Maxillofacial Imaging

Medical Imaging: is the process of creating visual representations of the interior of a body for clinical analysis and medical intervention.
Imaging is an integral part of the head and neck surgeries (trauma, oncology, orthognathic…) from diagnosis through pretreatment assessment to treatment response assessment and subsequent follow up monitoring.

The Maxillofacial imaging modalities are:

1- **Plain Radiograph**
2- **Computed Tomography (CT)**
3- **Cone Beam CT (CBCT)**
4- **Magnetic Resonance Imaging (MRI)**
5- **Ultrasound**
6- **Positron Emission Tomography (PET);** and they are often used in combination in the patient management.

1. PLAIN RADIOGRAPHS

a- Panoral Tomography:

For trauma patients;

- a panoral tomogram, or orthopantomogram (OPT) or (OPG) represents the best single overall view of the mandible, including an excellent view of the condyles.
- The combination of a posteroanterior (PA) view of the skull and an OPG usually exclude the need for further radiographs in most patients with mandibular fractures. The OPG demonstrate the masseter upward displacement of the angle in unfavorable fractures. However, the cervical spine is superimposed on the symphysis in both views and can obscure the detailed assessment.

For implant the OPG gives sufficient informations alveolar height, the position of (mental foramen, inferior alveolar canal, nasal and sinus floor).
Effective dose is 10-14 microsevert mSV.

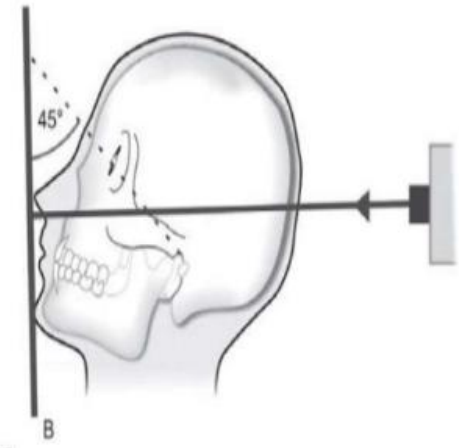
b- Postero- anterior (PA) view:

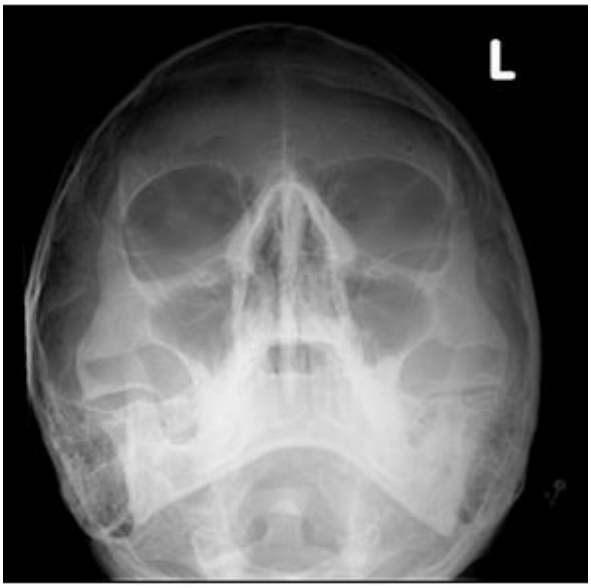
The standard PA view of the skull demonstrates fractures of the body and angle together with the degree of displacement in the sagittal plane (medial pterygoid muscle displacement), Combining it with an OPG provides the best overall assessment of mandibular fractures using plain radiographs alone.

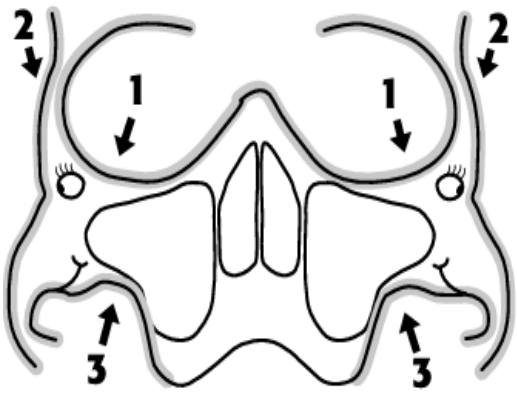
The condylar head may be obscured by superimposition of the skull base and mastoid process. For this reason; the 30° antero-posterior Townes projection and reverse Townes projection are sometimes used which demonstrate the condylar region very well.

c- Occipito- mental (OM) view

Is the single most useful plain radiograph in midfacial trauma. The zygomatic bone can be visualized clearly in this view and resemble an elephant head.
Lefort fractures is better to be visualized by CT scan.

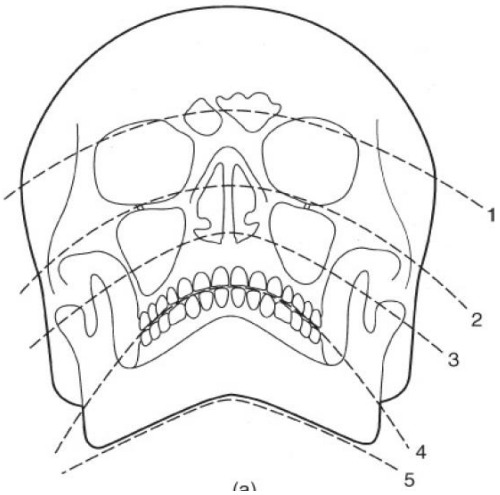






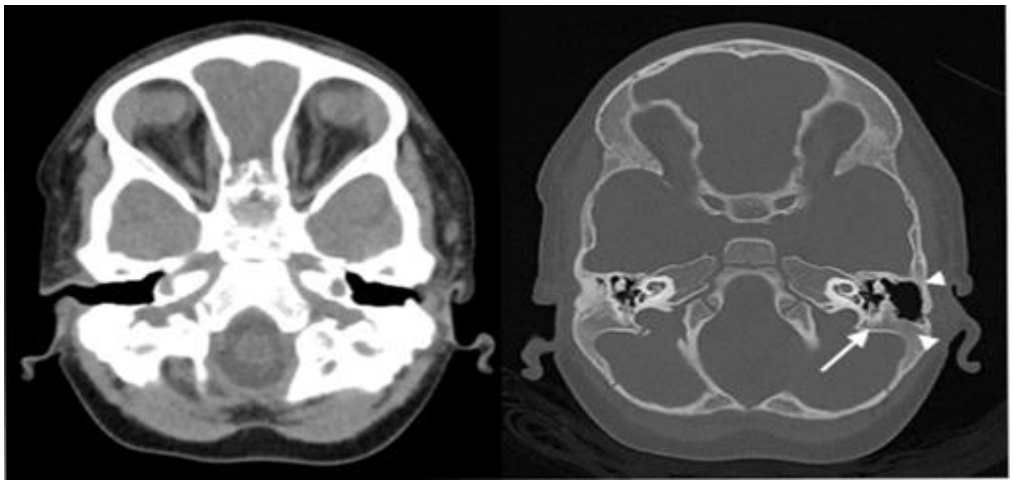
OM view (on the left), diagram representing the elephant head (on the right)

These views need to be examined systematically along four curved search lines, referred to as Campbell's lines, A fifth line that follows the lower border of the mandible was suggested later by Trapnell. (as in the diagram on the right)



2. COMPUTED TOMOGRAPHY (CT) SCAN

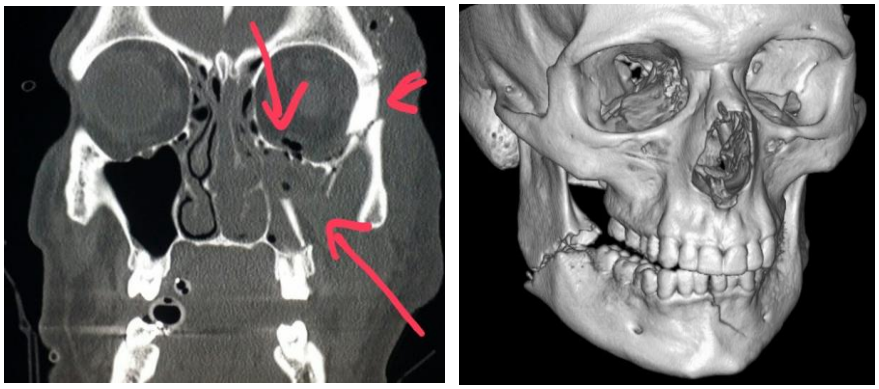
- In Computed Tomography high resolution images can be reconstructed in any plane (axial, Coronal, Sagittal and 3D).
- The patient is exposed to high radiation dose as the x-ray source rotate while the patient moves inside the machine and that's why the scan will be in spiral or helical design.
- Interpretation views include: bone window and soft tissue window.
- CT scans demonstrate excellent bone anatomy, pathology and good soft tissue contrast but not as good as MRI.
- A common problem with CT is artifact arising from high-density material in the area of interest. This is a problem in the oral cavity, where high-density fillings may degrade large areas of the image.
- CT scanning for the malignancies is routinely performed with intravenous contrast (iodine based) for outlining the tumor mass.



Axial view of skull base in soft tissue window (left) and bone window (right)

- **Most common indications of CT in maxillofacial Surgery:**

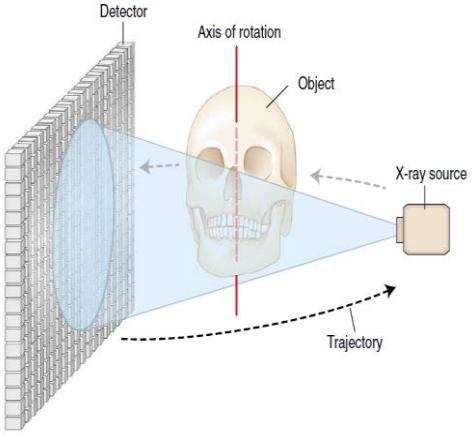
✓ Extensive fractures of the midface (including naso-orbito-ethmoid NOE, comminuted zygomatic complex fractures and isolated orbital trauma).
✓ Comminuted fractures of the mandible and complex injuries to TMJ.
✓ Assessment of tumors extension in the region and ct neck for assessment of lymph nodes involvement in case of malignancy.
✓ Construction of a three-dimensional model may be helpful to facilitate pre-surgical planning and the pre bending of a rigid reconstruction plate.

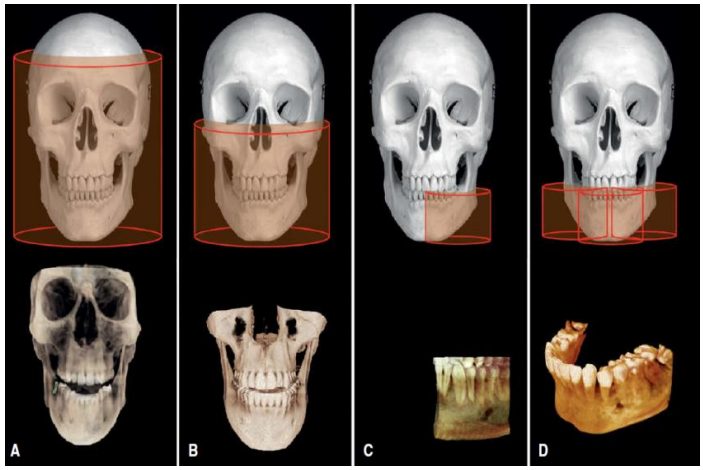


On the right: Coronal section of CT showing ZMC # (bone window).
On the left: 3D reconstruction showing right mandib. angle #

3. CONE BEAM CT (CBCT)

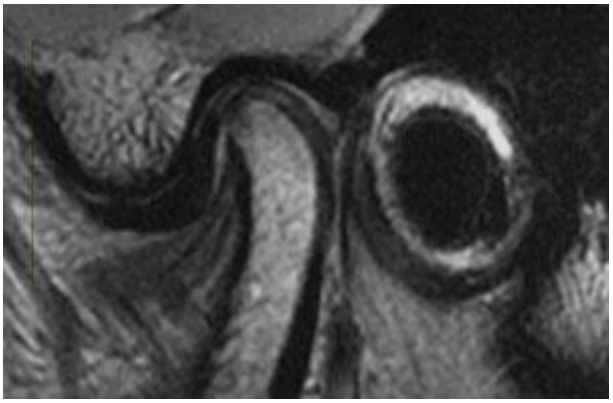
- It uses a cone-shaped or pyramid shaped ionizing radiation that is directed through the region of interest in the planes (axial, sagittal, and coronal) and 3D images.
- CBCT is much less radiation that conventional CT and can be guided to whole facial region, to both jaws, or single jaw only.
- CBCT is designed for the imaging of maxillofacial region only.
- CBCT is far more better than OPG in dental implant assessment.

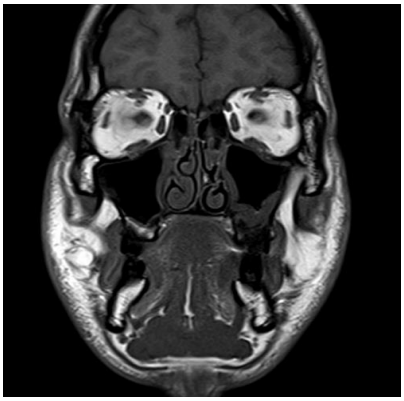




4. MAGNETIC RESONANCE IMAGING (MRI) SCAN

- The patient lies within a high strength magnetic field, usually 1.5 Tesla for head and neck images.
- MRI does not involve X-rays or the use of ionizing radiation as CT.
- In **facial trauma** it is rarely indicated but it is the only imaging method for visualizing the meniscus of the TMJ, therefore it used in suspected meniscal damage.
- Interpretation include: T1 weighted images (dark CSF), T2 weighted images (bright CSF) and fat suppression images.





On the right:MRI showing TMJ meniscus

On the left: Coronal view (T1)

In oncology: It is very precise in soft tissue imaging and that's why it is preferable to CT in assessment of tumor extension in soft tissue and lymph nodes metastasis.

Limitations and contraindications:

1- Machine design (closed MRI) is not suitable for patients with cluster phobia (solved by the open MRI).
2- Acoustic noise which is the audible noise produced by the scanner and ear protection must be worn.
3- Metal objects that are attracted by magnetic field should be removed before imaging.
4- There is inference with the action of cardiac pacemaker and other electronic devices.
5- The imaging is expensive and takes more time compared to CT.

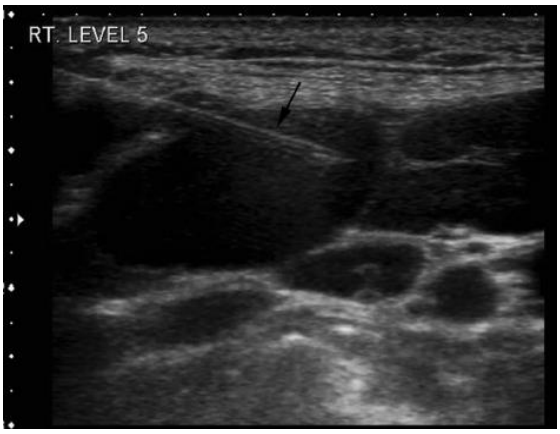
5. Ultra Sound (U/S)

Ultrasound images are the amplitude of reflected high-frequency sound waves.

Lower-frequency ultrasound penetrates further than higher frequencies therefore frequencies of 2.5 to 5 MHz are used in the abdomen (deep structures) while higher frequency as 12 MHz is used for the head and neck lesions (superficial), the less penetration; the better the resolution.

Indications

- Assessment of salivary gland pathology (tumor, stones …)
- Assessment of vascular anomalies and the flow rate (Doppler study)
- Assessment of neck lymph nodes in malignant tumors of the head
- Adjunct to other procedures as u/s guided FNA biopsy (fine needle aspiration)



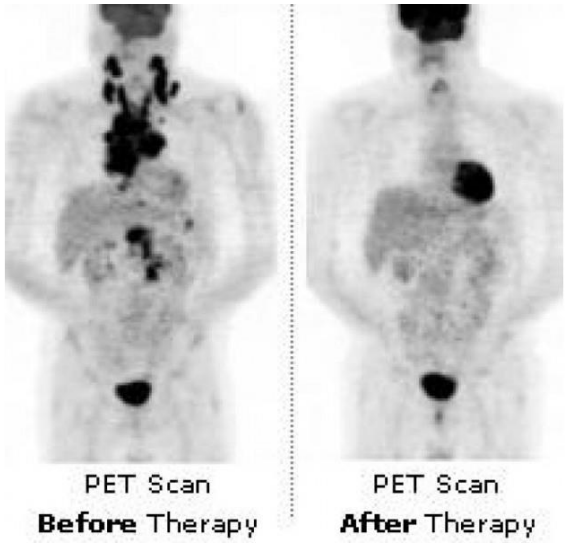
Ultrasound (gray-scale) image of cutting needle biopsy *(arrow)* of an abnormal lymph node.

6. Positron Emission Tomography (PET) Scan

PET/CT is a functional imaging technique that identifies pathology by detecting abnormal tissue metabolism. It relies on radio-tracers that are radioactive substances that given intravenously to the patient, and taken up by cells. Malignant cells trap more radiotracer compared with non-malignant cells.

The radiotracer is 18F-fluoro-2-deoxy-D-glucose (18F-FDG), which reflects glucose metabolism.

PET/CT is mainly used for malignancies (detection of occult primary, staging, assessment of treatment response, etc.)



That's it! Good Luck