Advanced Imaging

1-Tomography

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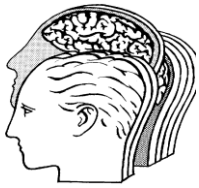
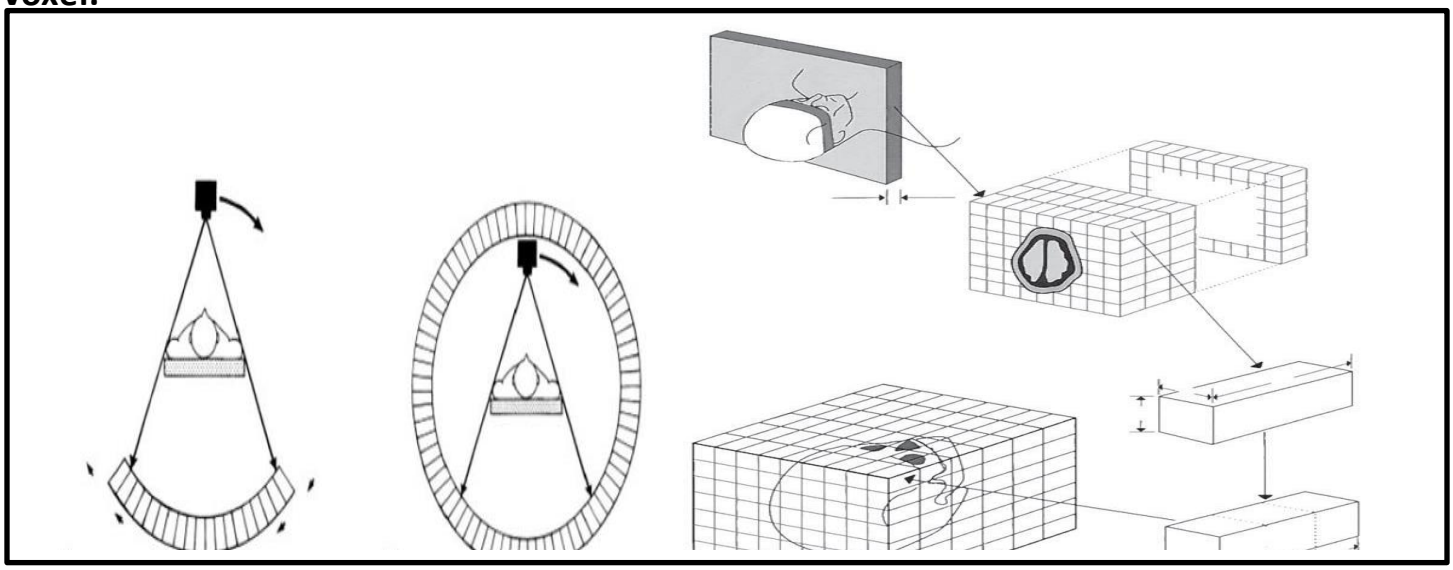
is a specialized technique for producing radiographs showing only a section or slice of a patient. Each tomograph (or slice) shows the tissues within that section sharply defined and in focus. The section is thus referred to as the focal plane or focal trough. Structures outside the section are blurred and out of focus. By taking multiple slices, three-dimensional information about the whole patient can be obtained. Production of each conventional tomographic slice requires controlled, accurate movement of both the X-ray tube head and the film during the exposure.



A-Computed tomography (CT)

CT scanners use X-rays to produce sectional or slice images, in its simplest form a CT scanner consists of a radiographic tube that emits a finely collimated, fan-shaped x-ray beam that is directed to a series of scintillation detectors or ionization chambers(the radiographic film is replaced by very sensitive crystal or gas detectors). The detectors measure the intensity of the X-ray beam emerging from the patient and convert this into digital data which are stored and can be manipulated by a computer. This numerical information is converted into a grey scale representing different tissue densities, thus allowing a visual image to be generated.

The image consists of a matrix of individual pixels representing the face of a volume called a voxel.



Main indications for CT in the head and Neck

1-Investigation of intracranial disease including tumors, hemorrhage and infarcts.

2-Investigation of suspected intracranial and spinal cord damage following trauma to the head and neck.

3- Assessment of fractures involving:

—The orbits and naso-ethmoidal complex

—The cranial base

—The cervical spine

4- Tumour staging — assessment of the site, size and extent of tumours, both benign and malignant, affecting:

—The maxillary antra.

—The base of the skull.

—The pterygoid region.

—The pharynx.

—The larynx.

5- Investigation of tumours and tumour-like discrete swellings both intrinsic and extrinsic to the salivary glands.

6-Investigation of osteomyelitis.

7- Investigation of the TMJ.

8- Preoperative assessment of maxillary and mandibular alveolar bone height and thickness before inserting implants.

Disadvantages:

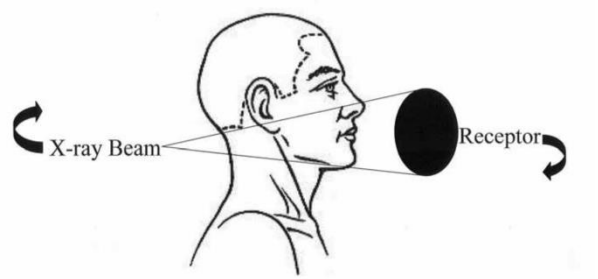
1-The equipment is very expensive.

2- Metallic objects, such as fillings may produce marked streak or star artifacts across the CT image.

3-Inherent risks associated with IV contrast agents.

B- Cone-beam CT(CBCT)

Is a recent technology. A divergent pyramidal- or cone-shaped source of ionizing radiation is directed through the middle of the area of interest onto an area x-ray detector on the opposite side. These recordings constitute " raw data " that is reconstructed by a computer algorithm to generate cross-sectional images



-Advantages of cone-beam CT in dentistry;

1- **Rapid scan time: may range from approximately 1 minute to 20 minutes.**
2- **Beam limitation: Collimation of the CBCT primary x-ray beam enables limitation of the x-radiation to the area of interest.**
3- **Reduced patient radiation dose; Comparison with patient dose reported for maxillofacial imaging by conventional CT (approximately 2000 mSv) indicates that CBCT(50.3 microsievert) provides substantial dose reductions of 98.5%.**
4- **Multiplanar reformation.**

- Limitations of cone-beam CT imaging:

1- Poor soft tissue contrast: scattered radiation contributes to increased image noise.

2- X-ray beam artifacts: Because the CBCT x-ray beam has lower mean kilovolt (peak) energy.

3- Patient-related artifacts: Patient motion can cause misregistration of data, which appears as unsharpness in the reconstructed image.

clinical applications

1-Investigation of jaw pathology including cysts, tumors and fibro-osseous lesions.

2- Investigation of the paranasal sinuses؛

3-Investigation of the bony components of the TMJ.

4- Pre- and post-implant assessment؛

5-Orthodontic assessment, both dental development and skeletal base relationship.

6- Assessment of wisdom teeth, in particular their relationship to the inferior dental canal.

7- Evaluation of facial trauma.

2-Magnetic resonance imaging (MRI):

The basic principles can be summarized as follows: Main atom is hydrogen IN H2O.

Atoms in the body act like bar magnets. In the MRI procedure, the area to be examined is subjected to an external magnetic field. The atoms line up with the magnetic field so that their long axes point in the same direction, just as one finds when bar magnets are subjected to a magnetic field. Once the atoms are so aligned, they are also subjected to a radio wave. The atoms absorb some of the radio wave's energy and lean over. When the radio wave is turned off, the atoms "relax" and emit the energy that they absorbed. This energy can be picked up by appropriate receivers and converted into a picture.

Main indications for MRI in the head and neck:

1-Assessment of intracranial lesions

2-Tumour staging (salivary glands, tongue and floor of mouth).,

3-Investigation of the TMJ

Advantages

- **1- Ionizing radiation is not used**
- **2- No adverse effects have yet been demonstrated**
- **3- Image manipulation available**
- **4- High-resolution images can be reconstructed in all planes (using 3D volume techniques)**

- **Disadvantages**

1- Bone does not give an MR signal, a signal is only obtainable from bone marrow.

2- Scanning time can be long and is thus demanding on the patient.

3- It is contraindicated in patients with certain types of surgical clips, cardiac pacemakers, Cochlear implants and in the first trimester of pregnancy.

4- Equipment tends to be claustrophobic and noisy.

5- Metallic objects, e.g. endotracheal tubes need to be replaced by non-ferromagnetic alternatives.

6- Equipment is very expensive.

7-Bone, teeth, air and metallic objects all appear black, making differentiation difficult.

Ultrasound(US))

Conventional X-ray-generating equipment is replaced by a very high frequency (3.5-10 MHz) pulsed ultrasound beam which is directed into the body from a transducer placed in contact with the skin. As the ultrasound travels through the body, some of it is reflected back by tissue interfaces to produce echoes, which are picked up by the same transducer and converted into an electrical signal and then into a black, white and grey visual echo picture image, which is displayed on a television screen.

Main indications for ultrasound in the head and neck

1- Evaluation of swellings of the neck, cervical lymph nodes or the major salivary glands — ultrasound is now regarded as the investigation of choice for detecting solid and cystic soft tissue masses.

2- Detection of salivary gland and duct calculi.

3- Assessment of blood flow in the carotids and carotid body tumors.

4-Assessment of the ventricular system in babies by imaging through the open fontanelles.

5- Therapeutically, in conjunction with the newly developed sialolithotripter, to break up salivary calculi into approximately 2-mm fragments which can then pass out of the ductal system so avoiding major surgery.

6- Ultrasound-guided fine-needle aspiration(FNA) biopsy.

Disadvantages

1- Ultrasound has limited use in the head and neck region because sound waves are absorbed by bone. Its use is therefore restricted to the superficial structures.

2- Technique is operator dependent.

3- Images can be difficult to interpret for inexperienced operators because image resolution is often poor.

4- Real-time imaging means that the radiologist must be present during the investigation.

BY

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