REVIEW ARTICLE

Different Imaging Techniques for Dental Implants

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ABSTRACT

Implant imaging techniques and their accurate interpretation are a very crucial step. Radiography is the only non-surgical method of assessment of quality and the quantity of the bone at implant site. With the advent of several types of imaging techniques ranging from conventional two-dimensional intraoral periapical radiographs and orthopantograph to highly sophisticated multidetector computed tomography (CT) and cone beam CT selection of appropriate imaging technique for implant treatment planning has become a challenge for the clinicians. In this article, latest imaging techniques used in implant dental practice are discussed along with their advantages and disadvantages in comparison with the conventional imaging techniques.

Keywords: Computed tomography, Implant imaging techniques, Multidetector computed tomography.

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INTRODUCTION

During the last couple of decades, implant dentistry has evolved to become an important part of modern dental practice. Until the late 1980s, dental implant treatment was restricted to edentulous patients only and was done at selected universities or specialist dental centers by a team of specialist dentists.[1,2] Later with developments in implant material, design, and components, the dental implants found their application partially edentulous patients.[3] Success of any dental treatment depends on accurate diagnosis and proper treatment planning. Diagnostic imaging techniques are important tool for treatment planning of implant prosthesis.[2-4] Implant treatment planning requires radiographic examination of the implant site to ascertain information about the quality and the quantity of the bone available at the implant site and to accurately locate the position of any critical anatomical structure present in immediate vicinity of the implant site. Until the late 1980s, conventional radiographic techniques such as intraoral periapical radiographs (PA) and cephalometric and panoramic views were considered standards. With developments in radiography, many more sophisticated cross-sectional radiographic imaging techniques like reformatted computerized tomography were introduced for implant dental treatment. In the year 2000, the American Academy of Oral and Maxillofacial Radiology specified that conventional cross-sectional tomography should be employed for the implant patients.[5] Currently, a wide variety of imaging techniques are available ranging from simple two-dimensional conventional imaging techniques such as intraoral PA and dental panoramic radiographs (DPRs) to highly accurate three-dimensional imaging techniques such as computed tomography (CT) and cone beam computed tomography (CBCT). Therefore, selection of imaging technique for implant treatment planning has become a challenge.[3,5] DPRs have disadvantage of distortion and magnification and require radio-opaque marker to correct distortion. On the other hand, intraoral PA is accurate but has the limitations in accurately locating critical anatomical structures like inferior alveolar canal. CT and CBCT are highly accurate and give three-dimensional images but have a drawback of higher radiation dose. In this article, latest imaging modalities for dental implants will be discussed along with their advantages and disadvantages.[4,5]

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IMAGING MODALITY IN THREE PHASES OF TREATMENT[1]

Phase 1: Preprosthetic Implant Imaging

Imaging in this phase determines the quantity, quality, and angulation of bone; relationship of critical structures to prospective implant sites; and the presence or absence of disease at the proposed surgical sites.

Phase 2: Surgical and Interventional Implant Imaging

Imaging in this phase evaluates the surgical sites during and immediately after surgery, assists in the optimal positioning and orientation of dental implants, and ascertains the healing and integration phase of implant surgery. It also ensures appropriate abutment positioning and prosthesis fabrication.

Phase 3: Post-prosthetic Implant Imaging

This phase commences just after placement of the prosthesis and continues as long as the implant remains in the jaw. Imaging in this phase evaluates the long-term change, if any, in the implant's fixed position and function, including the crestal bone levels around each implant, and evaluates the status and prognosis of the dental implant. It also helps to routinely assess the bone adjacent to the dental implant to note any changes in mineralization or bone volume.

THE GOALS OF IMAGING[1]

- To measure bone height and width (bone dimensions).
- To assess bone quality.
- To determine the long axis of alveolar bone.
- To identify and localize internal anatomy.
- To establish jaw boundaries.
- To detect any underlying pathology.

PLANAR IMAGING MODALITIES[1]

PA

PA is used to find the presence of pathosis and location of anatomic structures around the implant site and evaluate implants postoperatively. It is used to determine vertical height of the edentulous region, architecture, and bone quality.

Intraoral Imaging using Electronic or Charge-coupled Device (CCD) Imaging Techniques

CCD detectors consist of a serial chain of signal components such as phosphors, fiber optics or lenses, image intensifiers, and the CCD, which serve to convert the X-ray energy to light or electron-hole pairs and to record the spatially resolved image.

Occlusal Radiography

High-resolution planar images of the mandible or the maxilla are produced by occlusal radiography. Structures such as maxillary sinus, nasal cavity, and nasopalatine canal can be assessed through occlusal radiography. Mandibular occlusal radiograph projection is less distorted than the maxillary occlusal radiograph.

Cephalometric Radiography

Lateral cephalometric radiography helps in the analysis of the quality of the bony site (ratio of compact to cancellous bone), especially in the anterior region of the mandible. Although it gives limited information about the symphyseal area, the inclination and buccolingual dimensions of the anterior jawbone region can be obtained. These images do not provide useful information when planning placement of implants lateral to the midsagittal plane. Overly optimistic bone volume assessments are created due to the presence of genial tubercles.

Panoramic Radiography

These are narrow beam rotational tomographs, which use two or more centers of rotation with a predefined focal trough, to produce an image of both the upper and lower jaws. Optimal patient positioning is crucial in this procedure because jaw positioning errors in the sagittal plane can occur easily, especially in the edentulous patient. It provides an approximation of bone height, vital structures, and any pathological conditions that may be present.[1,2]

Zonography

Zonography is a modification of the panoramic X-ray machine and generates cross-sectional image of the jaws. The tomographic layer is around 5 mm. Zonography allows appreciation of spatial relationship between the critical structures and the implant site.

QUASI 3D IMAGING[3-9]

X-ray Tomography

This is a special X-ray technique that enables visualization of a section of patient's anatomy above and below the section of interest. Tomography is derived from the Greek words "Tomo" (slice) and "Graph" (picture).

Conventional Tomography

Conventional tomography differs from X-ray tomography in its ability to resolve details as small as a few microns in size, even when imaging objects are made of high-density materials. In the last two decades, conventional tomographic machines have been introduced in oral health care.

CT

CT was invented by Sir Godfrey Hounsfield and was introduced in 1972. This modality gives rise to high-density resolution images and allows soft tissues to be visualized. The reformatted CT image generates axial, panoramic, and cross-sectional images that allow rapid correlation of the different views.

Interactive Computed Tomography (ICT)

ICT allows the transfer of images to the clinician as a computer file. It helps the clinician measure the length

and the width of the alveolus and also bone quality. An important aspect of ICT is that the clinician and radiologist can together perform "electronic surgery."

CBCT

CBCT scanners are designed specifically for diagnosis and treatment planning in implant therapy. Multiple pictures of the region of interest are generated in a single scan. This enables the dentist to perform minimally invasive surgery without raising a flap, thereby reducing surgery time, post-operative pain and swelling, and faster recovery time.

Magnetic Resonance Imaging (MRI)

MRI was first discovered by Lauterbur. The presence of ferromagnetic (high magnetic susceptibility) metals can distort the magnetic field and compromises the images.

DOSIMETRY[10]

Appropriate selection criteria must be applied to choose the correct imaging modality. Dentist must consider potential risks versus perceived benefits of each imaging procedure.

RECENT ADVANCES[11]

Using the platform of the SCANORA (Soredex Orion Corporation, Helsinki, Finland), a limited-volume CBCT system 3DX Accuitomo was developed. PSR9000N is also a limited-volume CBCT system, which is an inherited technology from another dentomaxillary multimodal tomographic system, the AZ3000 (Asahi Roentgen, Japan).

DISCUSSION

Medical images can be assessed for their technical quality and diagnostic value. The clinician has to carefully weigh the pros and cons of each modality and chooses a particular technique accordingly.

CONCLUSION

As in the case of all imaging techniques, appropriate selection criteria must be applied before selecting one which is most suitable for each patient.

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