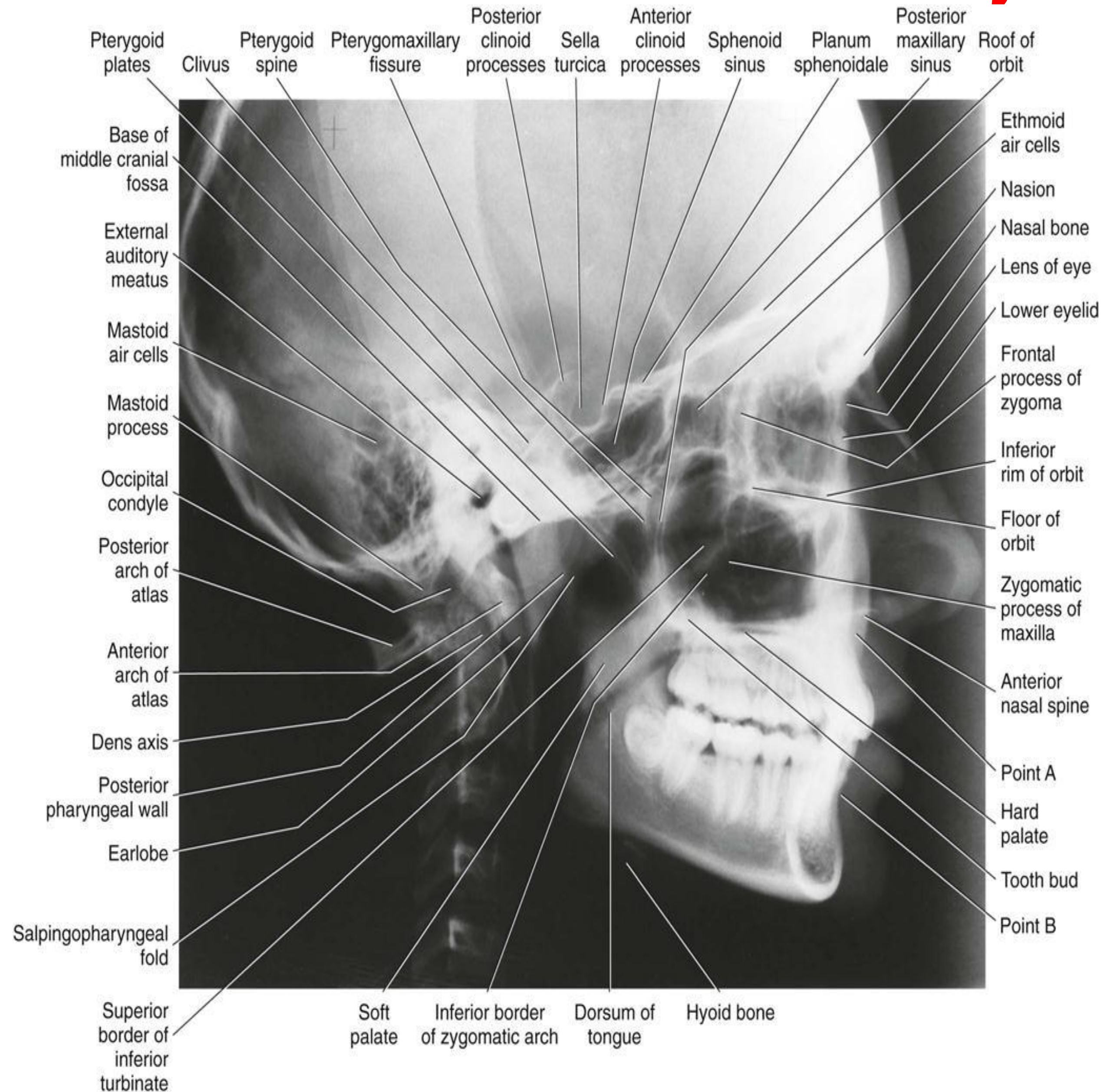
CRANIOFACIAL PROJECTION



PROF.ABBAS AY TAHER

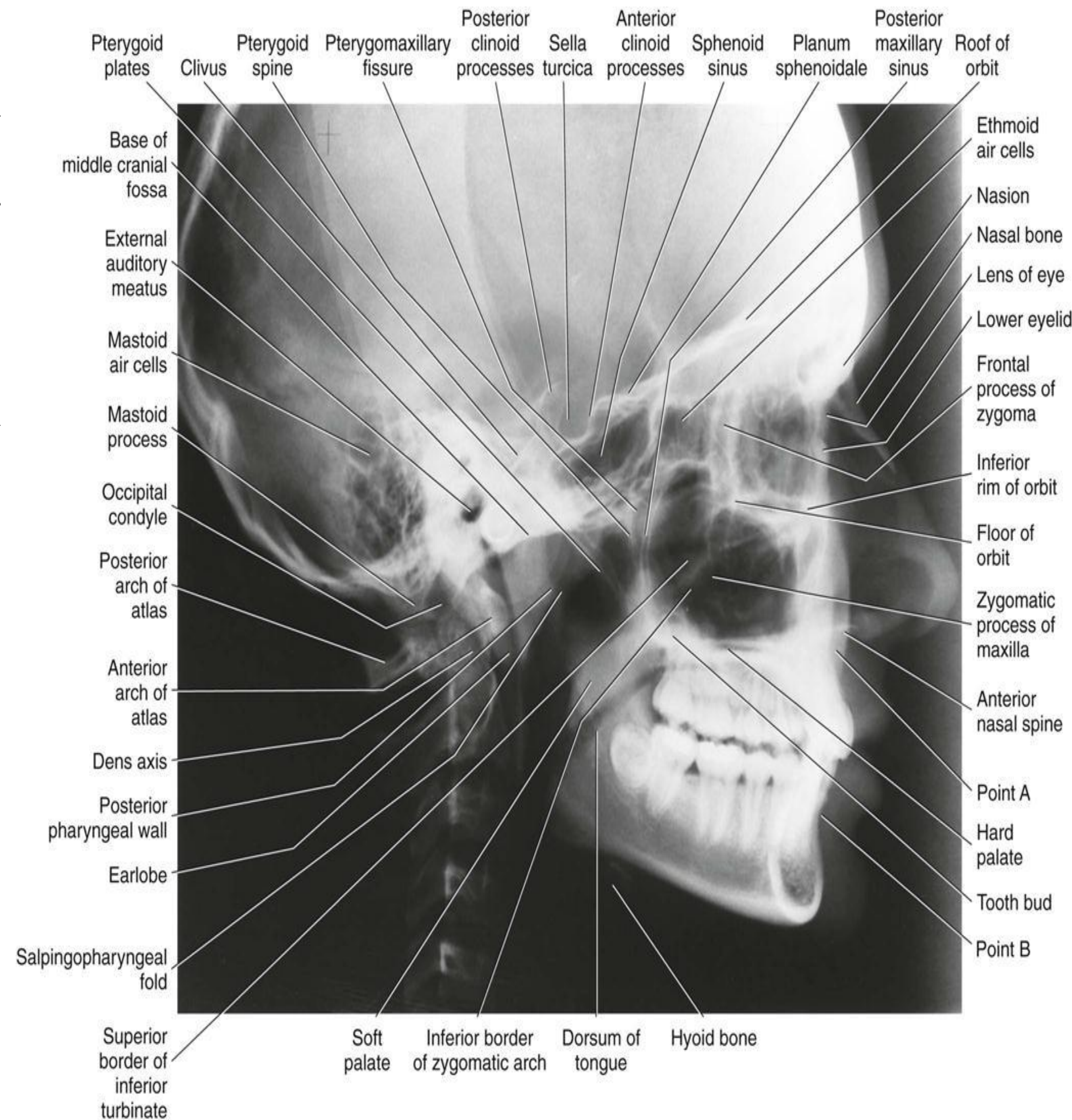
Extraoral radiographs:

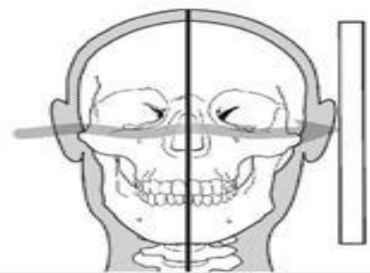
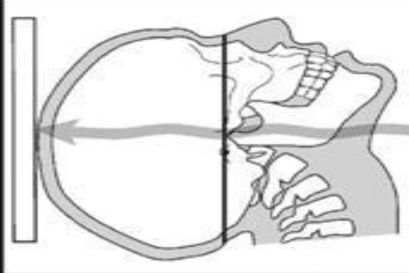
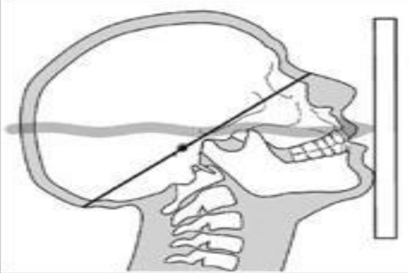
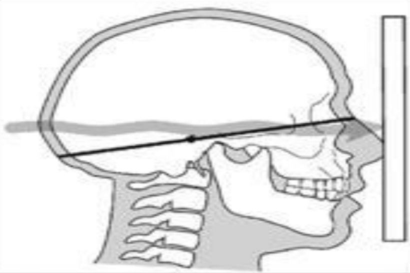
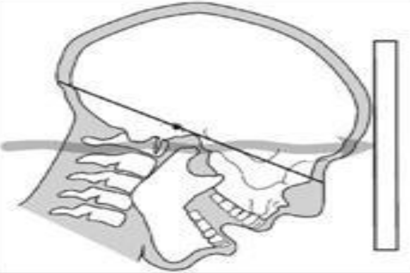
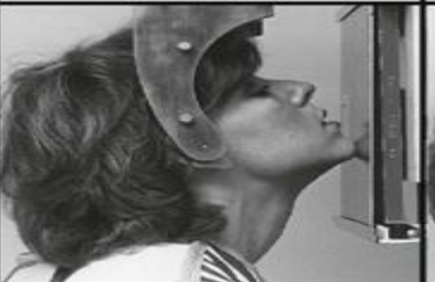
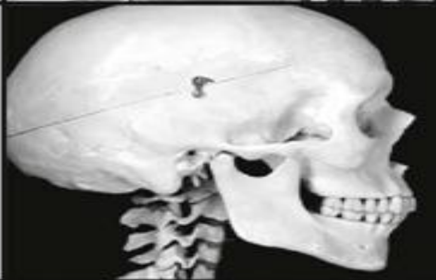
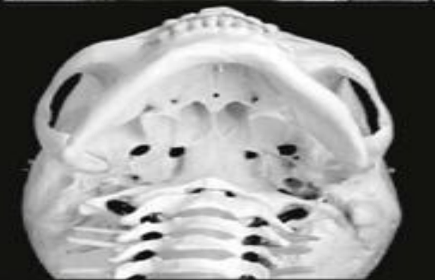
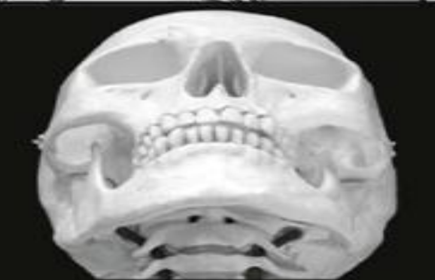
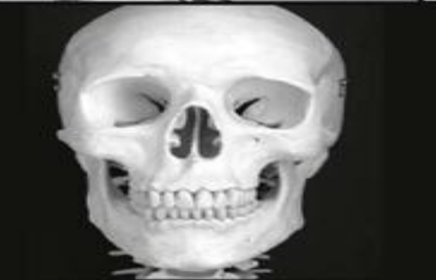
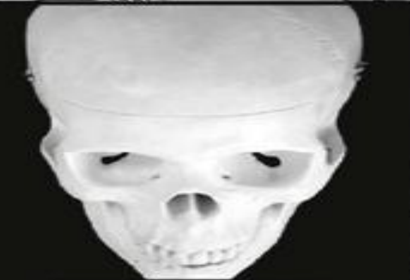
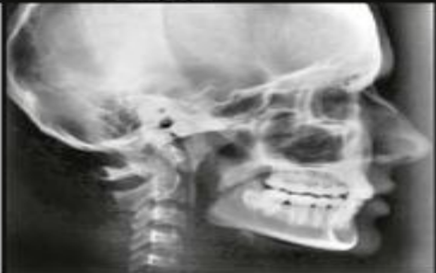
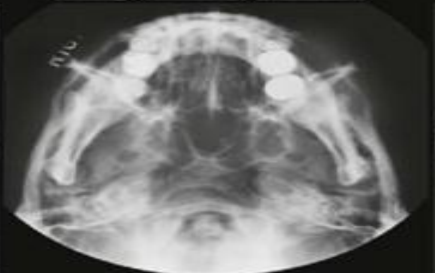
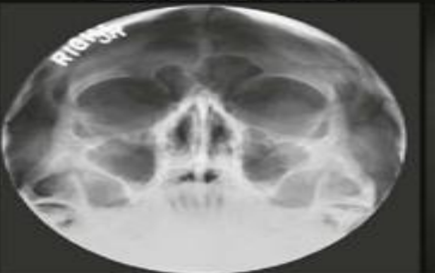
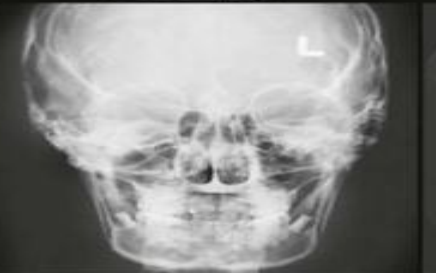
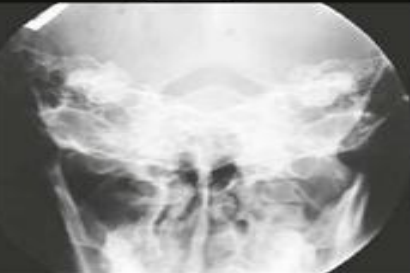
Extraoral radiographs are used to examine areas not fully covered by intraoral films or to evaluate the cranium, face (including the maxilla and mandible), or cervical spine for diseases, trauma, or abnormalities.

Standardized extraoral (cephalometric) radiographs also assist in evaluating the relationship between various orofacial and dental structures, growth and development of the face, or treatment progression.

Before obtaining an extraoral radiograph, it is essential to evaluate the patient's complaints and clinical signs in detail. **The clinician first must decide which anatomic structures need to be evaluated and then select the appropriate projection or projections**.

Selecting the appropriate extraoral radiographic examination for the diagnostic task at hand is the *first* step in obtaining and interpreting a radiograph. For spatially localizing pathology, usually at least two radiographs taken at right angles to each another are obtained



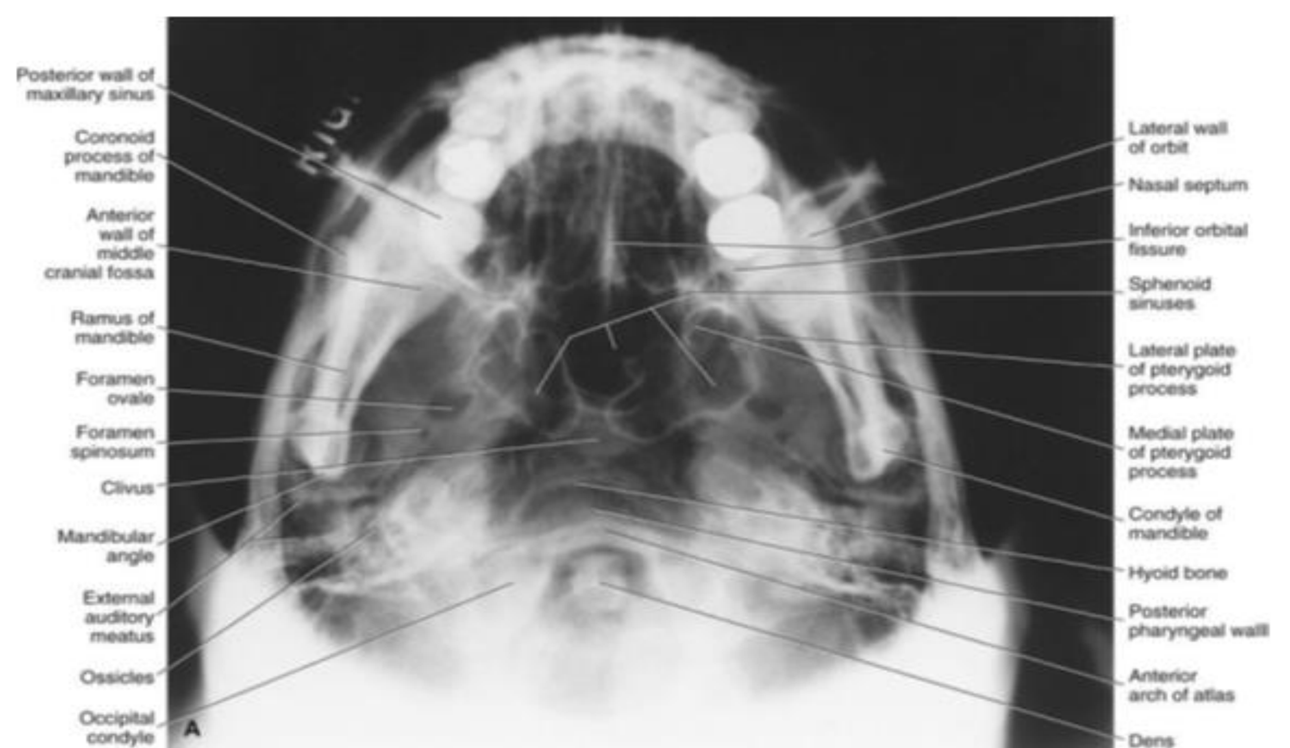
	LATERAL CEPH	SMV	WATERS	PA CEPH	REVERSE TOWNE
Patient placement	Film parallel to midsagittal plane	Canthomeatal line parallel to film	Canthomeatal line at 37° with film	Canthomeatal line at 10° with film	Canthomeatal line at –30° with film
Central beam	Beam perpendicular to film	Beam perpendicular to film	Beam perpendicular to film	Beam perpendicular to film	Beam perpendicular to film
Diagram of patient placement					
Illustration of patient placement					
Skull view					
Resultant image					

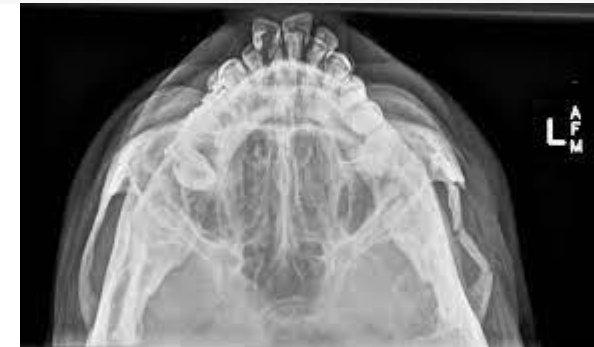
Craniofacial and Skull Projections

Examination made of the head and facial region using films located outside the mouth.
They allow the dentist to view large areas of the jaws and skull on a single radiograph not covered by intraoral films

Purpose and use of extraoral radiographs:

- Examine large areas of the jaws and Skull.
- Study growth and development of bone and teeth.
- Detect fractures and evaluate trauma
- Detect pathological lesions and diseases of the jaws.
- Detect and evaluate impacted teeth.
- Evaluate TMJ Disorders





Submentovertex (Base) Projection

Indications

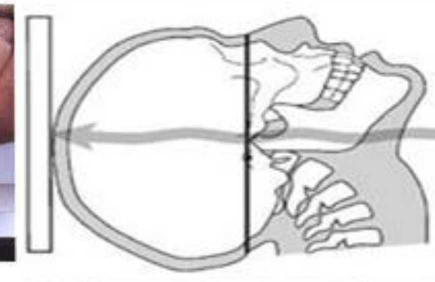
SMV radiographs display the base of the skull, the zygomatic arches, and the sphenoid sinuses .
These radiographs can demonstrate osseous changes from skull base tumors, fractures of the zygomatic arches, and the integrity and aeration of the sphenoid sinuses. These imaging indications are largely achieved by computed tomography

Image Receptor and Patient Placement

The image receptor is positioned parallel to the patient's transverse plane and perpendicular to the midsagittal and coronal planes. To achieve this position,the patient's neck is extended as far backward as possible, with the canthomeatal line parallel to the image receptor.

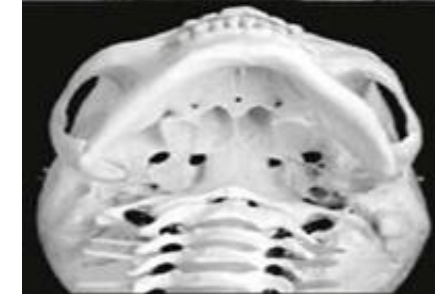
Position of the Central X-Ray Beam

The central beam is perpendicular to the image receptor, directed from below the mandible toward the vertex of the skull (hence the name SMV) and centered about 2 cm anterior to a line connecting the right and left condyles.



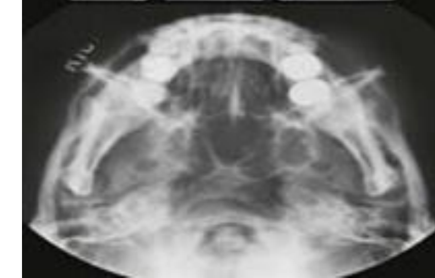
The midsagittal plane (represented by an imaginary line extending from the interproximal space of the maxillary central incisors through the nasal septum to the middle of the anterior arch of the atlas and to the dens) should divide the skull image into two symmetric halves. The buccal and lingual cortical plates of the mandible should be projected as uniform opaque lines.

An underexposed view is required for the evaluation of the zygomatic arches because they will be overexposed or **"burned out"** on **radiographs obtained with normal exposure Factors**



Interpretation

As described earlier for the lateral and PA cephalometric projections, a systematic approach that ensures interrogation of the complete image and evaluation of all anatomic structures is paramount in the interpretation of the SMV projection.



Submentovertex projection:

Purpose:

- used to show the base of the skull.
- The position and orientation of the condyles.
- Sphenoid sinus and fractures of the Zygomatic arch.

Image Receptor and Patient Placement

- The image receptor is positioned parallel to patient ' s transverse plane and perpendicular to the midsagittal and coronal planes.
- To achieve this, the patient ' s neck is extended as far backward as possible, with the canthomeatal line forming a 10-degree angle with the image receptor.

Position of the Central X-Ray Beam

- The central beam is perpendicular to the image receptor, directed from below the mandible toward the vertex of the skull (hence the name submentovertex, or SMV), and centered about 2 cm anterior to a line connecting the right and left condyles.
- The central ray is directed at right angles (or 5° to the horizontal) to the film midway between the external auditory meatus.

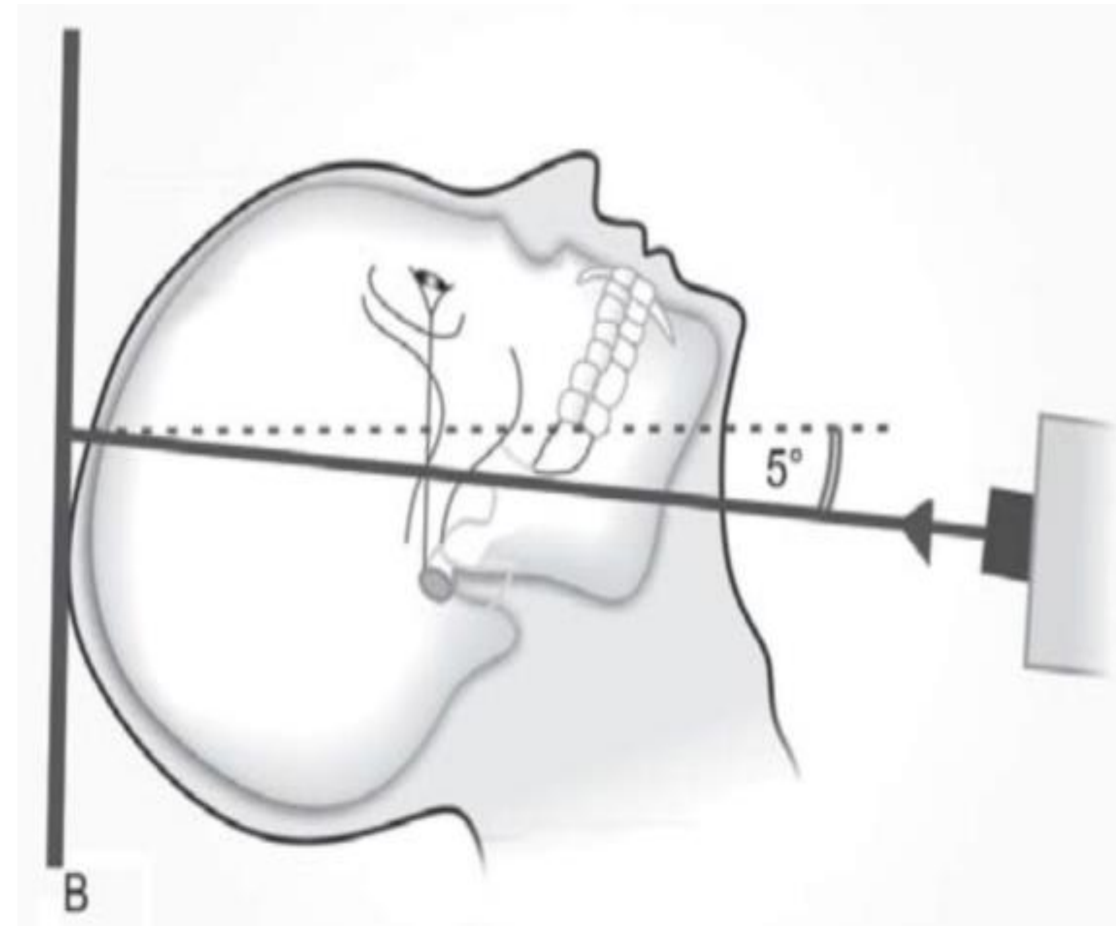


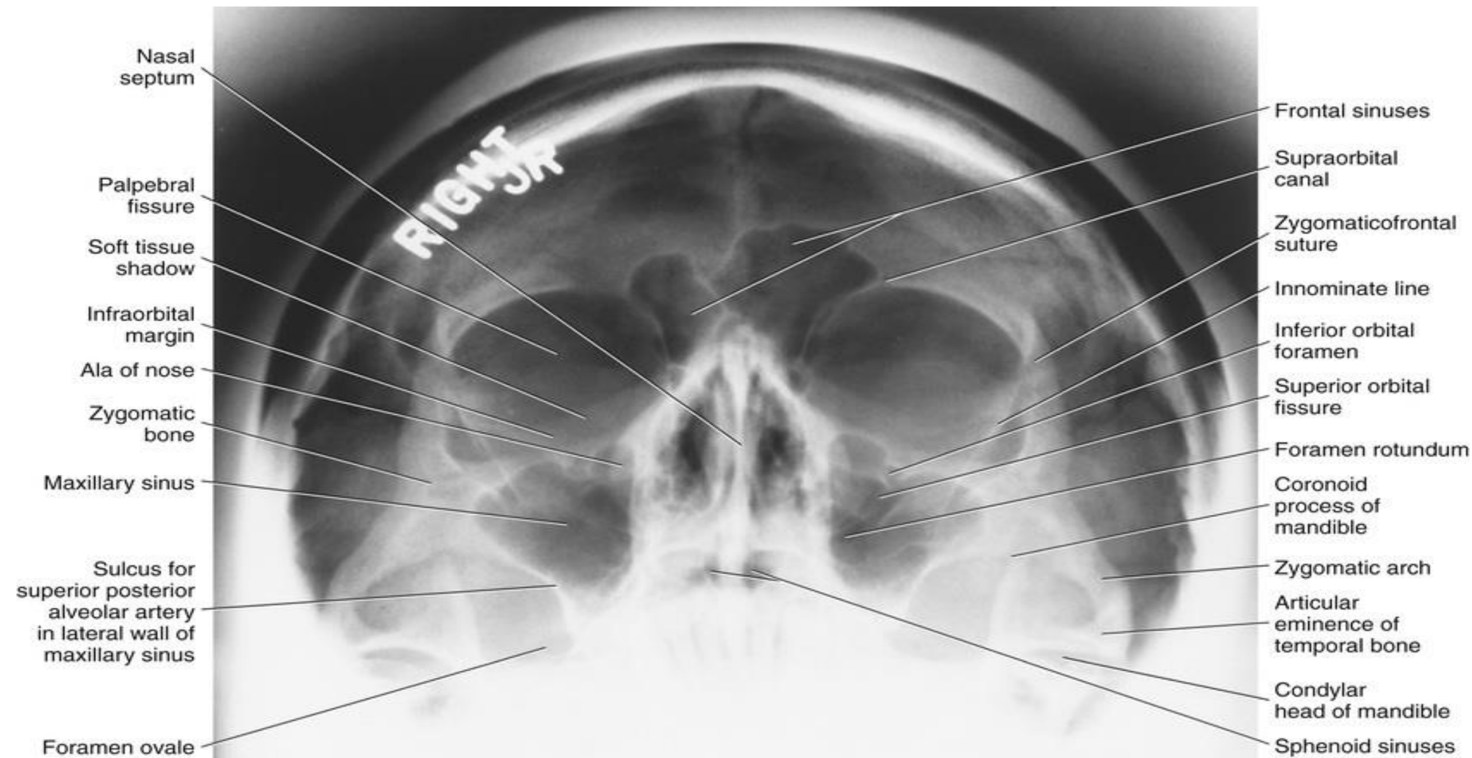
Diagram for the positioning of submentovertex projection, the radiographic base line is parallel to the film, and the X-ray is perpendicular to the film

Waters Projection

Indications

The Waters projection, also referred to as the occipitomental projection, displays the paranasal sinuses, predominantly the maxillary sinus and to a lesser extent the frontal sinus and ethmoid air cells. It also demonstrates the midfacial bones and orbits.

A Waters projection was used to evaluate maxillary sinusitis and midfacial fractures. Today these diagnostic objectives are accomplished by computed tomography . The American College of **Radiology Appropriateness Criteria** considers that this projection is usually not appropriate for the evaluation of trauma, orbits, and sinonasal disease



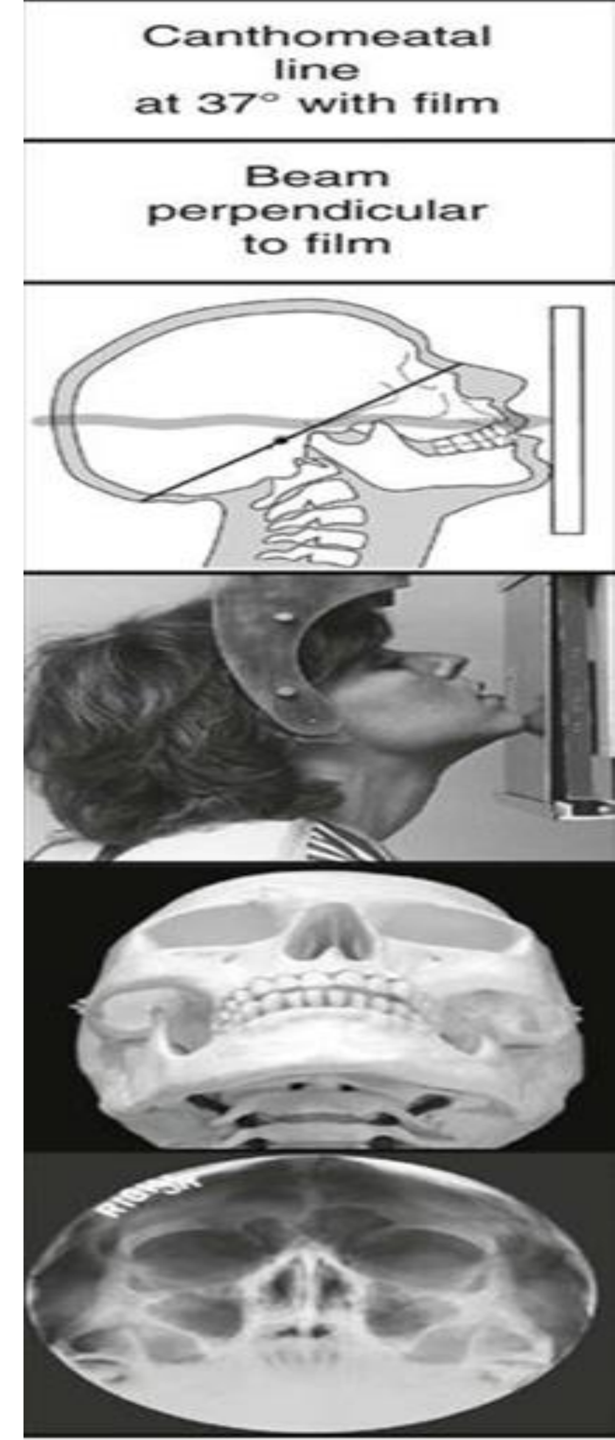


Image Receptor and Patient Placement

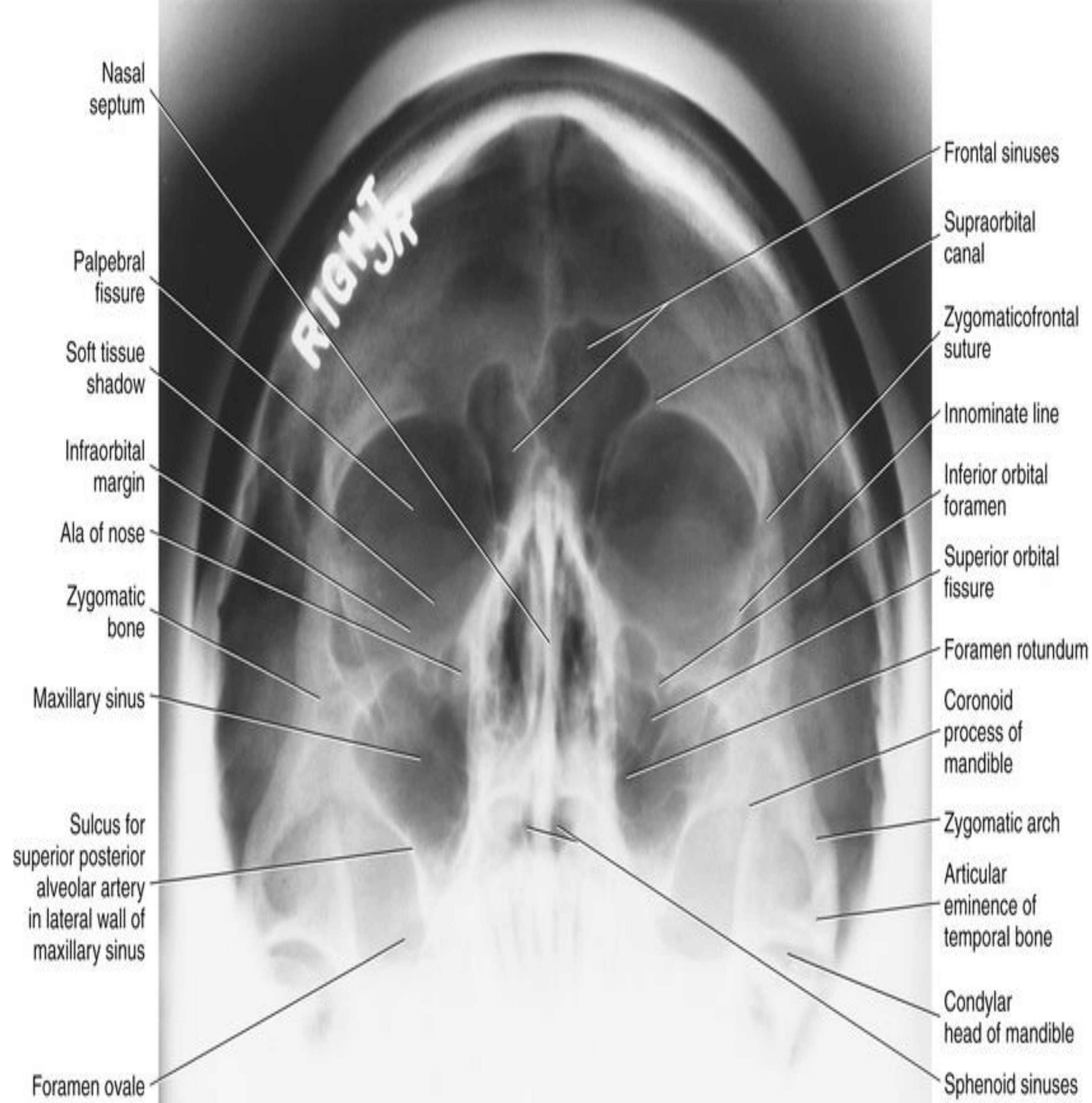
The image receptor is placed in front of the patient and perpendicular to the midsagittal plane. The patient's head is tilted upward so that the canthomeatal line forms a 37-degree angle with the image receptor. If the patient's mouth is open, the sphenoid sinus is seen superimposed over the palate.

Position of the Central X-Ray Beam

The central beam is perpendicular to the image receptor and centered in the area of the maxillary sinuses.

Resultant Image

The midsagittal plane (represented by an imaginary line extending from the interproximal space of the maxillary central incisors through the nasal septum and the middle of the bridge of the nose) should divide the skull image into two symmetric halves. The petrous ridge of the temporal bone should be projected below the floor of the maxillary sinus.



Reverse Towne Projection (Open Mouth)

Indications

The reverse Towne projection was frequently used to evaluate patients with suspected fractures of the condyle and condylar neck. Today these diagnostic objectives are best achieved by computed tomography

Image Receptor and Patient Placement

The image receptor is placed in front of the patient, perpendicular to the midsagittal plane and parallel to the coronal plane. The patient's head is tilted downward so that the canthomeatal line forms a 30-degree angle with the image receptor. To improve the visualization of the condyles, the patient's mouth is opened so that the condylar heads are located inferior to the articular eminence.

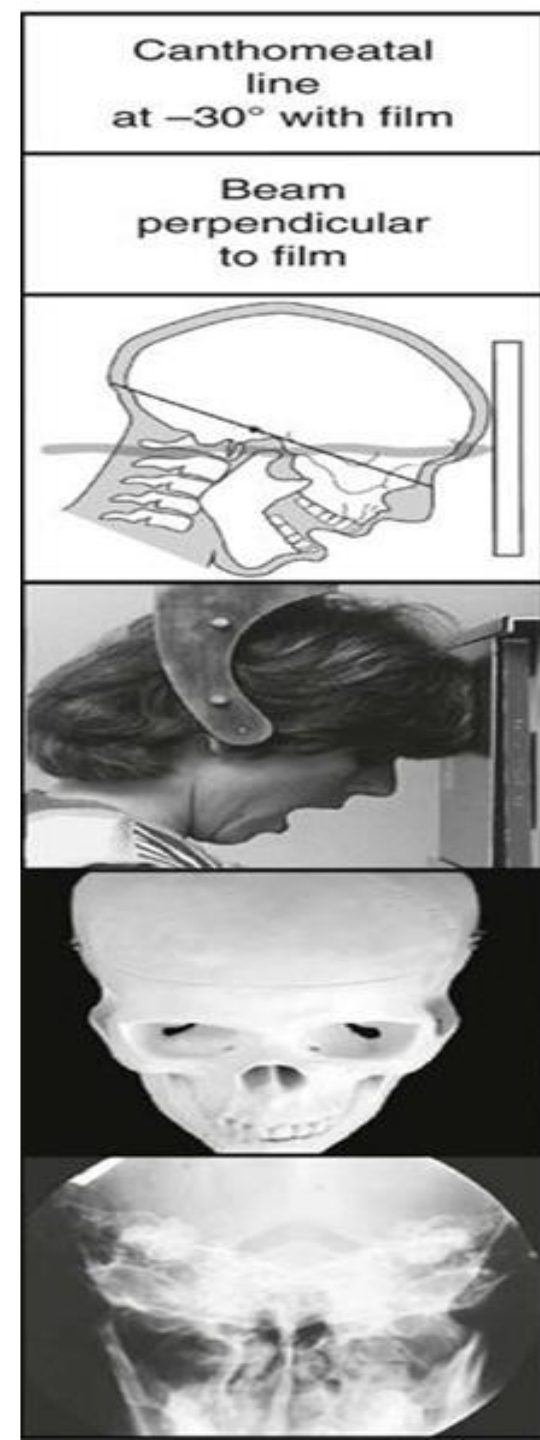
When requesting this image to evaluate the condyles, it is necessary to specify “open-mouth reverse Towne”; otherwise a standard Towne view of the occiput may result.

Position of Central X-Ray Beam

The central beam is perpendicular to the image receptor and parallel to the patient's midsagittal plane; it is centered at the level of the condyles.

Resultant Image

The midsagittal plane (represented by an imaginary line extending from the middle of the foramen magnum and the posterior arch of the atlas through themiddle of the bridge of the nose and the nasal septum) should divide the skull image in two symmetric halves. The petrous ridge of the temporal bone should

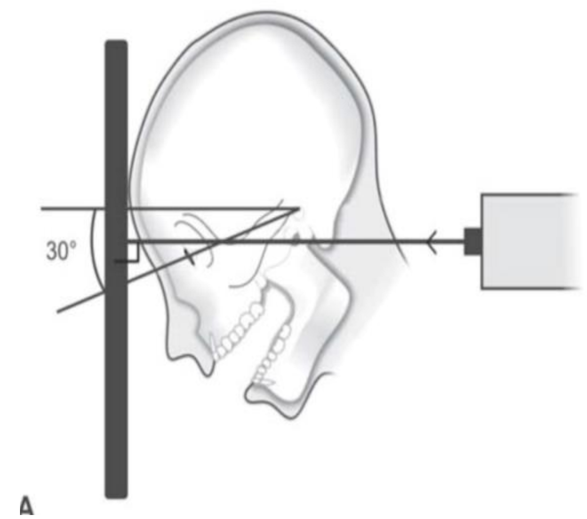


Reverse –Towne projection (open mouth)

Purpose:

To examine fractures of the condylar neck of the mandible.

Image Receptor and Patient Placement



□The image receptor is placed in front of the patient, perpendicular to the midsagittal and parallel to the coronal plane.

□The patient ’ s head is tilted downward so that the canthomeatal line forms a 25- to 30- degree angle with the image receptor.

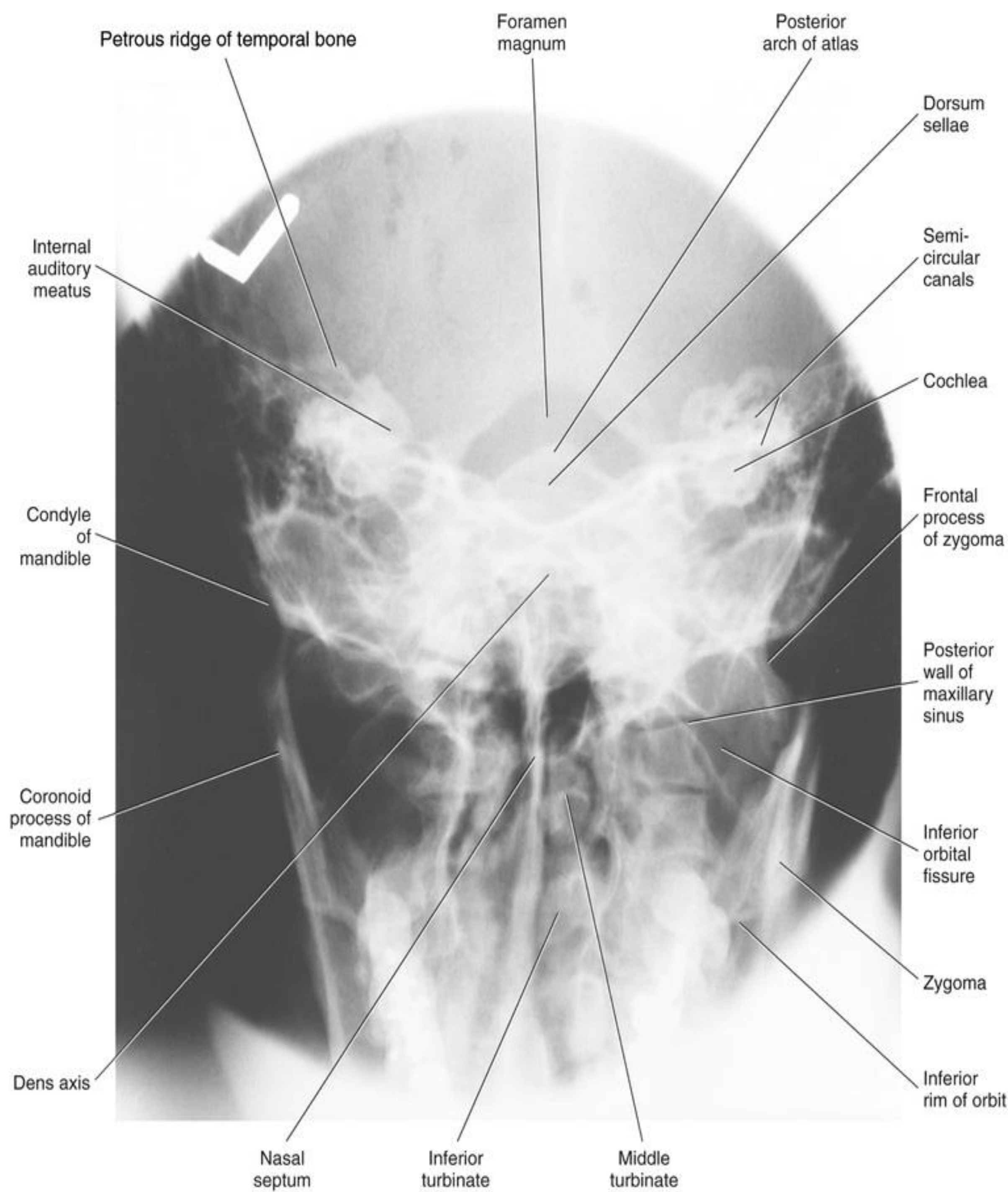
□To improve the visualization of the condyles, the patient ’ s mouth is opened so that the condylar heads are located inferior to the articular eminence. When the clinician requests this image to evaluate the condyles, it is necessary to specify “ open-mouth, reverseTowne ” otherwise a standard Towne view of the occiput may result.

Position of the Central X-Ray Beam:

The central beam is perpendicular to the image receptor and parallel to patient ’ s midsagittal plane and it is centered at the level of the condyles

Interpretation

As described earlier for the lateral and PA cephalometric projections, a systematic approach that ensures interrogation of the complete image and evaluation of all anatomic structures is paramount in the interpretation of the **Waters projection.** be superimposed at the inferior part of the occipital bone, and the condylar heads should be projected inferior to the articular eminence.



Area of interest	Lateral Ceph	SMV	Waters	PA Ceph	Reverse Towne	Panoramic
Anterior mandible	Medium	Medium		Medium		Low
Mandibular body	Low	Low		Medium		High
Ramus				Medium		High
Coronoid process			High	Medium	Low	Medium
Condylar neck				Medium	High	Medium
Condylar head		Medium	Low	Low	High	Low
Anterior maxilla	Medium		Low	Medium		Medium
Posterior maxilla	Low	Medium	Low	Low		High
Orbit	Medium	Low	High	High		
Zygoma	Low	Low	High	Low		Medium
Zygomatic arch		High	Medium			Low
Nasal bones	High		Medium	Low		
Nasal cavity	Low	Low	Medium	High	Low	Low
Maxillary sinus	Medium	Low	High	Low		Medium
Frontal sinus	High	Low	Medium	High		
Ethmoid sinus	Low	Medium	Medium	Medium		
Sphenoid sinus	High	High	Low			

Low usefulness
Medium usefulness
High usefulness
No symbol: not recommended

FIG. 8.11 Relative usefulness of extraoral radiographic projections to display various anatomic structures. *Ceph*, Cephalometric; *PA*, posteroanterior; *SMV*, submentovertex.

GOAL OF IMAGING

Achieve an **ACCURATE REPLICATION** or portrayal of the ANATOMIC TRUTH.

- Anatomic truth is the **accurate three dimensional anatomies**, static and **in function as it exists in vivo.**

PLASTER ERA

- Orthodontic imaging has come a long way since the 'plaster era' during the times of Edward Angle & Calvin case when plaster was the recording medium for the dentition as well as facial form.
- Although plaster provided 3-D information, there were limitations.

FILM ERA

- With the advent of dental impression materials & radiographic film, the orthodontic patient record evolved into ‘film era’.
- Since then use of **photography & radiography** has evolved in **orthodontic practice.**

Despite their limitation these **methods have served orthodontics well as research tool, diagnostic aid** & **medico-legal records.**

DIGITAL ERA

Now we are in ‘digital era’ in which new digital imaging methods are being used to resolve previous limitation.

Imaging has evolved from merely a diagnostic aid to advanced functions such as patient specific modeling & virtual treatment simulation.

3-D information has allowed for computer assisted design (CAD) approaches to orthodontic, enabling the manufacturing of surgical models, guides, other patient specific appliances.

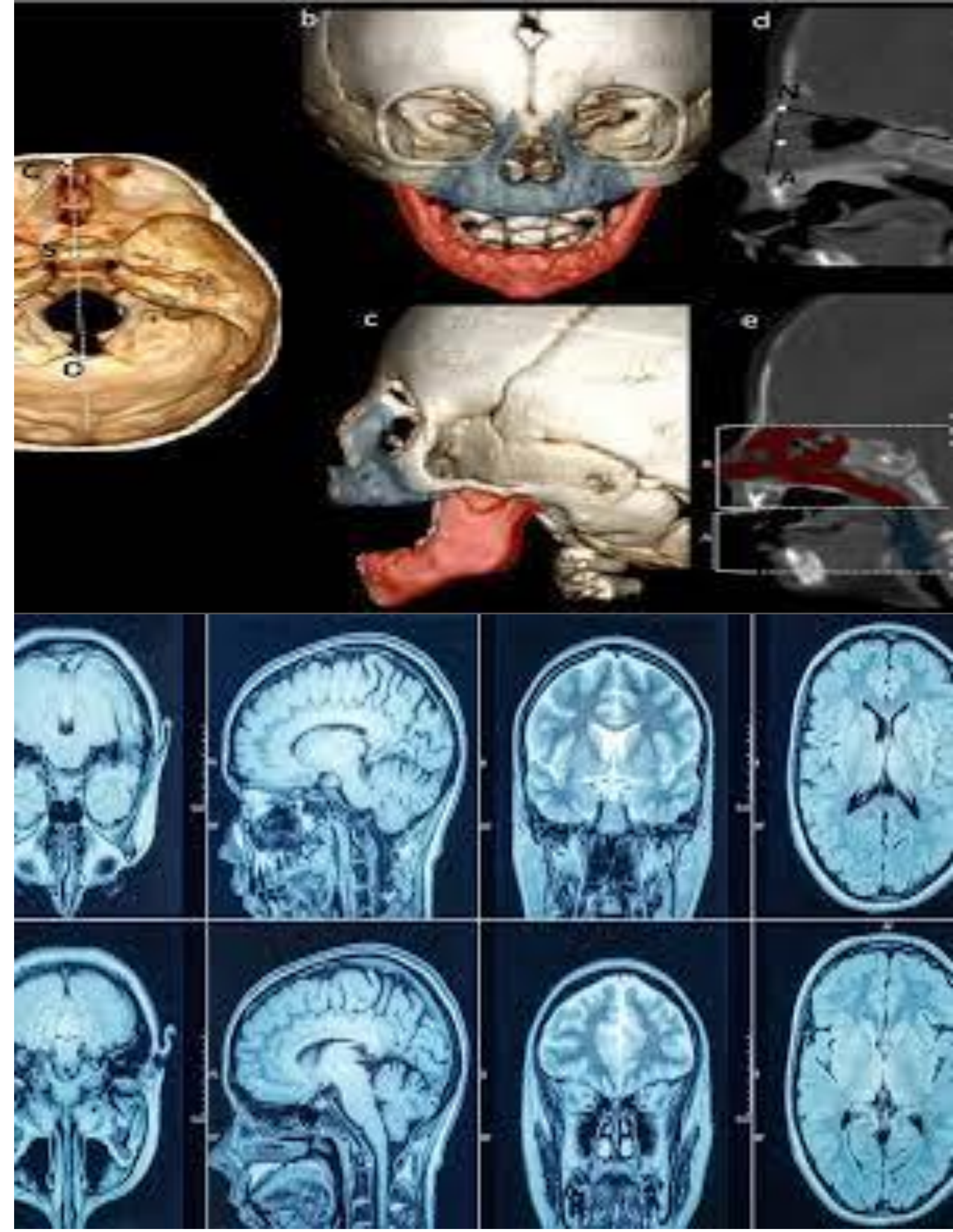
FUTURE

Upcoming developments allow the technique for **hypothesis testing** and **biomechanical analysis of 3-D patient data**.

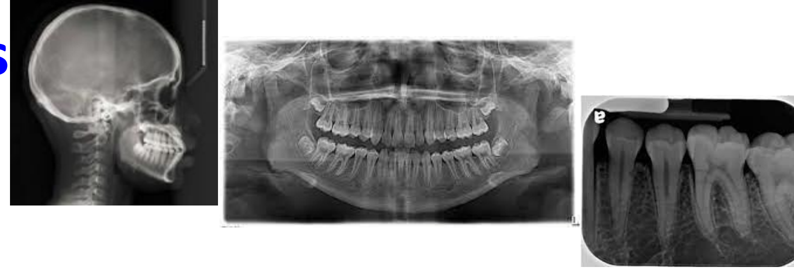
In this manner orthodontic materials can be selected and tested on the virtual patient before appliance fabrication and patient treatment.

Also the ability to interact with individual anatomic parts (i.e. **facial soft tissue**, **muscles**, **bone** & **teeth**) and to **analyze their 3D Spatial relationships**.

The smart Model constructed would contain multidimensional information that includes three dimensional space time and anatomic attributes such as tissue resiliency, tissue type and structural objects.

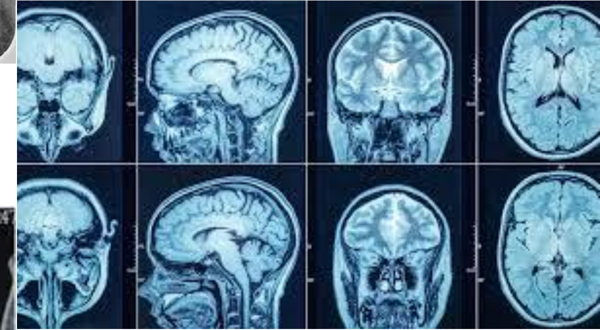


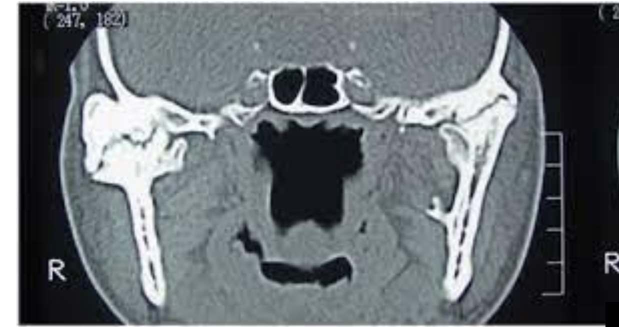
Conventional Craniofacial Imaging Methods



Hard tissue Imaging:

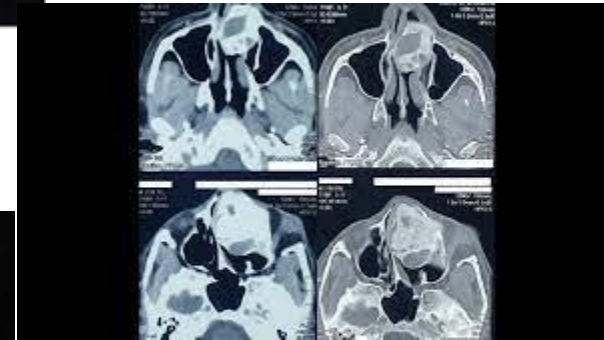
- Cephalometric radiography
- Panoramic projections
- Periapical projections
- Tomography / C T Scans
- Corrected Tomography of the TMJ

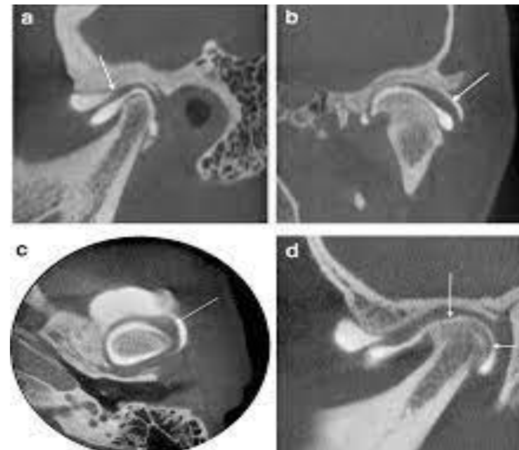


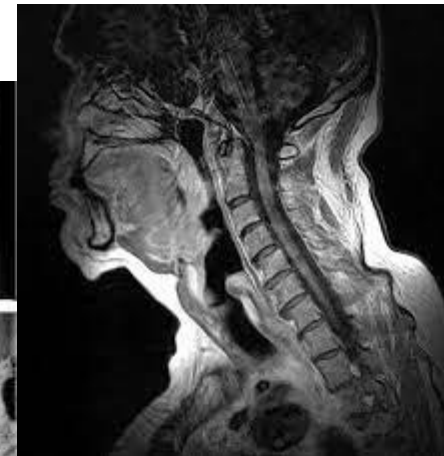


Soft tissue Imaging:

- C T
- MRI
- Arthrography

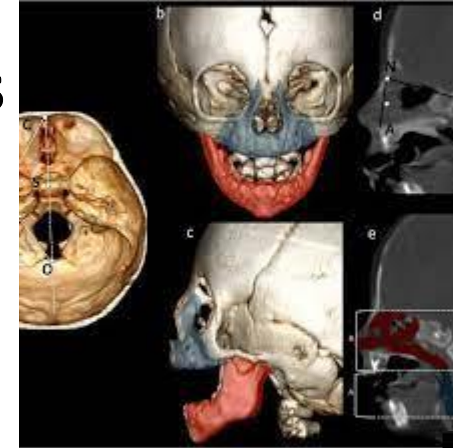




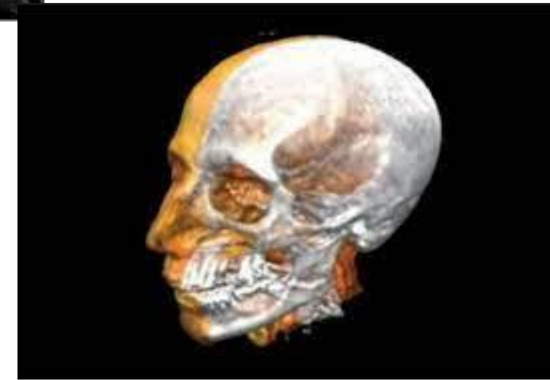


Contemporary and Evolving Imaging Techniques

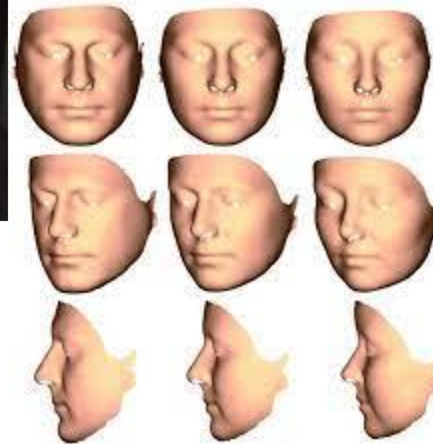
Digital Imaging



Volumetric imaging

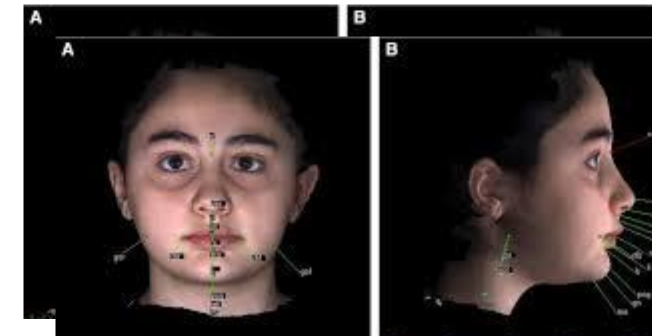


Structured light imaging

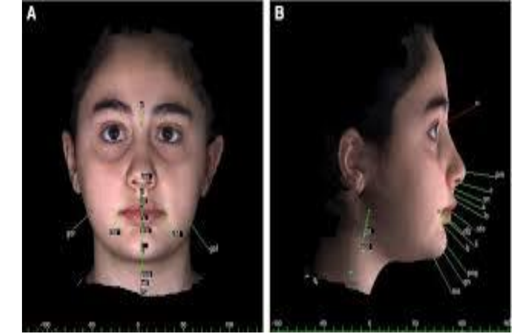


Laser scanning

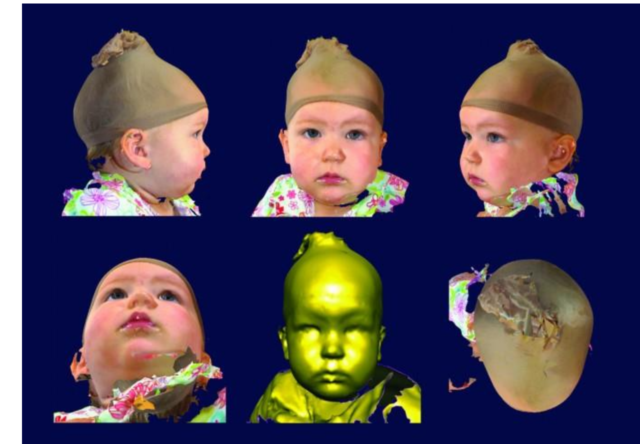
Stereophotogrammetry



Stereophotogrammetry:

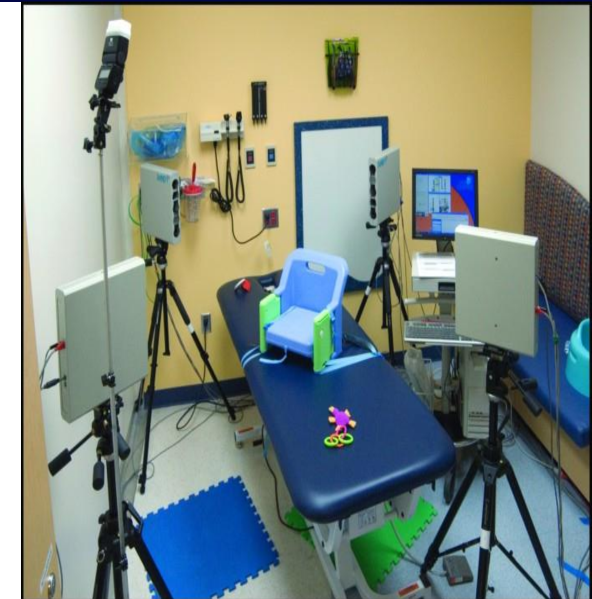


The use of 3D surface imaging technology is becoming increasingly common in craniofacial clinics and research centers. Due to fast capture speeds and ease of use, 3D digital stereophotogrammetry is quickly becoming the preferred facial surface imaging modality.



These systems can serve as an unparalleled tool for craniofacial surgeons, proving an objective digital archive of the patient's face without exposure to radiation. Acquiring consistent high-quality 3D facial captures requires planning and knowledge of the limitations of these devices.

Currently, there are few resources available to help new users of this technology with the challenges they will inevitably confront.



To address this deficit, this report will highlight a number of common issues that can interfere with the 3D capture process and offer practical solutions to optimize image quality.

The most common class of 3D surface imaging system is based on digital stereophotogrammetric technology. These systems are capable of accurately reproducing the surface geometry of the face, and map realistic color and texture data onto the geometric shape resulting in a lifelike rendering .The mathematical and optical engineering principles involved in the creation of 3D photogrammetric surface images have been thoroughly described .

The combination of fast acquisition speed and expanded surface coverage (up to 360 degrees) offer distinct advantages over older surface imaging modalities like laser scanning

Computed Tomography:

Godfrey Hounsfield in 1972 invented the revolutionary imaging technique, refers as computerized axial transverse scanning.

With this he was able to produce an axial cross sectional image of the head using a narrowly collimated, moving beam of x-rays.

The remnant radiation of this beam was detected by scintillation crystals, the resulting analog signal was fed into a computer, digitized and analyzed by a mathematical algorithm and data were reconstructed as an axial tomographic image.

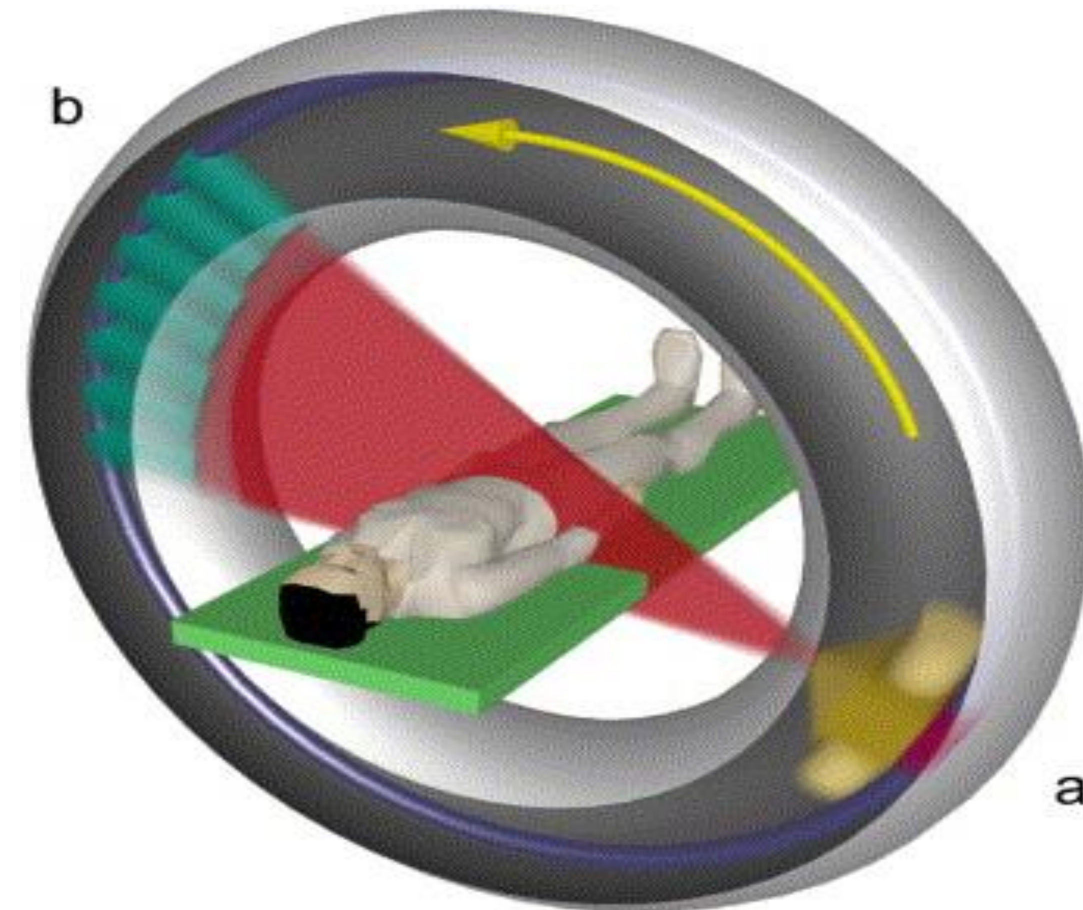
Image produced are 100 times more sensitive than conventional X-ray systems.

Computed Tomography

Depending on the scanners ,mechanical geometry, both the radiographic tube and detector may rotate synchronously about the patient. Or the detector may form a continuous ring about the patient and the x-ray tube may move in circle within the detection ring.

Regardless of the mechanical geometry, the transmission signals recorded by the detectors represent a composite of the absorption chacteristics of all element of the patient in the path of x-ray.

X-ray tube (*a*) rotates in tandem with detectors (*b*) on opposite side to image 1 thin axial slice. Bed is then advanced through machine for next slice.



- Compared with conventional CT, spiral CT provides multiplanar image reconstruction, reduced examination time (12 sec. Vs 5 Min.) and a reduced radiation dose (upto 75 %).
- Despite significant advances in other aspect of CT technology the radiation dose has remained essentially unchanged. For this reason and for those associated with cost, access & training, the use of traditional CT examination in dentistry has remained low and is restricted to C-F anomalies & comprehensive treatments. However situation is evolving rapidly with the advert of cone beam CT for dentistry.

Computed Tomography

Advantages:

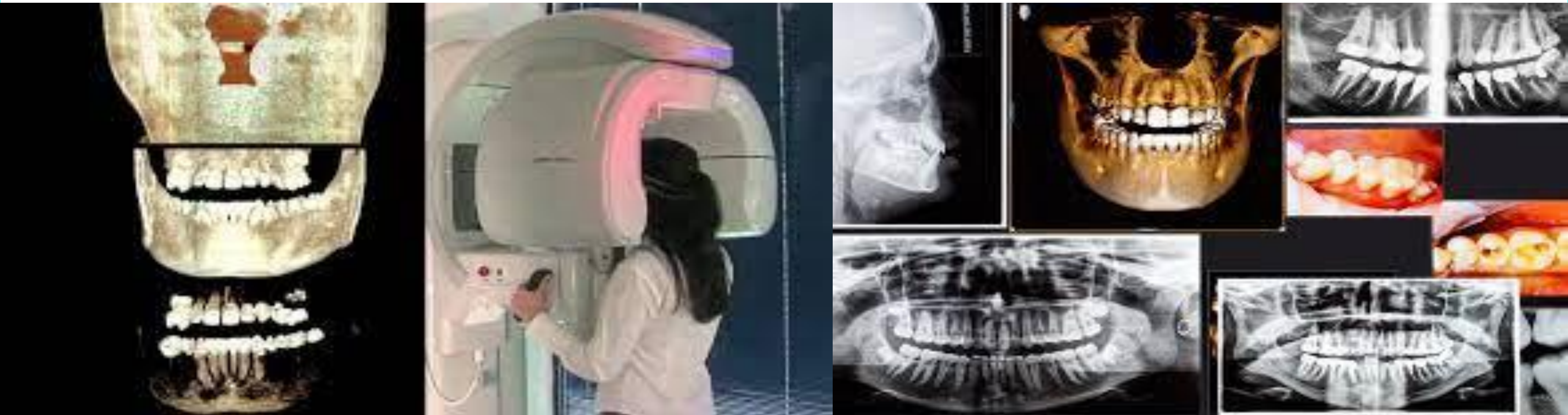
- Different planes can be visualized (saggittal, coronal, transverse) once the scan is completed viewing the subject at different levels can be done by computer
- Greater sensitivity (changes less than 1 % can be visualized).
- Superimposition of anatomical structure is not an issue to confuse diagnosis.
- (Prederisken et al 1995 have reported that the effective dose for M-F complex range from 0.11—20 mSv)

Disadvantages:

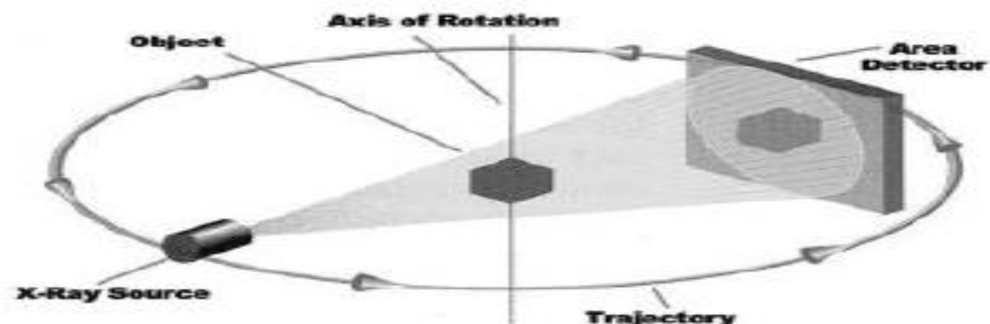
- CT has great difficulty in imaging metallic objects anything denser than enamel producing serous artifacts giving rise to **SUN RAY ARTIFACTS.**
- Expensive

• CONE BEAM VOLUMETRIC TOMOGRAPHY (CBVT / CBCT)

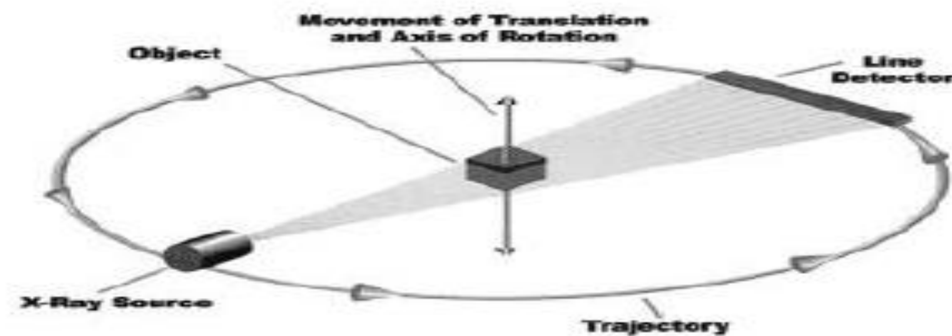
- The principle differences in distinguishing from traditional CT are the type of imaging source detector complex & method of data acquisition.
  - ☞The X-ray source for CT is a high –output rotating anode generator, where as for CBVT can be a low energy fixed anode tube similar to that used in dental panoramic machines.
  - ☞CT uses fan shaped X-ray beam from its source to acquire images and records the data on a solid state image detectors arranged in a 360 degree array around the patient. CBVT uses cone shaped X-ray beam with a special image intensifier and solid state sensors or an amorphous silicon plate for capturing the images



(a)



(b)



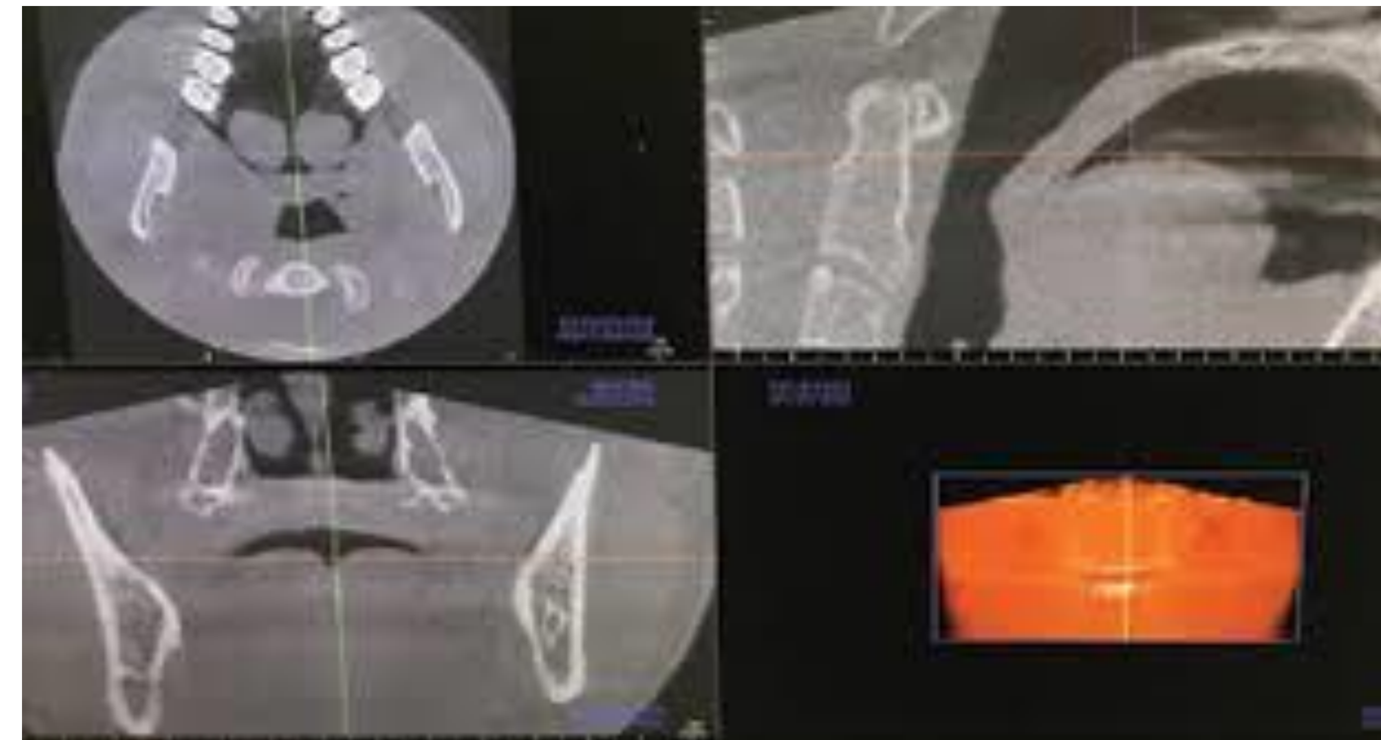
- The main difference b/w CBVT & traditional CT are the type of imaging source-detector complex & the method of data acquisition

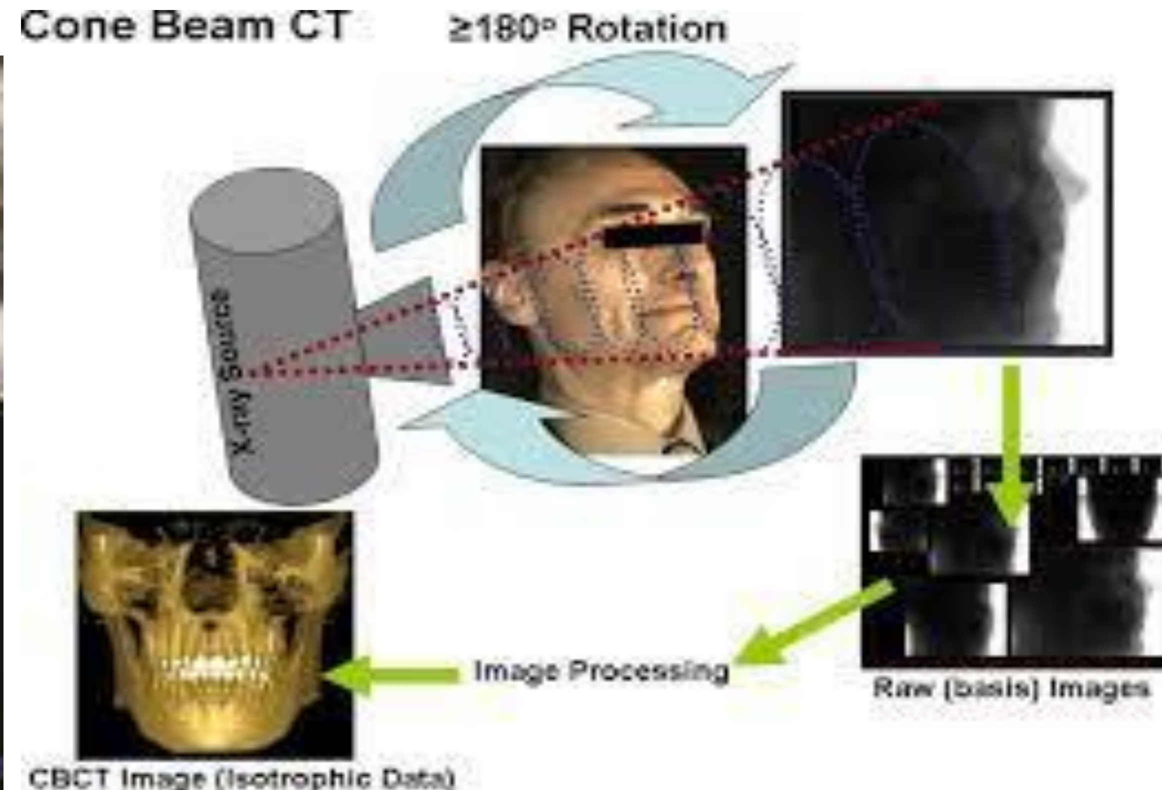
CBVT(CONE BEAM VOLUMETRIC TOMOGRAPHY)

CT images the patients in a series of axial plane slice that are captured as individual stacked sliced or from a continuous spiral motion over axial plane. CBVT uses one sweep of the patient similar to that for panoramic radiography.

•Image data collected for complete dental / M-F volume or limited regional area of interest. Scan time varies from 10 – 90 seconds, dose 40 – 50 uSv (similar to conventional dental radiograph).

•In comparison to radiation dose from a panoramic examination is in the range of 2.9 – 9.6 uSv and that from a complete mouth series ranges from 33- 84 uSv and 14 -100uSv.





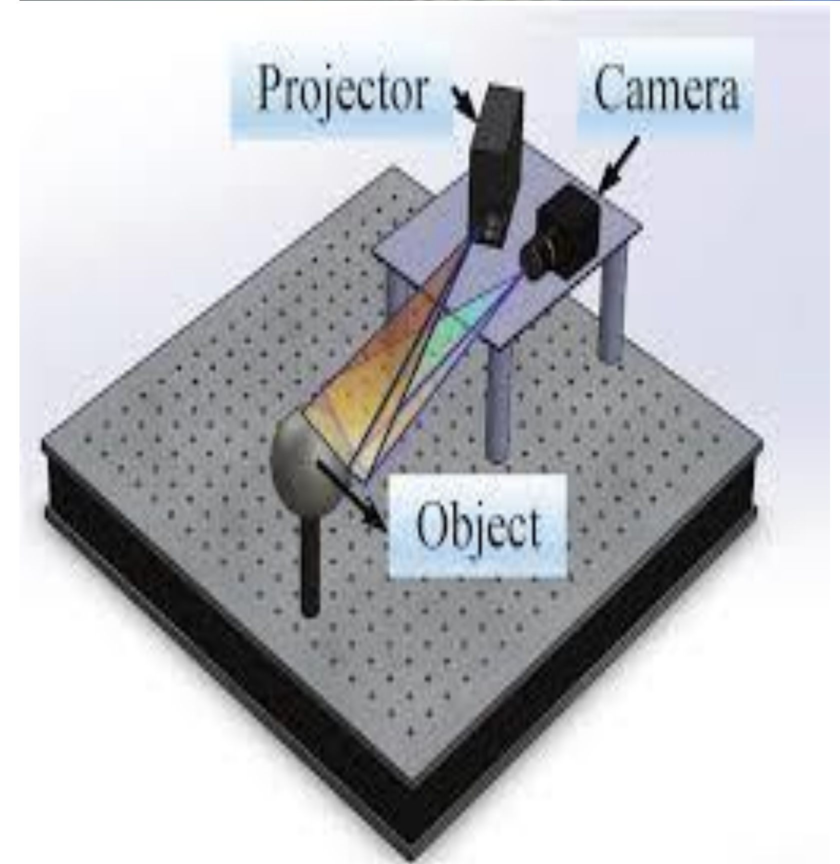
Structural light Imaging

- Principle behind structured light system is the projection of a pattern onto a surface that is distorted and interpreted as 3-D information to produce a surface map.
- Patterns used vary from lines, stripes, grids, circles and other designs.

An e.g.: of this basic system from eyeronics that uses a 35mm slide projector to project a grid pattern and a common digital camera to record images.

Because these system capture images from only one perspective or camera viewpoint, several images are taken to obtain front, left, right views of face.

To produce full face model (ear to ear) with these systems, different perspective are combined in a process called stitching to produce one model.



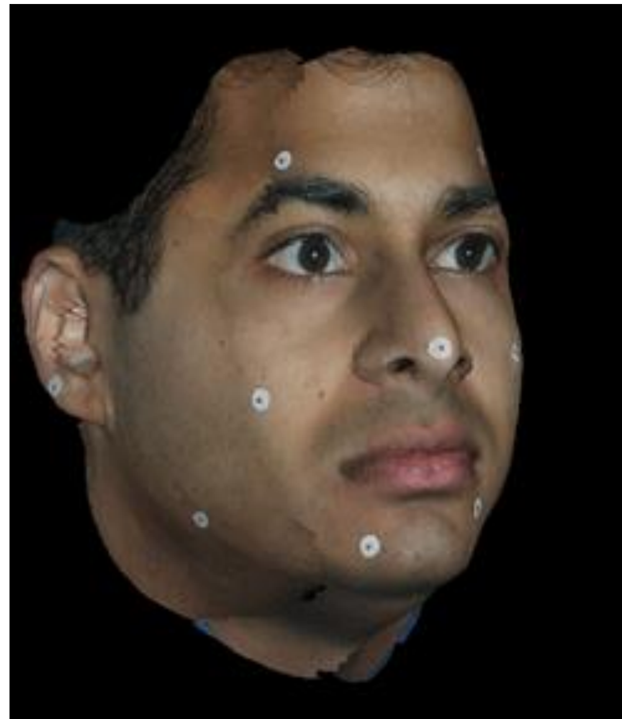
Structural light Imaging

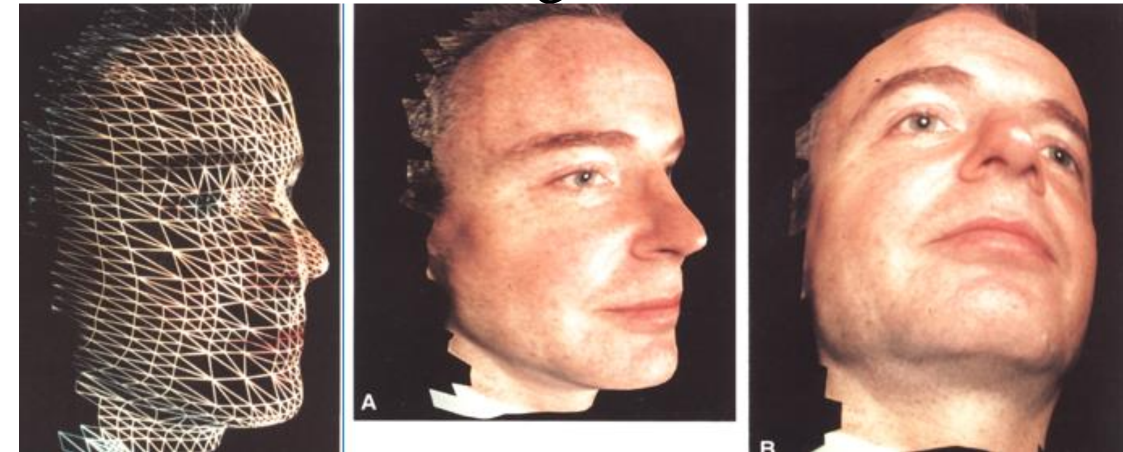
Stitching can be done manually / semi automatically.
Developments are underway to develop automatic process.

Structural light Imaging

Because a pattern is projected onto the face, the texture map (color information) contains this pattern information and can be distracting. For this reason, a 2nd image taken with identical position with out projected pattern. In this way the surface map, derived from the projected pattern, is used with a clean texture map to produce more realistic 3-D images.

The reconstructed representation of the face can be rotated on a standard computer monitor and the 3D coordinates of any visible point can be captured by pointing and clicking with a standard mouse or other





The analog picture of a stereopair of video cameras are converted into a digital mode with a standard frame grabber . The software does the entire capture in 50 milliseconds

Laser Scanning:

- **Another technology for 3-D facial imaging involves the use of lasers.**
- **Laser scanner are capable of producing detailed models , however the scanning process requires the object/subject to remain still for a period of seconds to minute or more while scanner revolves around the subjects head.**
- **Laser provides only the surface map and cannot provide color information for the texture, a color camera that is registered with the laser scanner provides this information.**

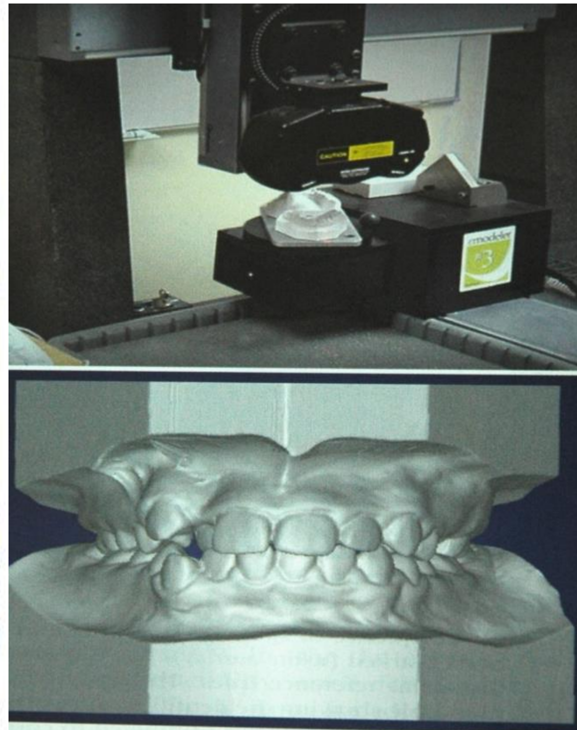
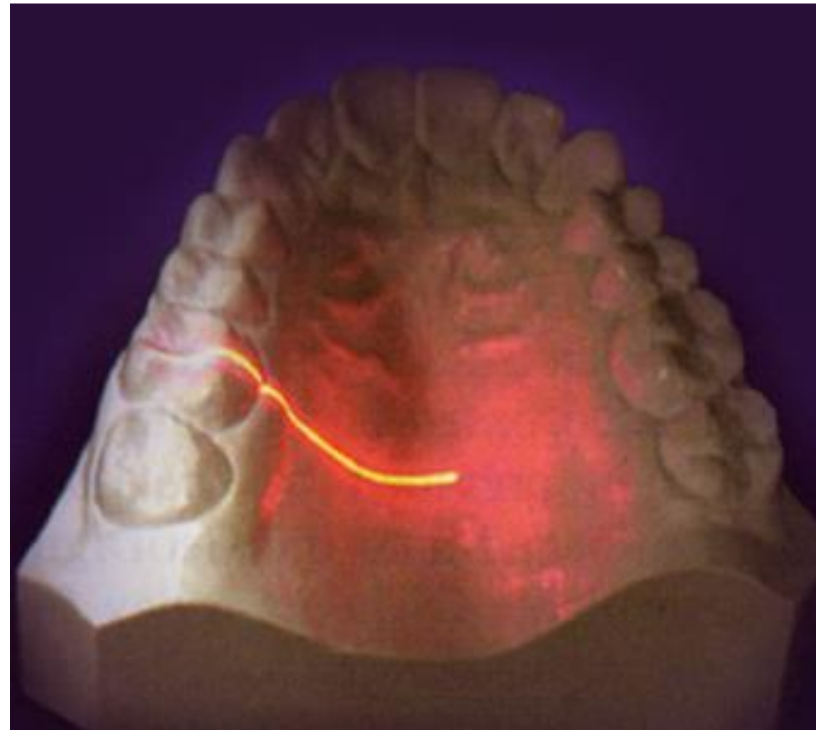


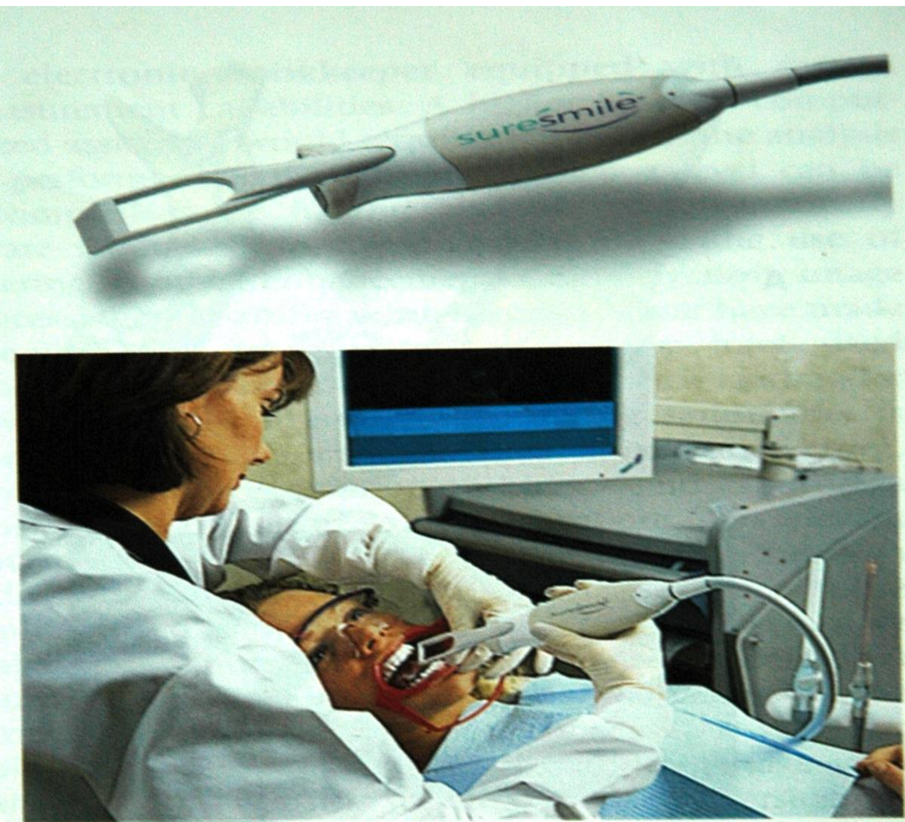
Fig. 2. Laser-scanning of a plaster model with a multi-axis robot to obtain several perspectives (image courtesy of Geodigm, Corp.).

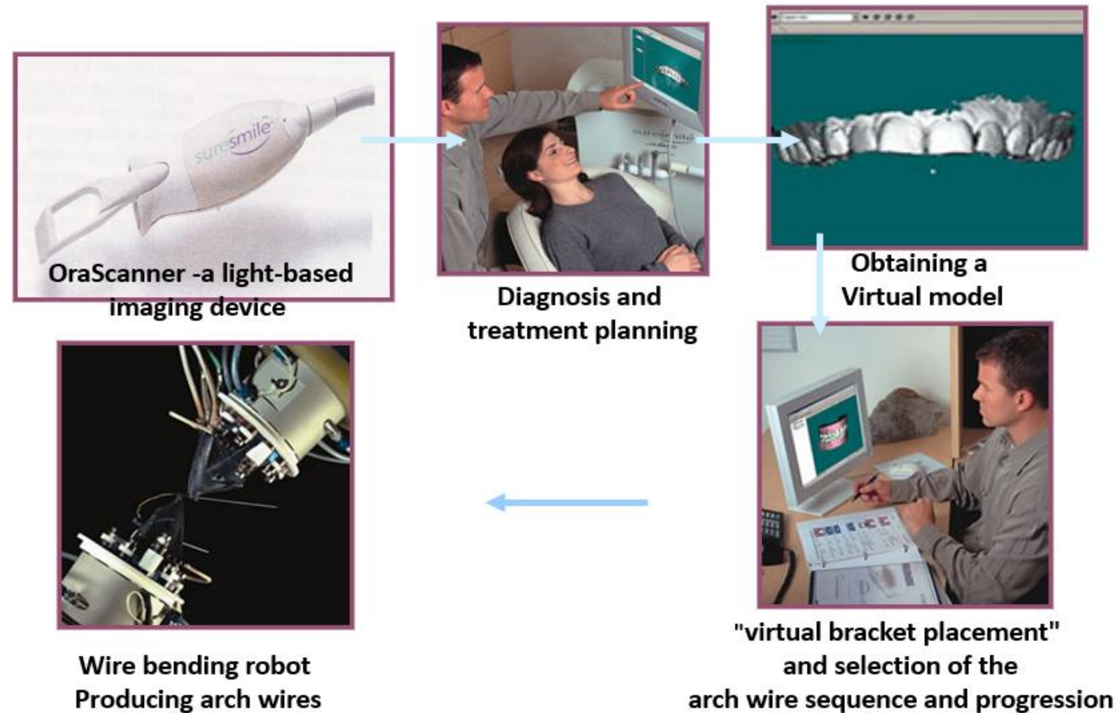


A new Laser scan based approach called e-models was developed to improve the accuracy and efficiency of orthodontic diagnosis, treatment planning, and bracket placement

Stereophotogrammetry:

- It is similar to human visual process, uses two images separated in viewpoint by a small distance.
- Images from human eye are interpreted by the brain to provide images with depth.
- The use of Stereophotogrammetry for CF imaging has been reported using dry skull, cleft lip and palate for quantification and validation of the linear and angular facial measurements.
- In the latter the absolute value of the reproducibility error for localizing the landmarks reported 1mm for distance and 1.1 degree for the angles.





MORE WE START KNOWING,MORE WE FEEL INCOMPLETE

WHICH IS BETTER THAN REMAINING INCOMPLETE,
WITHOUT KNOWING

Thank you