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Implant envision for the dentist

Shreya Sabharwal[1], Ankur Sabharwal[2], Sameksha Arora[3]

[1]*B.D.S. and M.D.S in Periodontics and Implantology , D.J.College of dental sciences and research ,Modinagar*

[2]*B.D.S. and M.D.S in Prosthodontics including crown and bridge , A.B Shetty Memorial Institute of Dental Sciences, Mangalore*

[3]*Tutor, Dept of Pedodontics and Preventive Dentistry, D.J. College of dental sciences and research ,Modinagar*

ABSTRACT

Dental implants have revolutionized the field of dentistry. A presurgical treatment planning is required for the success of implants. For safe implant placement, full knowledge of the shape and quality of the implant site is a prerequisite To aid this, diagnostic imaging plays a vital role which implement a cohesive and comprehensive treatment plan for the implant team and the patient. Various modalities have been described in these articles which are intraoral radiography, cephalometric radiography, panoramic radiography, conventional tomography, computed tomography and magnetic resonance imaging .These examinations provide information regarding the locations of vital anatomic structures (mandibular canal, mental foramen, maxillary sinus, nasal sinus and incisive canal) that are to be taken care during implant placement.

Keywords: Diagnostic imaging, Magnetic resonance imaging, implant, conventional tomography

Introduction

Loss of natural dentition can have a significant impact on the quality of life[1]. Previously, the only means available for treating totally and many partially edentulous patients was removable prostheses. A major advancement in the treatment of the edentulous or partially edentulous patient came i.e. dental implants and today, the use of endosteal implants in the rehabilitation of dental patients represents one of the most technologically advanced forms of dentistry [2]. For safe implant placement, full knowledge of the shape and quality of the implant site is a prerequisite. Incorrect presurgical assessment can at best lead to implant failure, and at worst to damage to nerve[3] and blood vessels, perforation of the maxillary sinus[4] and other squeal. A thorough clinical and radiologic evaluation of patients is required to determine the presence of pathologic conditions (retained roots, cysts, infection, lesions, and so forth) during treatment planning for implants. These examinations also provide infection, lesions, and so forth) during treatment planning for implants. These examinations also provide information regarding the locations of vital anatomic structures (mandibular canal, mental foramen, maxillary sinus, nasal sinus and incisive canal) that are to be taken care during implant placement. A number of methods for assessment have been developed, both physical and radiological. Among them diagnostic imaging and techniques help to develop and implement a cohesive and comprehensive treatment plan for the implant team and the patient. Diagnostic images are required to assess bone sites for implant placement; the number of implants required; angulations at which implants are to be placed and dimension (length and width) of implants required depending upon the available bone volume. Cross sectional radiographic views are often useful in determining the outside contour of the jaw for difficult anatomic locations, and some imaging techniques may also provide an indication of bone density. Bone quantity and quality are determining factors in the success of implant treatment, and therefore need to be assessed prior to implant placement[5].Postoperatively, radiographs verify the presence of the bone adjacent to the implant, prior to placement of the transmucosal abutment for two stage implant systems. Thus this review provides an insight on imaging and provide one means of monitoring implant therapy and have the role in evaluation of dental implant patient both pre and post operatively.

*Correspondence
Shreya Sabharwal
D.J.College of dental sciences and research ,Modinagar
E Mail: dr.ravneetmalhi@gmail.com

IMAGING MODALITIES

Many imaging modalities have been reported as useful for dental implant imaging, including devices recently developed specifically for dental implant imaging. These imaging modalities can be described as analog or digital and two or three dimensional imaging. Most dentists are more familiar with analog two dimensional imaging.

Types of 2D imaging modalities are as follows-

1. Periapical radiography
2. Panoramic radiography
3. Occlusal radiography
4. Cephalometric radiography

1. PERIAPICAL RADIOGRAPHY

Periapical radiographs provide a lateral view of the jaws and no cross sectional information. The most accurate radiographic technique used for periapical radiology is the paralleling technique that necessitates placing the film or sensor parallel to the long axis of the implant, tooth, or osseous structure in question. But image shape distortion occurs when the total area in question (alveolar bone, implant) does not have the same focal spot to object distance. When x ray is perpendicular to the film but not to the object foreshortening will occur [6]. Image magnification may be assessed by placing a known dimension radiographic marker (e.g. 5 mm ball bearing) at the crestal region of the desired implant location. When the marker is elongated, so is the implant site.

2. DIGITAL RADIOGRAPHY

In digital radiography the sensor is used in place of the film to collect data. The analog information received is then interpreted by specialized software, and an image is formulated on a computer monitor. Thus implant surgical procedures and prosthetics have been simplified with increased efficiency. When compared with conventional radiographs, the most current digital systems have significantly less radiation[7] with superior resolution [8.] The most significant advantage of digital radiography is the instantaneous speed in which images are formed that is highly useful during surgical placement of implants and the prosthetic verification of component placement. Only disadvantage is size and thickness of the sensor that makes positioning of sensor more difficult in some sites.

3. OCCLUSAL RADIOGRAPHY

Occlusal radiographs are planar radiographs produced by placing the film intraorally parallel to the occlusal plane with the central x ray beam perpendicular to the film for the mandibular image and oblique (usually 45 degrees) to the film for the maxillary image. Occlusal radiography produces high resolution planar images of the body of the mandible or the maxilla[9]. Critical structures such as the maxillary sinus, nasal cavity and nasal palatine canal are demonstrated, but the spatial relationship to the implant site generally is lost with this projection.

4. CEPHALOMETRIC RADIOGRAPHY

Cephalometric radiographs, especially those of the lateral view, have been recommended for evaluation of the anterior maxilla and mandible for implant placement[10]. The height and width of the residual bone at the anterior midline of both the maxilla and mandible can be accurately measured using a combination of lateral and postero- anterior cephalograms[11]. The lateral cephalometric view also can help evaluate a loss of vertical dimension, skeletal arch interrelationship, anterior crown / implant ratio, soft tissue profile, anterior tooth position in the prosthesis, and resultant moment of forces. Disadvantages of cephalometric radiographs include cross sectional information limited to the midline area and difficulty in cephalometric machine accessibility and operator technique.

5. PANORAMIC RADIOGRAPHY

The panoramic radiograph plays an essential role in the initial evaluation of bone dimensions and in screening for the detection of pathologic conditions when planning for dental implants[12]. The complete maxilla and mandible are visible on a single film with minimal radiation exposure to the patient[13]. However, proximity to adjacent structures in the horizontal direction, such as the mental foramen or adjacent teeth, is not as

predictable. The poor image resolution and unpredictable image distortion limit the panoramic image's usefulness when assessing bone adjacent to implants during follow-up[14]. Panoramic radiographs may provide information to determine pathologic conditions and vertical dimensions for implant placement, but they are unreliable for measurements in the horizontal direction and for assessing bone quality.

3D IMAGING MODALITIES

Three dimensional imaging techniques are quantitatively accurate, and enable the dentist to view a volume of the patient's anatomy. These techniques are used to produce stereotactic surgical guides and prosthetic frameworks.

3D imaging techniques include-

- Conventional Tomography
- Computed Tomography
- Magnetic Resonance Imaging

1. CONVENTIONAL TOMOGRAPHY

Tomography is a generic term formed from the Greek words tomo (slice) and graph (picture) that was adopted in 1962 and the basic principle of tomography is that the x ray tube and film are connected by a rigid bar called the fulcrum bar, which pivots on a point called the fulcrum. When the system is energized, the x ray tube moves in one direction with the film plane moving in the opposite direction and the system pivoting about the fulcrum. The fulcrum remains stationary and defines the section of interest, on the tomographic layer. Different tomographic sections are produced by adjusting the position of the fulcrum or the position of the patient relative to the fulcrum in fixed geometry systems[15].

Mainly, two types of tomographic movement sare known: linear and multidirectional. The latter comprises four motions: circular, spiral, elliptic, and hypocycloid. It is the technique of choice when a limited edentulousarea is to be assessed for suitability for implant placement because it provides good image quality for a limited amount of radiation 16. With the introduction of some new tomography machines, it has becomepossible to visualize the inter jaw relation because part ofthe opposite jaw appears on the tomographic image. This is an advantage when deciding on the inclination axis ofthe oral implant, especially if a splint with radio opaquemarkers is used.

2. COMPUTED TOMOGRAPHY

CT is a digital and mathematical imaging technique that creates tomographic sections where the tomographic layer is not contaminated by blurred structures from adjacent anatomy. CT enables differentiation and quantification of soft and hard tissues. Thus the radiologist can view hard and soft tissues on an image without performing an invasive procedure on a patient, such as the injection of contrast media. Originally introduced in 1972 by Godfrey Hounsfield, CT was called computerized axial transverse scanning[17].

There is ability of CT to preserve soft tissue detail when reconstructions are to be done in esthetic area. Bone density can be measured on CT data, and this is important in assessing bone quality, especially for the upper jaw, which has, in general, lower bone density. The vertical relation between the upper and lower jaw can also be seen on the sagital view. Through CT data it is now possible to reconstruct 3D images of the jaw bone and fabricate stereo lithographic models[18]. The jaws can be seen from any view point on a computer screen, and the implant placement can be done interactively.

Computed tomography has many indications especially in oral implant placement or maxillofacial surgery. It should be mentioned that total radiation dose of CT scans is higher than that of conventional radiographs. However multiple conventional tomograms may be necessary to examine an entire edentulous arch, as opposed to a single CT scan, thus negating this difference[19]. And moreover costs are generally higher than for other techniques.

CT enables the evaluation of proposed implant sites and provides diagnostic information that other imaging techniques cannot provide. But the access to this diagnostic information required a radiologist to communicate with the referring dentist in detail about prospective surgery and then to sit at the imaging

computer for a long time to reformat the study, interpret the resulting images, and produce hard copy images to send to the referring dentist. This limitation spawned the development of a number of techniques referred to as Dentascan imaging.

Dentascan imaging provides programmed reformation, organization and display of the images[19]. The radiologist simply indicates the curvature of the mandibular or maxillary arch, and the computer is programmed to generate cross sectional and tangential/ panoramic images of the alveolus along with 3D images of the arch. This technique provides diagnostic information that is accurate, detailed, and specific.

3. **MAGNETIC RESONANCE IMAGING (MRI)**

The main advantage of magnetic resonance imaging is that the patient is not exposed to radiation because the technique is based on magnetism. It visualizes soft tissues and therefore is less recommended for pre operative planning of implants. The use of MRI to demonstrate the contents of the mandibular canal has increased in recent years, and good results have been reported[20]. It may be used in implant imaging as a secondary imaging technique when primary imaging techniques such as complex tomography fail. Failure to differentiate the inferior alveolar canal may be caused by osteoporotic trabecular bone and poorly corticated inferior alveolar canal. MRI visualizes the fat in trabecular bone and differentiates the inferior alveolar canal and neurovascular bundle from the adjacent trabecular bone. Lately, dental imaging software has been used that makes dental MRI a possible alternative to plan films or CT for patients requiring surgery near the mandibular canal[21]. MRI is contraindicated in claustrophobic patients and those with cardiac pacemakers. There exist numerous disadvantages for the use of MRI for implant dentistry. MRI is not useful in characterizing bone mineralization or as a high yield technique for identifying bone or dental disease. In addition it is not readily available in hospitals.

Role in site assessment and treatment planning

Intraoral periapical views of the area of interest and panoramic views are recommended to begin with[6]. Intraoral periapical views offer the best resolution (line pairs/mm) among all the imaging modalities. Using these images, the target area can be carefully examined for trabecular patterns, residual roots, periodontium, as well as angulations of adjacent teeth. However, because periapical radiographs show a 2-dimensional perspective of 3-dimensional anatomy, they are not adequate to estimate the amount of available bone in the edentulous site. Also, their limited size makes them inadequate for evaluating large edentulous areas and associated maxillary and mandibular structures. A good panoramic radiograph will outline the bony anatomy clearly and is generally used for diagnosis of gross pathoses within the jaws as well as the relation of anatomic structures such as sinuses, canals, fossae and foraminae to the implant site[8]. Although some panoramic machines (Panelipse, Gendex, Des Plaines, Ill.) have uniform magnification (19%), in general, most machine shave varied and unreliable magnifications (25% to 30%)especially in the vertical dimension. Magnification is more pronounced in posterior than in anterior areas. This may give a false sense that more bone exists between the crest of the alveolar process and the inferior alveolar canal, nasal fossae or maxillary sinuses. Improper patient positioning may further contribute to image distortion. Even properly positioned and exposed panoramic radiographs cannot be used for direct bony measurements unless the magnification factor for the target area is predetermined. Predetermination of the magnification factor can be accomplished by using a radiographic stent with ball bearings embedded in acrylic and imaged in the patient's mouth. The diameter of the ball bearings in the area can be measured radiographic ally and compared with their actual diameter. Bone measurements can then be adjusted accordingly. Measurements from panoramic projections are generally not precise enough for implant placement.

Conclusion

Dental implantology is rapidly expanding area of dentistry. Advanced diagnostic imaging can play important roles in pre and post-operative evaluation of implant patient. The development of precise pre-surgical imaging techniques and surgical templates allows the dentist to place these implants with relative ease and predictability. Today clinician has wide array of diagnostic tools at his disposal. The excellent imaging modalities that exist today can enhance the success of and satisfaction with implant placement. But selection of

projections should be made with consideration to the type and number of implants, location and surrounding anatomy.

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