cephalometric radiograph. It is useful because it demonstrate the geometry of the alveolus in the anterior region and the relationship of the lingual plate to the patient's skeletal anatomy. As a result cephalometrics are important for implant treatment plan, especially for the completely edentulous patient. Advantages of cephalometric radiographs are, loss of vertical

e-ISSN:2320-7949
p-ISSN:2322-0090
dimension, skeletal inter archrelationship, anterior crown-implant ratio, anterior tooth position in the prosthesis and resultant moment of forces [1,6].

Figure 3: Lateral cephalometric radiograph

Computed Tomography (CT)

Computed tomography is introduced by British engineer Godfrey Hounsfield in 1972 [10,11]. It is 3 dimensional radiograph [12]. CT takes the advantage of radiographic attenuation [13]. It reproduce the anatomy with submillimetric accuracy [14]. This helps to reveal a multiple views of implant site; which are axial, reconstructed panoramic and cross-sectional views of the jaws [15]. It has following advantages, CT helps to (i) eliminates the superimposition of images of structures outside the area of interest. (ii) Because of the inherent high contrast resolution of CT. (iii) Single CT imaging consist of multiple views so it is known as multiplanar reformmated imaging [3]. (iv) It enables differentiation and quantification of both soft and hard tissues without performing an invasive procedure [2]. The information provided by CT is a life size image, which is highly desirable for ease of measurements. Recent advances in CT are microtomograph and multislice helical CT. A study conducted by CE Sakakura on 2003 analysed on 69 dentists that 7.2% of the practitioners are prescribing computed tomography for implant assessment. Reason for prescribing computed tomography is its precision [9].

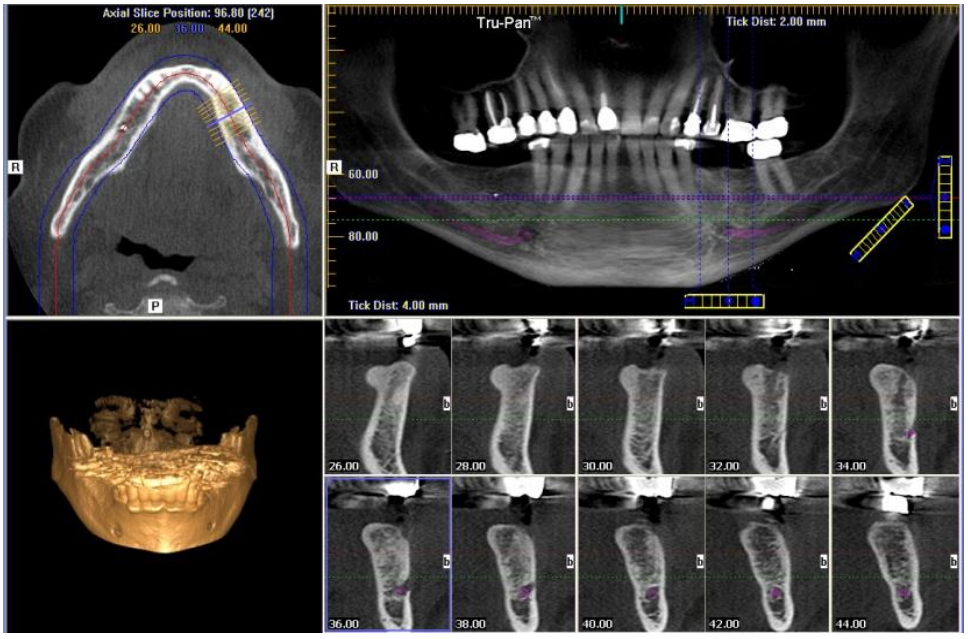

Figure 4: Computed Tomography

Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging is introduced in 1946, used to image the protons of the body by employing magnetic fields, radio frequencies, electromagnetic detectors and computers. It is a 3 dimensional imaging technique. MR images can be varied to obtain fat, water, or balanced imaging of the patient's anatomy. Oriented MR imaging of the posterior mandible is dimensionally quantitative between critical structures and the proposed implant site [2,6].

e-ISSN:2320-7949
p-ISSN:2322-0090

Cone Beam Computed Tomography (CBCT)

Cone beam comuputed tomography is a three dimensional imaging technique. With this technique, treatment results in optimal implant placement and improved clinical outcome. It helps in improved visualization and comprehension of the anatomy in the areas in which implants are being planned for placement [15]. This helps to visualize the implant site in axial, reconstructed panoramic and cross sectional views of the jaws. CBCT generates cone shaped beams and the images are acquired in one rotation by an image intensifier of flat panel detector, resulting in reasonably low levels of radiation dosage [3]. Patients who are being considered for multiple implant placements may be best imaged by these techneques. Once treatment planning is determined in the computer, it can be saved and applied to surgical sites by means of image aided template production or image aided navigation [3]. Advantages of using cone beam computed tomography are (i) It provides information on the continuity of the cortical plates. (ii) Residual bone in the maxilla and mandible. (iii) the relative location of adjoining vital structures. A three dimensional image can provide a visualization of the overall morphology of the intended implant site [6].

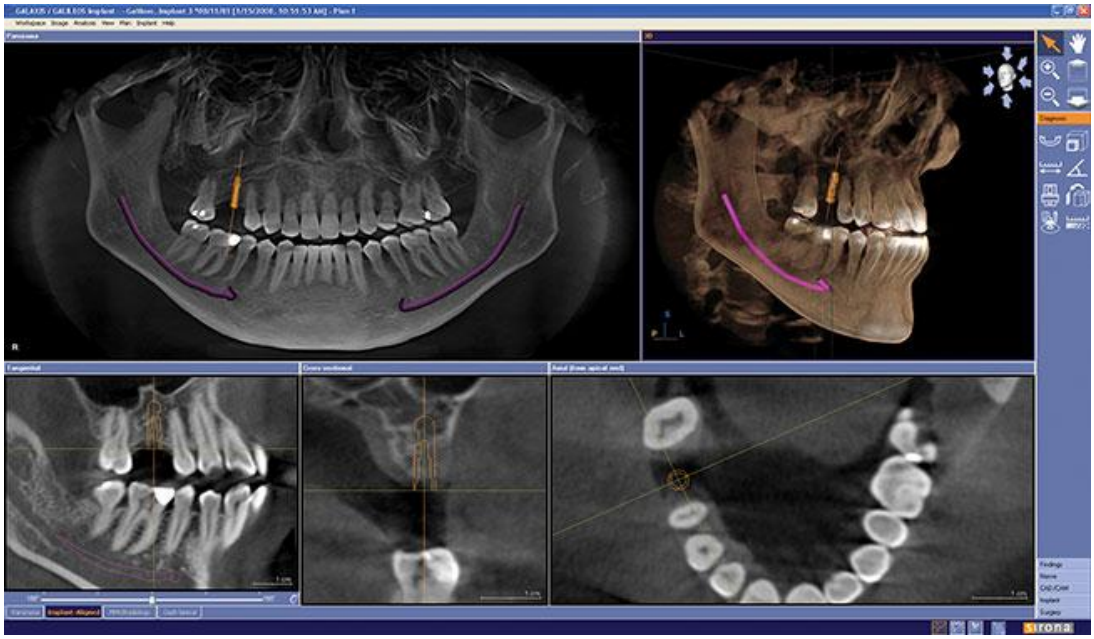

Figure 5: Cone Beam Computed Tomography

DISCUSSION

For successful implant placement numerous factors to be considered in diagnostic imaging which includes amount and type of information required and time period of the treatment rendered. On viewing the diagnostic image following requirements should be monitored; (1) there should be 1-1.5mm of bone on either side of the fixture and 1-2mm of bone between the base of the fixture and adjacent structures eg: floor of maxillary sinus, mandibular canal and inferior border of mandible

Periapical radiograph gives 2 dimensional image in which height can be measured with high resolution, but inadequate information about the cross sectional view of the bone. Mainly used to analyze single implant site. It results in distortion and magnification. It helps to analyse the position of mandibular canal to the edentulous ridge for placing implant [2,6].

Occlusal radiographs are helpful sometimes to find the facio-lingual measurements of the mandibular ridge, but it's not helpful for maxi lla due to its distortion of the image and oblique angulation [2,6].

OPG gives information about the gross anatomy of the jaws and related pathologic findings [6]. But there is large horizontal magnification of the image depending on its region [9]. It is usually prescribed over other diagnostic image due to its broad coverage and cost [9]. Due to lack of image sharpness and resolution, coupled with nonuniform distortion often leads to inaccurate interpretation and measurements [3].

Lateral cephalometric radiograph helps to demonstrate the geometry of the alveolus in the anterior region and relationship of the lingual plate to the patient's skeletal anatomy [6]. Its use for implant planning is limited due to its minimal information about the cross sectional view of the alveolus, magnification and superimposition [2,6].

CT provides unique means of imaging analysis. It enables differentiation and quantification of both soft and hard tissues. It is proposed on the implant sites by reformatting the image data to create tangential and cross sectional tomographic images of the implant site [6].

MRI provides accurate technique with exact tomographic sections and no distortion. It is not useful in analysing in bone mineralization or as high yield technique for identifying bone or dental disease [6].

Because of high radiation, high cost and difficulty in accessibility associated with CT, CBCT was developed. CBCT is especially used in patients with multiple missing teeth. CBCT is widely used nowadays due to the following reasons: shorter examination time, reduction of image unsharpness caused by the translation of the patient, reduced image distortion due to internal patient movements and increased x-ray tube efficiency.

CONCLUSION

In conclusion, unlike other imaging modalities CBCT gives a three dimensional view and helps in better assessment and treatment planning and hence has revolutionised the field of imaging technology. Prior to implant placement it is very essential to gauge the correct dimensions of the alveolar bone and to rule out any defects, this can be achieved only with the help of CBCT. This is the reason why CBCT has become the gold standard imaging technique prior to implant planning.

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