INTRODUCTION

Recent advances in dentistry have been as remarkable such as the use of dental implants to restore orofacial form and function. The imaging modalities contribute information for every stage of treatment, extending from presurgical diagnosis and treatment planning, through surgical placement and postoperative assessment of the implant to the prosthetic restoration and long-term surveillance phase.

DIAGNOSTIC IMAGING MODALITIES

1. Periapical Radiography

Periapical radiographs produce a high resolution planar image. Periapical radiographs may suffer from both distortion and magnification which is limited by using long cone paralleling technique.¹

Advantages/Disadvantages

i) A useful for ruling out local bone or dental disease.

ii) Of limited value in determining quantity because the image is magnified, may be distorted, and does not depict the third dimension of bone width.

iii) Of limited value in determining bone density or mineralization.¹

Fig. 1: Periapical radiographs

2. Occlusal radiography

Occlusal radiograph is a planer radiographs produced by placing 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 maxillary image. It is an intra-oral
technique in which large occlusal areas of maxilla and mandible is recorded.\textsuperscript{3}

Fig. 2: Maxillary occlusal radiograph

Advantages/Disadvantages
i) Produces high resolution planer image of the body of the mandible and maxilla.

ii) The degree of mineralization of trabecular bone is not determined by this projection and spatial relationship between critical structures, such as mandibular canal and the mental foramen.

iii) The proposed implant site is lost with this projection.\textsuperscript{2}

3. Bitewing Radiography

Bitewing radiographs are used as post prosthetic imaging. The x-ray beam should be angled to be perpendicular to the crestal bone region of the implant or abutment to implant connection. A vertical bite-wing radiograph is often ideal and much easier to position once the prosthesis is in place.\textsuperscript{3}

Fig. 3: Bitewing radiograph

Advantage/Disadvantages
i) Quality bitewing radiographs placed parallel to the implant body with central ray of source oriented perpendicular to the film enable sequential radiograph for crestal and perimplant bone loss.

ii) Used as postprosthetic imaging.\textsuperscript{3}

4. Lateral Cephalometric Radiography

Cephalometric radiographs are oriented planar radiographs of the skull. In lateral cephalometric projection the image receptor is positioned parallel to the patient’s midsagittal plane. The site of interest is placed towards image receptor, and a wedge filter at the tube head is positioned over the anterior aspect of the beam to absorb some of the radiation and allow visualization of the soft tissues of the face. The geometry of cephalometric imaging devices results in a 10% magnification of the image with a 60 inch focal object and 6 inch object to film distance.\textsuperscript{4}

Fig 4: Lateral cephalometric radiograph

Advantages/Disadvantages
i) It helps evaluating a loss of vertical dimension, skeletal arch relationship, anterior crown/implant ratio, anterior tooth position in the prosthesis and resultant moment of the forces.

ii) This technique is not useful for demonstrating bone quality and only demonstrates a cross-sectional image of the alveolus where the central rays of the x-ray device are tangent to the alveolus.\textsuperscript{4}

5. Panoromic Radiography

Panoramic radiography is the most utilized diagnostic modality in implant dentistry.
This radiographic technique produces an image of a section of the jaws of variable thickness and magnification.\textsuperscript{2}

![Panoromic Radiograph](image)

**Fig.5: Panoromic Radiograph**

**Advantage/Disadvantages**

i) Opposing landmarks and Vertical height of bone initially can be assessed.

ii) Gross anatomy of the jaws and any related pathologic findings can be evaluated.

iii) Misleading quantitatively because of magnification and because the third dimension, cross-sectional view is not demonstrated.\textsuperscript{2}

**6. Conventional Tomography (Body Section Tomography)**

Tomography is a generic term formed from the greek words tomo (slice) and graph (picture) that was adopted in 1962. This is a special X-ray technique that enables visualization of a section of the patient’s anatomy by blurring regions of the patient’s anatomy above and below the section of interest.

Essential equipment for tomography includes an x-ray tube radiographically connected and capable of moving about a fixed axis or fulcrum.\textsuperscript{5}

**Advantages and Disadvantages**

i) High quality complex motion tomography demonstrates the alveolus and, taking magnification in consideration, enables quantification of the geometry of magnification.

ii) Complex tomography is not particularly useful in determining bone quality or identifying dental and bone disease.\textsuperscript{5}

**7. Computed Tomography (CT)**

CT is a digital and mathematical imaging technique that produces axial images of a patient’s anatomy. CT images are inherently three-dimensional digital images typically 512 by 512 pixels with a thickness described by the slice spacing of the imaging technique. The individual element of the CT image is called a voxel, which has a value referred to in Hounsfield units, that describes the density of the CT image at that point. Each voxel contains 12 bits of data and ranges from –1000 (air) to + 3000 (enamel/dental materials) Hounsfield units.

Current generation CT scanners, reformatted images are characterized by a section thickness of 1 pixel (0.25 mm) and an in-plane resolution of 1 pixel by the scan spacing (0.5 to 1.5 mm) producing a geometric resolution similar to that of planar imaging.\textsuperscript{5}

![CT of mandible](image)

**Fig.6: CT of mandible**

**Advantages/ Disadvantages**

i) It provides axial, coronal and sagittal view of the tissue.

ii) A clearer picture is obtained as compared to conventional tomography which is often blurred due to the superimposition of the surrounding structures.
iii) Very thin contiguous or overlapping slices may result in a high dose of radiation.\(^5\)

8. Dentscan

Dentscan imaging provides programmed reformation, organization, and display of the imaging study. The radiologist or technologist simply indicates the curvature of the mandibular or maxillary arch and the computer is programmed to generate referred cross-sectional and tangential panoramic images of the arch.\(^2\)

Advantages/Disadvantages

i) CT enables identification of disease, determination of bone quantity and quality, identification of critical structures at the proposed regions, and determination of the position and orientation of dental implants.

ii) Limitations of dentscan imaging include images that may not be true size and require compensation for magnification and determination of bone quality.\(^5\)

9. Interactive Computed Tomography (ICT)

This technique enables the radiologist to transfer the imaging study to the clinician as a computer file and enables the clinician to view and interact on their own computer. An important feature of ICT is that the clinician and radiologist can perform “electronic surgery” (ES) by selecting and placing arbitrary size cylinders that simulate root form implants in the images.\(^6\)

Advantages/Disadvantages

i) ES and ICT enable the development of a three-dimensional treatment plan that is integrated with the patient’s anatomy and can be visualized before implant surgery by the members of the implant team and the patient for approval or modification.

ii) ES enables placement of electronic implants in the imaging study but refinement and exact relative orientation of the implant positions is difficult and cumbersome.\(^6\)

10. Cone Beam Computed Tomography (CBCT)

One of the novel developments in CT imaging technology is cone beam imaging, which not only reduces the size and cost of CT scanners but also improves the resolution of the image with lesser amount of radiation dose than that used in CT scans. CBCT is devoted to maxillofacial area to scan and visualize jaw bone lesions especially cancellous bone. This technology offers the surgeon precise views of preplanned locations in the patients jaw.\(^7\)

11. Magnetic Resonance Imaging (MRI)

It is the latest non-invasive imaging modality that used electrical signals generated from response of hydrogen nuclei to strong magnetic field and radiowave/ radiofrequency pulses to produce an image to allow specialist to explore inner working of human body, to detect and define the difference between healing and disease tissue without the use of x-ray.\(^8\)

Advantages/Disadvantages
i) MRI can obtain direct, sagittal, coronal and oblique image which is impossible with radiography and CT.

ii) Claustrophobia – because the patient is within the large magnet up to one hour.

SUMMARY
Diagnostic imaging and techniques develop and implement a cohesive and comprehensive treatment plan. Clinicians however must recognize that each technique has advantage and limitations. Cross-sectional imaging is increasingly considered as essential for optimal implant placement especially in case of complex reconstruction but the question of which technique to apply remains for the clinician to answer carefully considering all variables.

REFERENCES

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