CRASH COURSE IN ORAL RADIOLOGY

DENTISCOPE

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Basics and background

X rays were accidentally discovered when **Roentgen in 1895** noticed fluorescent glow of crystals on a table near him when he was working with high voltage [evacuated light bulb with +ve and -ve electrodes]

- **Radiation =** the transmission of energy through space , could be in particulate or electromagnetic form.
- Atoms have protons [+ve] and neutrons [no charge] in the nucleus and electrons [-ve] orbiting around the nucleus
- An atom is electrically neutral because the number of electrons = the number of protons

Two types of xrays are produced:

- **Majority = Bremsstrahlung (breaking) radiation** – happens when high speed electrons are slowed down as they pass close to or strike the nucleus
- **Minority = characteristic radiation** - If a K-shell electron is ejected and an L-shell electron drops into the space, the energy of the x-ray will be equal to the difference in binding energies between the K- and L-shells

How xrays are generated:

Electrical energy goes to → a tungsten filament [cathode] → filament heats and releases electrons that pass and hit a target [anode] generating x rays

Low energy soft xrays don't contribute to the formation of an xray image – they expose the body to radiation but without reaching the film – they are useless and must be eliminated

- **Filtration =** The process of removing soft x rays .
  provided by **inherent filtration** in the x ray machine + added filtration by **aluminum disks** placed in the path of the x-ray beam [aluminum disks remove the x-rays that had enough energy to get through the inherent filtration but are still not energetic enough to contribute to image formation]
  x-ray machine operating at 70 kVp or higher → must have total filtration of 2.5 mm aluminum
  X-ray machines operating below 70 kVp → need to have a total filtration of 1.5 mm aluminum
- **Collimation =** to restrict the area of the head that is exposed to radiation + reduce scatter radiation
- **Collimator = lead disk** with a hole in the middle - located in the end of the PID - The size / shape of the hole determines the size/ shape of the x-ray beam

X-ray films and processing

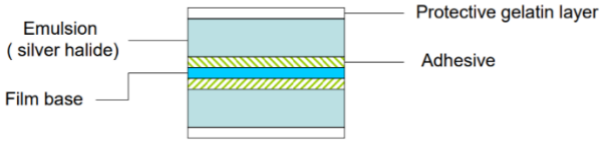
Images are stored as an unseen (latent) image that will be changed to a seen image by processing the film.

Analogue Xray films :

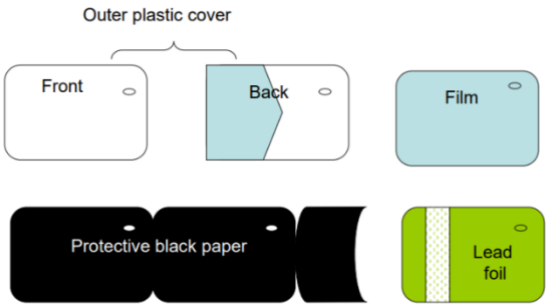
A. ***Intraoral [non screen films]***
B. ***Extraoral [screen films]***

Intra oral films:

Consist of a film base with gelatin emulsion containing **silver bromide crystals** on both sides of the film base .



- Gelatin is used as an emulsion medium because it is **chemically inert**
- Outer protective packet has 2 sides:
  A. **Front**: faces the x-ray tube, single color (white)
  B. **Back:** opposite side to x-ray tube, two colors (white and green) + has the opening tab



1- **Black paper wrapper**: protects the film base from light, saliva and damage during opening.
2- **Lead foil:** thin sheet of lead present at the back of the film to: prevents x –rays from going to deeper tissues after passing through the film + prevent scattered radiation from deeper tissues to come back to the film

Raised dot:

> **Convex:** indicates front of the film (facing x-ray)
> **Concave:** indicates back of film (facing lead foil)

Latent image formation:

- **Radiolucent objects [soft tissues]** → Many x-rays penetrate and expose many silver halide crystals → maximum silver precipitate
- **Thick radiolucent objects [bone]** → Fewer x-rays penetrate and not as many silver halide crystals are exposed → fewer silver precipitate
- **Radio opaque objects [amalgam]** → very few x-rays penetrate → silver halide crystals not exposed → no silver precipitate

Film processing : changing the latent image into a seen image - has 5 stages:

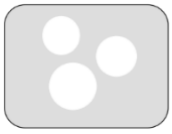
1- **Developing :** alkaline solution, acts on the Ag atoms initially separated by the x-ray photons and are further precipitated and increased in size by Oxidization
2- **Washing**
3- **Fixing :** acidic solution, acts on the AgBr crystals not affected by the x-ray photons, all crystals are removed from the gelatin emulsion.
4- **Washing**
5- **Drying**

Q: how to check for light leaks or improper safe lights in the dark room [where you process the films]?
Turn all lights off → Close door(s) → Wait for 10 minutes [so your eyes adjust to the darkness] → Check light leaks by eye (door hinges, ceilings and other possible light leaks) → Correct → Check again or you can do the **coin test**

Coin test : Open an unexposed film under the light → Put a metal coin on the film + wait for 5 minutes → Process the film :

- Clear film it means the light OK

- Dark film with clear image of the coin → improper safe light/light leak



Safe lights are either :

A. Orange [Morlite] – used only for D speed films
B. Red [GBX -2] – used with all film types, intra and extra oral films **[used in most clinics]**

X-ray dsage and safety

- **Dose =** energy absorbed per unit mass
- **Exposure =** radiation quantity, or the capacity of radiation to ionize air
- **Radiation absorbed dose =** amount of energy absorbed from the radiation beam per unit mass of tissue
- **Equivalent dose =** allows comparison between different types of radiation in regard to their absorbed doses in the body
- **Quality factor (Q) =** the biological effect of each type of radiation
- **Effective dose =** allows comparison of doses from different investigations of different parts of the body
- **Tissue weighing factor (TWF) =** radio sensitivity , the risk of the tissue being damaged by radiation.- **Tissues that have high mitotic rates are more radiosensitive**

Factors affecting radio sensitivity:

1- Dose [the higher the dose the higher the effect]
2- Dose rate [single large doses → higher damage than fractionized doses]
3- Oxygen [the higher the O2 level in irradiated cells → the greater is the damage]
4- Linear energy transfer

** As a radiation worker, you should not be exposed to more than 0.05 Sv (50 mSv) per year

Biological effects of Xrays:

1- directly by excitation or ionization of atoms
2- indirectly by chemical changes occurring near the cells

** environmental - radon decay represents the highest source of radiation

Biological effects of radiation:

Deterministic	Stochastic
severity of response is proportional to the dose There is a dose threshold below which the response is not seen occurs in all people when the dose is high enough ex: Oral effects after radiation therapy	occur years after exposure no dose threshold you either get the condition or not The probability of occurrence of the change, rather than its severity, is dose dependent Ex: radiation induced cancer

In oral and maxillofacial diagnostic imaging the primary concern is the risk for stochastic effects, namely radiation induced cancer [because the doses given are all well below the thresholds for deterministic effects]

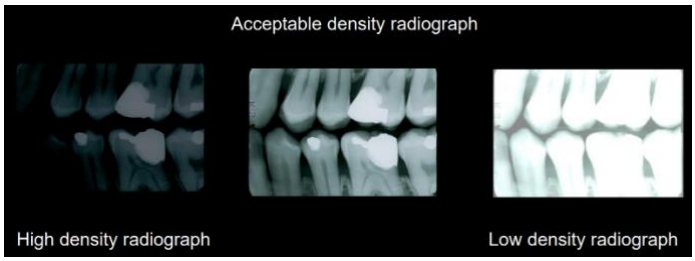
Xray protection : ALARA [As Low As Reasonably Achievable]

Patient protection	Staff protection
1- Radiographs are only taken when necessary [there should be a clinical indication] 2- Use high output DC x- ray generators 3- Minimum kilovoltage = 60kV 4- Minimum milliamperage = 8 mA 5- Minimum filtration = 1.5 mm Al 6- Maximum Beam diameter should be 7 cm + Use rectangular collimation for intra oral films 7- Minimum target – skin distance should be 20 cm 8- Do not use close ended pointed plastic cones 9- Use high speed films (D or E) 10- Use film holders and beam-aiming devices 11- Avoid retakes, master radiographic techniques 12- Use lead aprons + thyroid collars	1- Never hold the x- ray head / film during exposure 2- Never stand in the path of the primary beam 3- Stand behind a lead barrier (2 mm thickness) **4-** Stand minimum 2 M from the x-ray beam behind the patient's head

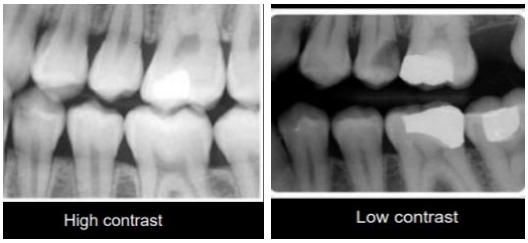
Radiographic image quality

Density = degree of blackness of the processed radiograph

- You'll get a dark film if:
  - Film was opened in the light
  - High exposure time, Ma, kVp was used
  - Developer solution was at high temp or concentration or you kept the film for a long time
  - If you open the film under incorrect safe light in the dark room
- You'll get a lighter film if you expose the opposite side
- If you get a clear film with no image → there was no exposure

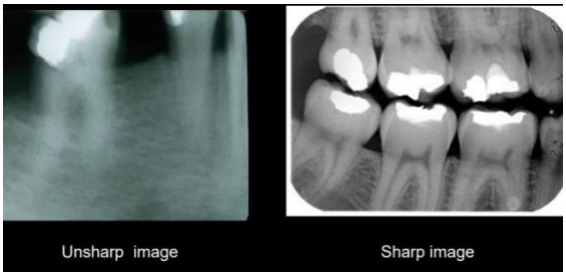


Contrast = range of densities on the radiograph [the difference between black, grey and white]



Sharpness = the ability to produce sharp outlines of objects

- You'll get an unsharp image when:
  Pt or tube of film moves during xray



Resolution= The ability of a radiograph to record separate structures that are close together

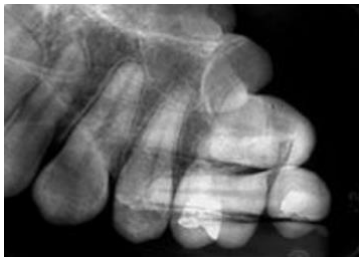
Radiograph errors:

Fogged film: increase in density caused by

- Storing film at high Temperature/Humidity
- Storing film in a radiation area
- Films without lead foil
- Light leaks / Improper safe light

Black line on the film[film softening] : caused by bending the film before exposure or before processing

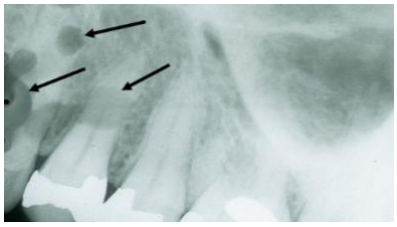
Double image : film was exposed twice



Tree like black lines : caused by static electricity

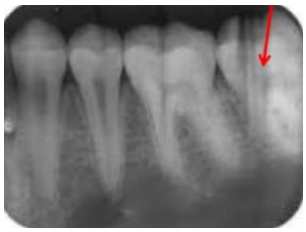
Clear spots on the radiograph: fixer drops on the film

Dark spots on the radiograph : developer splashes on the film

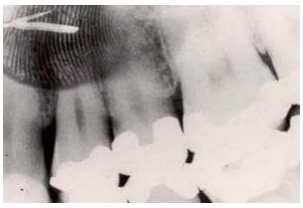


Brown spots : failure to wash the film or developer splashes

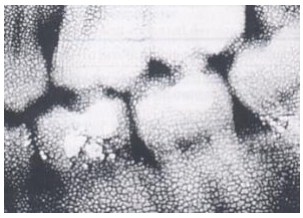
Roller markings on the radiograph: when you place more than one film at a time – or dirty rollers



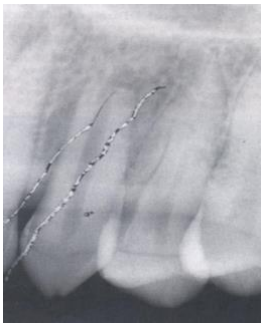
Finger prints: holding the film while wet



Cracked emulsion: difference In the processing solution temperatures



Scratches on the radiograph: wet film or film scratched by fingernails



Film partially opened in light

Film not fully immersed in developing solution

Digital radiography

Digital radiography can be :

1- **A sensor with a cable connected to a computer (real time acquisition) :**

- **Charged couple devices – CCD:**

  Silicone chip that has intensifying screen to increase the xrays detected → xrays changed to light by fiber optic coupling → light changed to binary code (1010101) that the computer can read

- **Complimentary metal oxide semi conductors – CMOS**
- **Charge impulse devices – CID**

2- **An image storage plate (cordless acquisition) :**

- **Photo stimulable phosphor imaging plates – PSP:**

  The PSP after exposure to x-rays → they store the image → film is scanned by a laser beam→ this causes the PSP to fluoresce → fluorescent image is detected by a photo diode that changes it to an image the computer can display – the image is then erased by exposing the film to intense light

3- **Digitization of analog radiograph [with a digital camera or with a scanner + transparency adapter]**

PSP [DIGORA]	Direct capture sensors [dentimax]
A. slim	a. thick
B. multiple teeth are covered	b. limited area covered
C. can fit in regular film holders	c. need a special film holder
D. no need for nearby computer	d. must be connected to a computer

10- Both have less radiation exposure compared to analogue films but less image quality compared to analogue films

**** PSP films are toxic – don't use them if u suspect that the pt might swallow them [if swallowed contact a doctor to remove it ASAP] – if the pt chews on the film → rinse the pt's mouth with large amounts of water [SENSORS SHOULD NOT BE AUTOCLAVED]**

Digital radiographs

Advantages	Disadvantages
1- Lower radiation exposure	1- Lower image quality
2- Quick / Real time image	2- Expensive
3- Easier storage and archiving pt's info	3- Sensors are rigid and difficult to place intra orally
4- Easier to communicate with other doctors	4- Image has no history
5- No need for chemicals or processing	5- No dot to tell which side of the sensor was exposed [right or left]
6- Image can be manipulated [you can enlarge, invert the image do measurements , change contrast etc]	

- Films that are **slightly light** are more useful for examining cortical margins of bone
- A **longer gray scale contrast** provides **better visualization of the extent of bony detail and tooth roots**

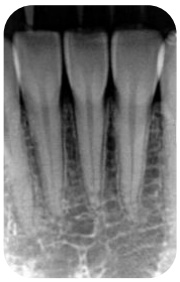
Intra oral radiography techniques

Radiograph will not show any soft tissues.

Ideal radiograph should :

1- Show the same shape / size of the object without distortion
2- Show a sharp image of the object [single border of the object]
3- Proper density and contrast

Periapical radiograph: [shows crown + root + Pa region]



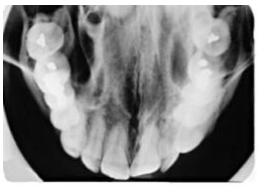
Ideally should :

1- Show the whole length of the examined tooth (crown + root)
2- At least 2 mm of the periapical area
3- The adjacent teeth on each side of the examined tooth (mesial and distal)
4- **Separated proximal surfaces (no overlapping contacts)**

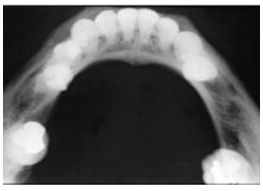
Bitewing radiograph: [shows the crowns + interproximal surfaces of the upper and lower teeth + crest of alveolar bone]

Ideally should:

1- Show the whole crown of the examined upper and lower teeth
2- **Separated proximal surfaces (no overlapping contacts)**
3- The level of the crests of the alveolar bone between adjacent teeth

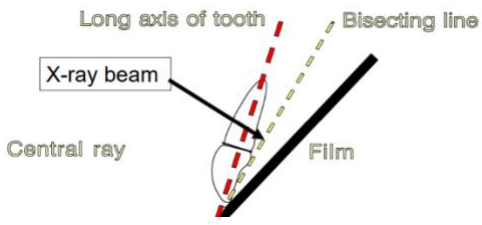


Occlusal radiograph: [used to cover a large area that is not usually covered by the PA film, shows the entire jaw in axial view]

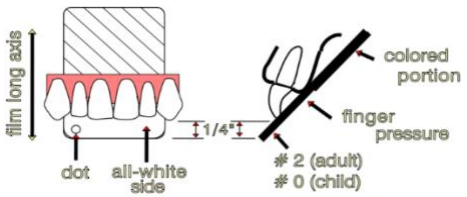


Radiograph techniques : Periapical Radiographs

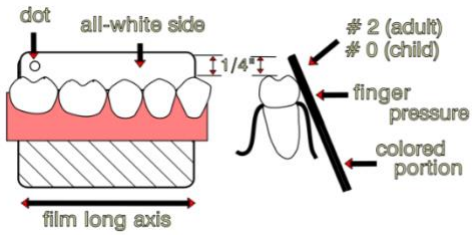
Angle bisecting technique: Xray beam is perpendicular to the bisecting line between the long axis of the tooth and the film



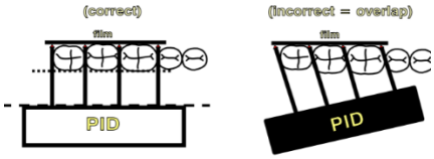
Anterior teeth: The film positioned with the long axis vertically and the dot-end of film extending 2 mm beyond the incisal edge- finger pressure is applied at the cervical portion of the crown to avoid film bending.



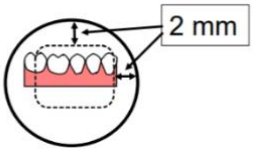
Posterior teeth: The film is positioned with the long axis horizontally and the dot-end of film extending 2 mm beyond the occlusal surface - finger pressure is applied at the cervical portion of the crown to avoid film bending.



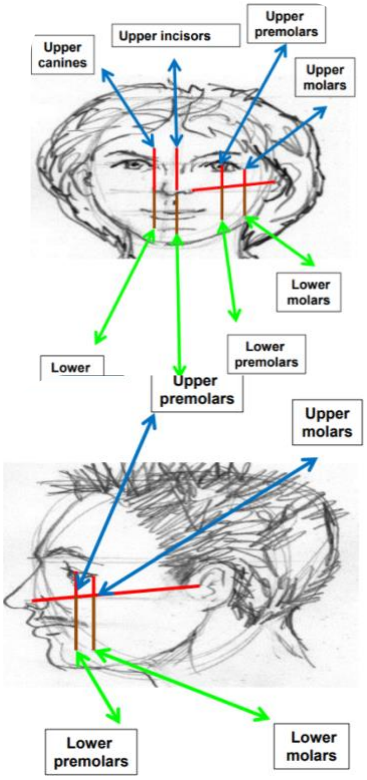
The horizontal angulation : a line connecting the buccal surfaces of the posterior teeth is parallel with a line connecting the front and back edge of the position indicating device -PID → opening the contacts.



PID should extend 2 mm around all sides of the film – to ensure that the film is completely covered by the beam and there are no undercuts.



Facial refrence points in relation to the direction of the xray beam	
Upper Central and Lateral incisors	direct the beam at the tip of nose
Upper Canine	direct the beam at the ala of nose
Upper Premolars	direct the beam at the junction of a line dropped from the pupils of the eye to the ala-tragus line
Upper Molars	direct the beam at the junction of a line dropped from the outer canthus of the eye to the ala-tragus line
Lower centrals and lateral incisors	direct the beam at a line dropped from the tip of nose the symphasis area
Lower canine	direct the beam at a line dropped from the ala of nose to the curvature point of mandible
Lower premolars	direct the beam at a line dropped from the pupils of the eye to the ala-tragus line down to the mental foramen area
Lower molars	direct the beam at a line dropped from the canthus of the eye to the ala-tragus line down to the body of mandible



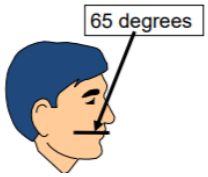
Q: what can you do if the pt has a narrow maxilla and the film cannot be placed properly to record the PA area? Place the film diagonally

Radiograph techniques : bitewings Radiographs

- Tab is placed in the center of the film + pt bite on the tab [teeth in question should be in the center of the film]
- Direct the **cone to be parallel to buccal surface**
- Direct the beam **+10 degrees vertically**
- **Ask the pt to smile and make sure the PID covers the film from all sides**

Radiograph techniques : occlusal Radiographs

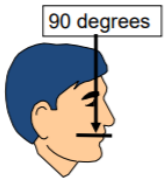
Size 4 for adults **size 2 for pedo**



Maxilla:

A. **Standard maxillary occlusal :** mostly used – shows **the premaxilla region** the vertical angulation is set at **65 degree**s. Because of this angle, **structures located toward the back of the mouth may not show .**

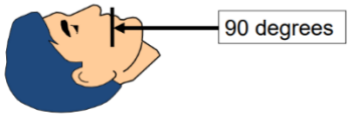
If a patient has difficulty opening the mouth due to trismus, an occlusal film can be used centered on the side of interest .



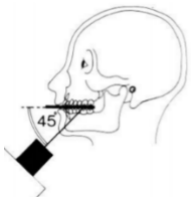
B. **Vertex maxillary occlusal:** vertical angulation is **90 degrees**, the x-ray beam passes through the canines **Structures located farther back in the maxilla will show**.

Mandible:

A. **Mandibular 90° occlusal :** head tipped back as much as possible, the x-ray beam is directed at a **90 degree angle** to the film.

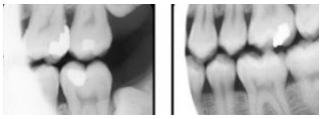


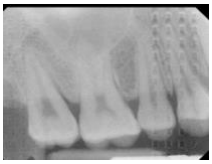
B. **Standard lower occlusal:** the x-ray beam is directed at a **45 degree angle** to the film.

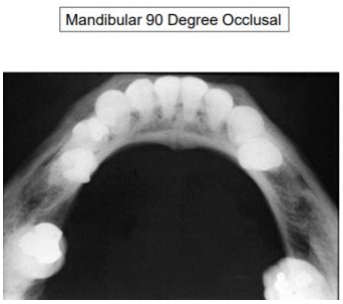


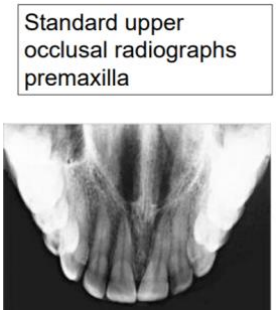
Angle bisecting technique errors:

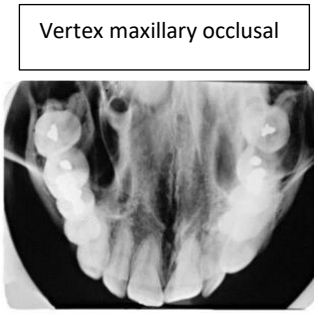
1- **Elongation** : caused by **decreased vertical angulation** (beam perpendicular on tooth)
2- **Foreshortening**: caused by **Increased vertical angulation** (beam perpendicular on film)
3- **Apex not showing / cone cuts** : caused by the PID not covering all of the film
4- **Film bending**: caused by pt stabilizing the film in an area other than the cervical portion of the crown
5- **Reversed film**: caused by the back side of the film facing the xray - the pattern stamped on the lead foil appears on the film + the film will have low density
6- **Overlapping :** cause by incorrect horizontal angulation
Remove eyeglasses before taking any radiograph (mandibular or bitewing radiographs). Glasses may be in the path of the x-ray beam.

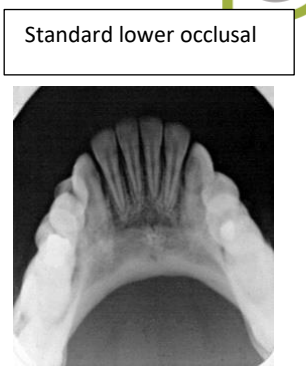












You Can watch our vidoes :

| How to Take Bitewing Radiograph :

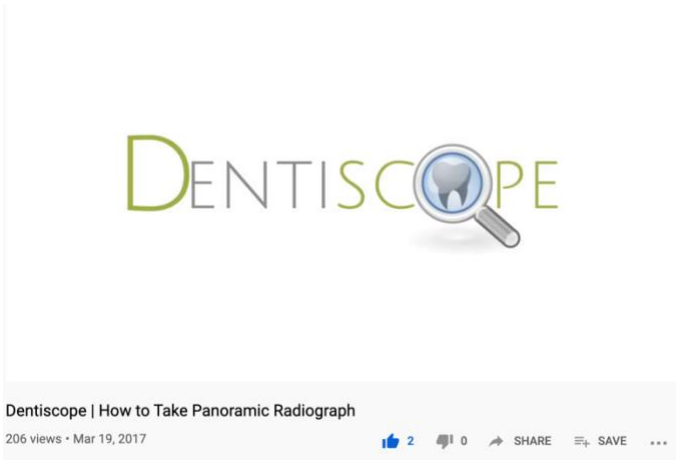
https://youtu.be/qXZWC0pzMRE

| How to Take Preiapical Radiograph :

https://youtu.be/gbZnX9e9QV4

| How to Take Panoramic Radiograph

https://youtu.be/9sHSoaaWDK8



Patient management in radiology

Children: are apprehensive and scared of radiographs - this is solved by familiarizing children with the procedure.

1- Describe the X-ray machine as a camera used to take pictures of teeth
2- allow the child to touch the xray film and xray machine
3- Carry on a conversation with children to distract them
4- Let the child to watch an older brother or sister being radiographed or let the parent or dental assistant serve as a model

- Children who experience a gagging : distract them by telling them to breathe through their nose, curl their toes or make a fist
- If the procedure is postponed for another appointment, the gag reflex may not be encountered or it becomes easier for the patient to control - Explain to the patient that it gagging will be less the next time - ***If you insist on completing the examination, the problem of gagging may become chronic and even progressive***

Mentally disabled patients: patients lack coordination or are in able to comprehend what is expected

- Take the radiograph quickly to avoid unpredictable movements by the patient
- In **severe involuntary movements sedation may be required -** If heavy sedation is used, the radiographic examination is performed with the **patient in the supine position**
- When an intraoral radiograph is taken with the patient supine, film-holding and beam-aiming devices are used to ensure proper film placement and tube angulation

Trauma: A traumatized patient may have a fracture of the facial skeleton may be bedridden because of involvement of several other areas of the skeleton

- extraoral radiographic examination with the patient in the supine position is necessary
- Satisfactory intraoral radiographs can be produced if you ensure proper positions of the tube, patient, and film
- Intraoral periapical radiographs are not large enough to delineate the size and extent of oral fractures – **Occlusal films and extraoral projections must be used**

Trauma / mentally disabled:

- Utilize assistant (s) to help hold the film and/or steady and reassure the patient better to use [accompanying relative] rather than staff
- Perform any necessary radiography under general anaesthesia, if an uncooperative patient is having their dental treatment in this manner - Radiographs taken are oblique laterals + periapicals + bitewings
- Avoid OPG because of the patient needs to remain still for approximately 18 seconds
- Extra oral view = Oblique lateral radiographs - Use the paralleling technique, i for periapical radiography because the relative positions of the film packet, teeth and X-ray beam are maintained, irrespective of the position of the patient's head

Pregnant patient : No incidences have been reported of damage to a fetus from dental radiography BUT Keep radiographs to minimum with full safety measure [lead apron with thyroid collar] – only take a radiograph if it is needed for diagnosis

Physically disabled pt: These patients usually are cooperative and eager to assist + Their tolerance level is usually high [they are not irritated by radiographs]

- Members of the patient's family often are very helpful in assisting the patient into and out of the examination chair and in film positioning and holding

Trismus: Using periapical film with hemostat

Gag reflex: Gag reflex might be due to the pt being apprehensive or because the pt has very sensitive tissues

relax and reassure the patient by the following :

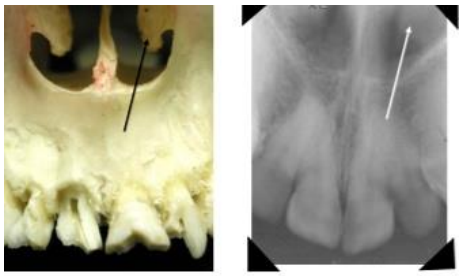
1- Describe and explain the procedures
2- show authority tempered with compassion
3- The gag reflex often is worse when a patient is tired – book the appointment in the morning, when the individual is well rested, especially in the case of children.
4- During film placement the tongue should be very relaxed and positioned well to the floor of the mouth - Ask the patient to swallow deeply just before opening the mouth for placement of the film Never mention the tongue + Never ask patients to relax the tongue; this usually makes them more conscious of it and precipitates involuntary movements
5- Carry the film into the mouth parallel to the occlusal plane - when the desired area is reached, rotate the film to contact the palate or the floor of the mouth - AVOID Sliding the film along the palate or tongue
6- Advise to breathe rapidly through the nose because mouth breathing usually aggravates this condition
7- Shift the patient's attention from the film and the mouth to relieve the gag reaction by asking patients to hold their breath or keep a foot or arm suspended during film placement and exposure
8- Administer topical anaesthetic agents in mouthwashes or spray to produce temporary numbness of the tongue and palate to reduce gagging
9- If all measures fail → extraoral film

Infection: result in edema and lead to trismus of some of the muscles of mastication -Intraoral radiography may be painful & difficult → take **Extraoral or occlusal** films instead

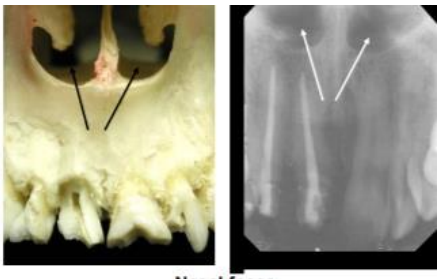
In the case of edema → **increased exposure time is required to compensate for the tissue swelling.

Intraoral radiographic anatomy

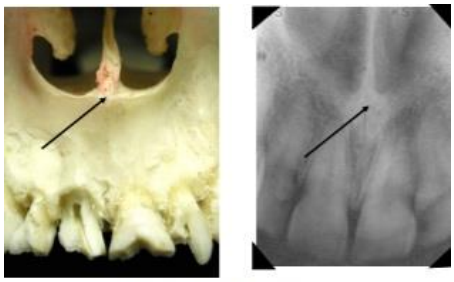
Nasal septum



Inferior concha

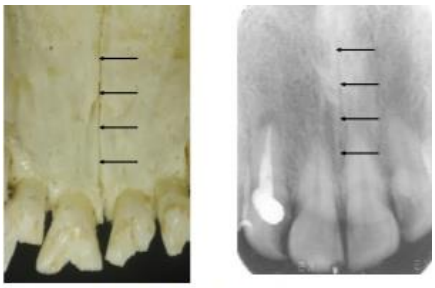


Nasal fossa



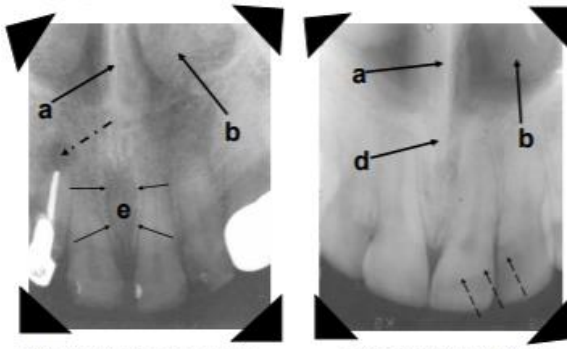
Anterior nasal spine

Incisive foramen



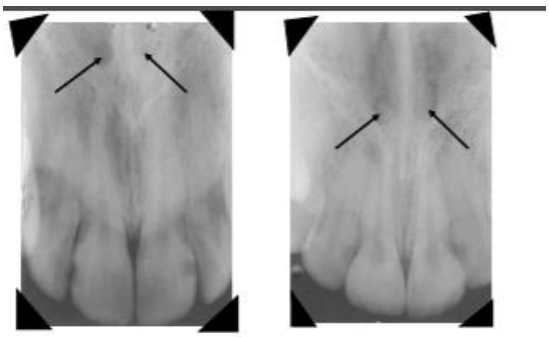
Median palatal suture

a: nasal septum; b: inferior concha; d: anterior nasal spine; e: incisive foramen



Dotted arrow points to periapical lesion

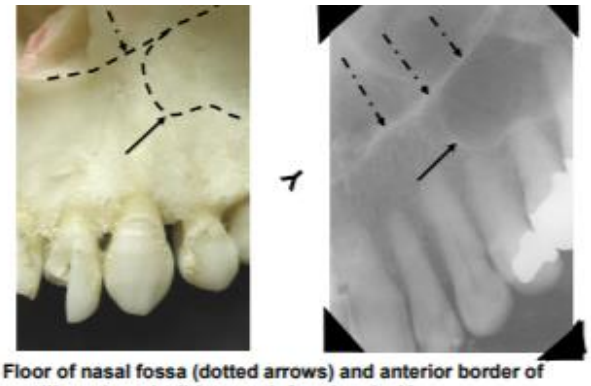
Dotted arrows = lip line



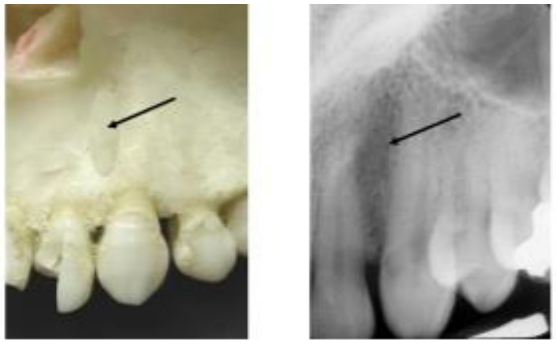
Superior foramina of the nasopalatine canals. These foramina lie in the floor of the nasal fossa. The nasopalatine canals travel downward to join in the incisive foramen.

Soft tissue of the nose

The dotted arrows point to the soft tissue of the nose. The solid arrows identify the lip line.



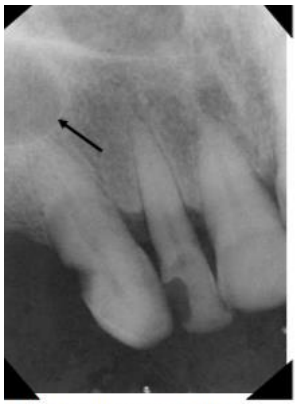
Floor of nasal fossa (dotted arrows) and anterior border of maxillary sinus (solid arrows), forming the Y.



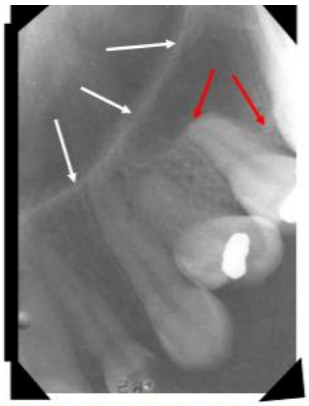
Lateral fossa. The radiolucency results from a depression above and posterior to the lateral incisor. To help rule out pathology, look for an intact lamina dura surrounding the adjacent teeth.

Dotted arrows point to soft tissue of the nose

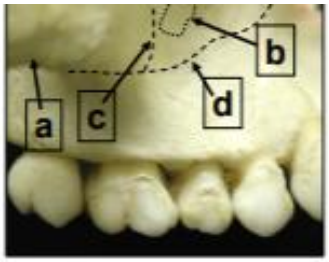
Solid arrows point to nasolabial fold. Note the inverted Y.

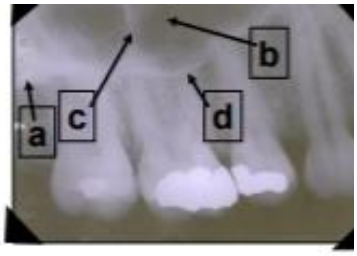


Solid arrow points to the maxillary sinus surrounds the root of the canine, which may be misinterpreted as pathology.



White arrows indicate the floor of the nasal fossa.
The maxillary sinus (black arrows) has pneumatized between the 2nd premolar and first molar

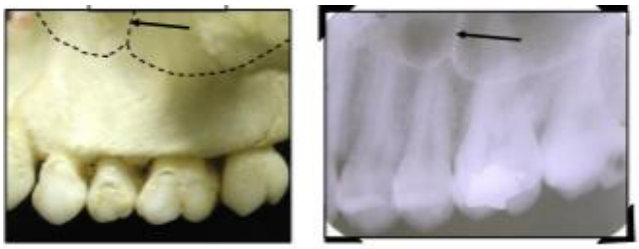




a = malar process
b = sinus recess
c = sinus septum
d = maxillary sinus

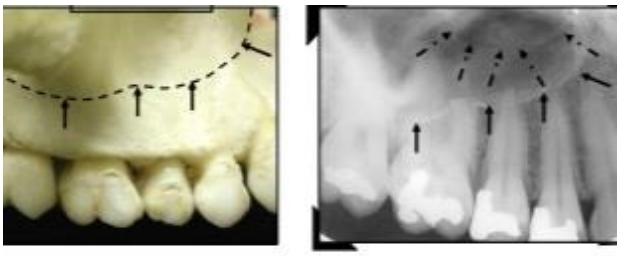
Malar (zygomatic) process. U or j-shaped radiopacity, often superimposed over the roots of the molars, especially when using the bisecting-angle technique.

Q: what is the J shaped radiopacity that shows near the roots of upper molars ? the zygomatic process

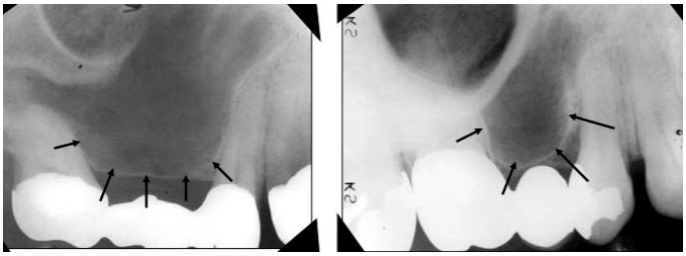


Sinus septum. This septum is composed of folds of cortical bone that arise from the floor and walls of the maxillary sinus, extending several millimeters into the sinus. The septum may completely divide the sinus into separate compartments.

Sinus recess. Increased area of radiolucency caused by localized expansion of sinus wall. If superimposed over roots, may mimic pathology.

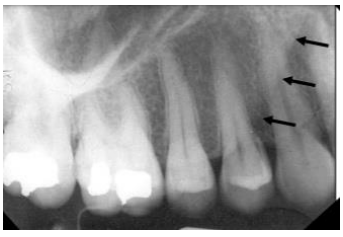


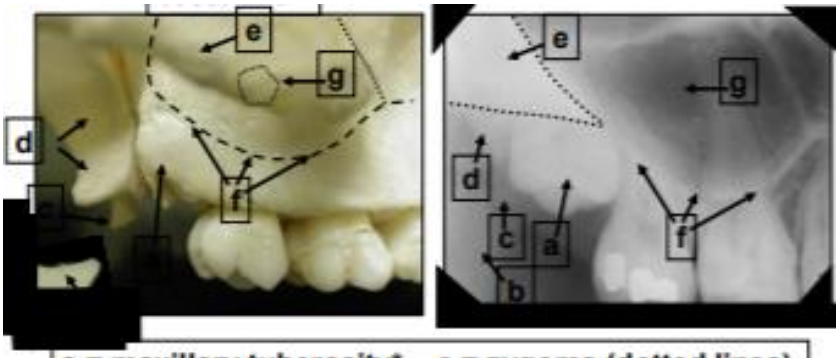
Maxillary Sinus. An air-filled cavity lined with mucous membrane. Communicates with nasal cavity through 3-6 mm opening below middle concha. Dotted arrows point to neurovascular canal containing superior alveolar vessels and nerves. Solid arrows point to the floor of the sinus



Pneumatization of the maxillary sinus – expansion of the sinus due to tooth loss

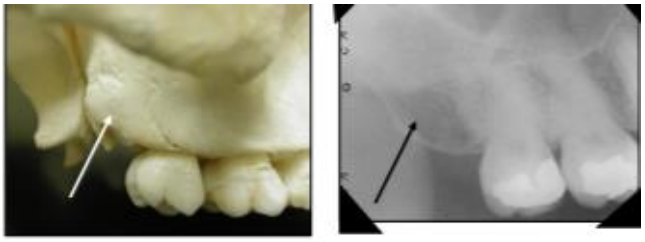
Solid arrow = nasolabial fold [because the tissue is thick it appears radio opaque]



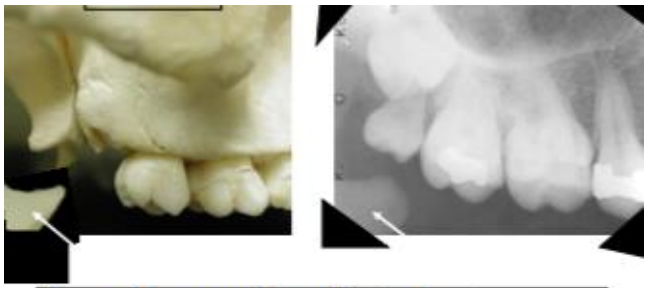


a = maxillary tuberosity* e = zygoma (dotted lines)
b = coronoid process f = maxillary sinus
c = hamular process g = sinus recess
d = pterygoid plates

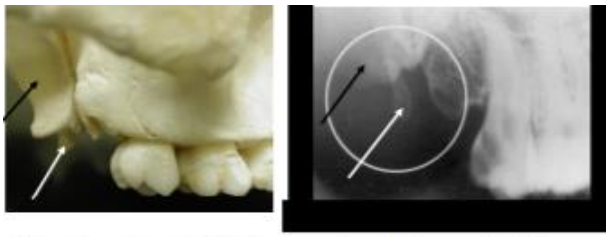
* image of impacted third molar superimposed



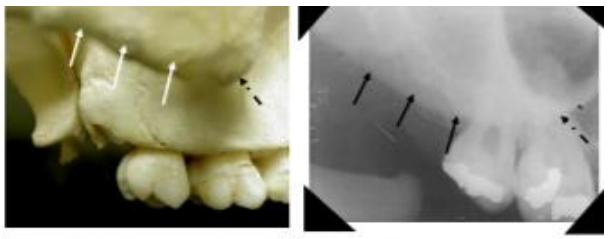
Maxillary Tuberosity located at the posterior aspect of sides of the maxilla.



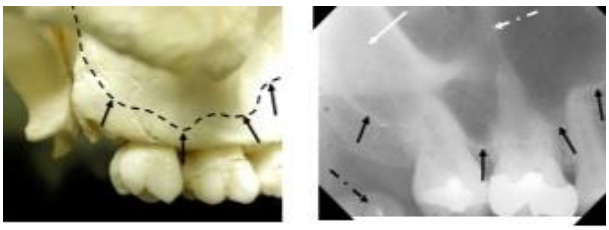
Coronoid process. A mandibular structure sometimes seen on the maxillary molar periapical film when using the bisecting angle technique with finger retention (The mouth is opened wide, moving the coronoid down and forward).



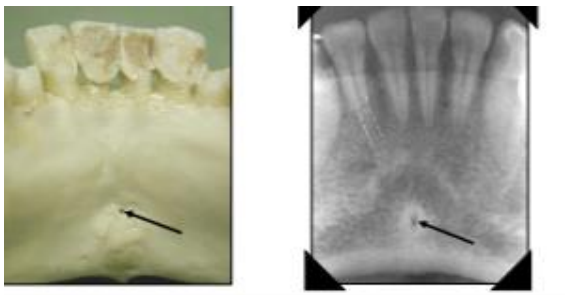
Hamular process (white arrows) and pterygoid plates (black arrows). The hamular process is an extension of the medial pterygoid plate of the sphenoid bone, positioned posterior to the maxillary tuberosity.



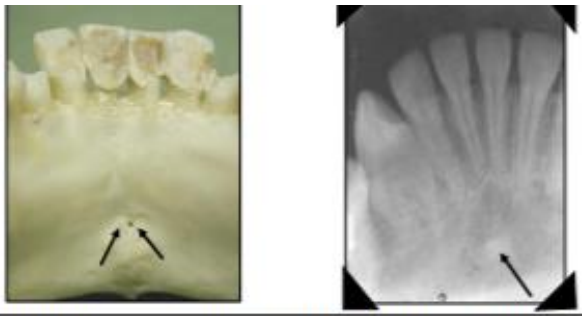
Zygomatic bone (white/black arrows)
Zygomatic process (dotted arrow), which has a U or J shape.



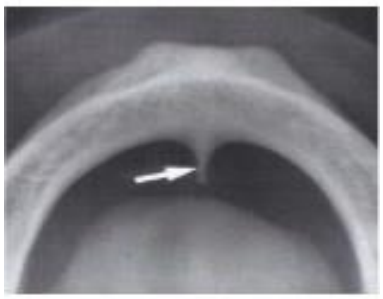
The floor of the maxillary sinus (solid arrows) flows around the roots of the maxillary molars and premolars
Coronoid process (dotted black arrow)
Zygomatic bone (white arrow)
Sinus septum (dotted white arrow)



Lingual foramen. Radiolucency in center of genial tubercles.



Genial tubercles. Radiopaque area in the midline, midway between the inferior border of the mandible and the apices of the incisors.

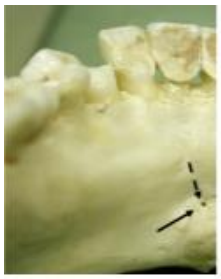


Genial tubercles

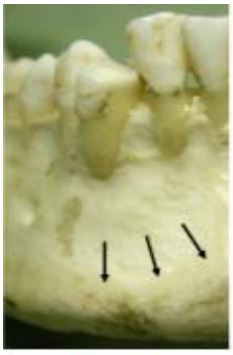

Mental ridge. Mental protuberance on either side of the midline.


Mental fossa. Adepression on the labial aspect of the mandible overlying the roots of the incisors. The resulting radiolucency may be mistaken for pathology.

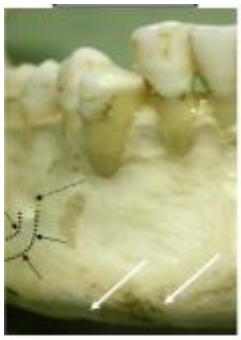
Solid arrows point to nutrient canals. Mostly seen in older persons with thin bone, and in those with high blood pressure




Lingual foramen (dotted arrows)
Genial tubercles (solid arrows)

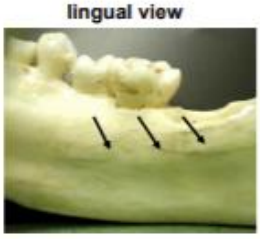
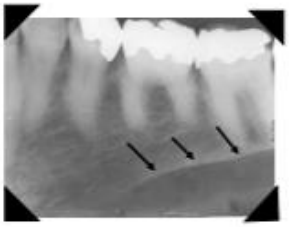



Mental ridge sloping downward and backward from the midline.

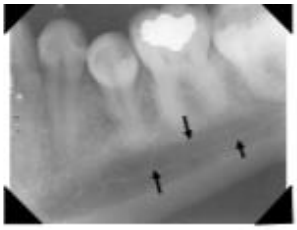



Solid arrows point to the mandibular canal
Dotted arrow points to the mental foramen
White arrows show the cortical bone at the lower border of the mandible.

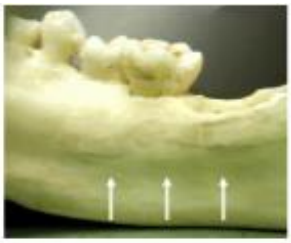
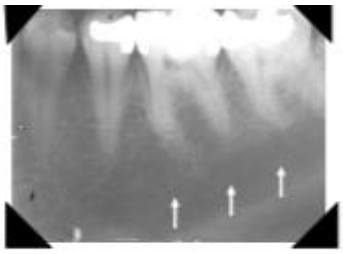
lingual view

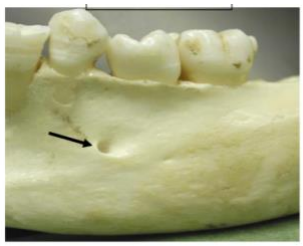
Mylohyoid (internal oblique) ridge.
The ridge runs downward and forward from the third molar region to the area of the premolars.

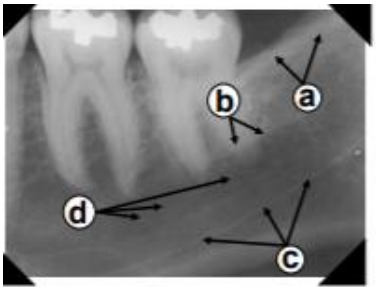
Mandibular canal. (Inferior alveolar canal). Runs downward from the mandibular foramen to the mental foramen, passing close to the roots of the molars. More easily seen in the molar periapical.

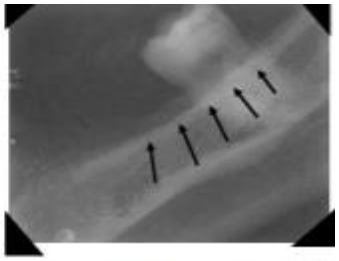
Submandibular gland fossa. The depression below the mylohyoid ridge where the submandibular gland is located. More obvious in the molar periapical film.



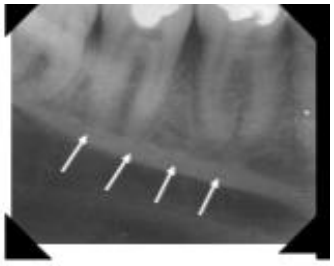

Mental foramen. Usually located midway between the upper and lower borders of the body of the mandible, in the area of the premolars. May mimic pathology if superimposed over the apex of one of the premolars.



a = external oblique ridge
b = mylohyoid ridge
c = mandibular canal
d = submandibular gland fossa

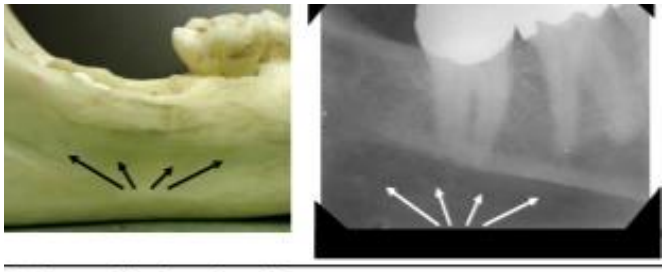



External oblique ridge. A continuation of the anterior border of the ramus, passing downward and forward on the buccal side of the mandible. It appears as a radiopaque line which usually ends anteriorly in the area of the first molar.

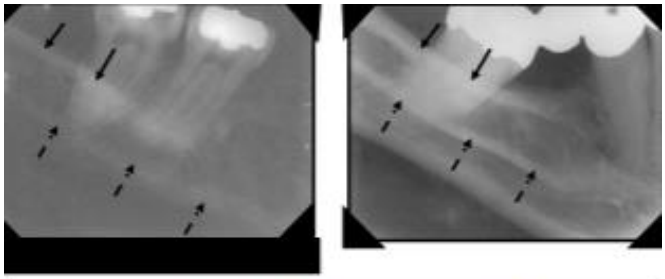



Mylohyoid ridge (internal oblique). Located on the lingual surface of the mandible, extending from the third molar area to the premolar region. e.


Mandibular (inferior alveolar) canal.



Submandibular gland fossa.



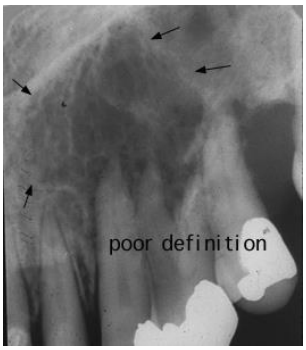
The external oblique ridge (solid arrows)
The mylohyoid ridge (dotted arrows) usually run parallel with each other, with the external oblique ridge always being higher.

Lecture Source: http://dent.osu.edu/radiology/reso urces.htm

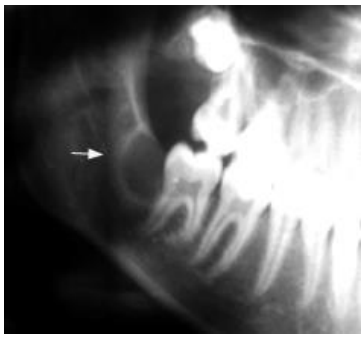
Interpretation of radiographs

Intraoral radiographs: radiograph is examined from right to left , examining each pathology separately.

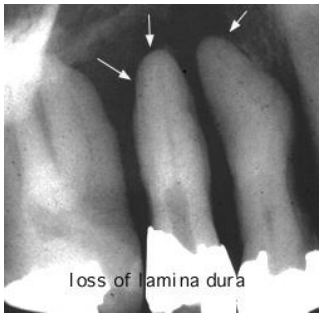
Extraoral radiographs: radiograph is examined in a clockwise direction

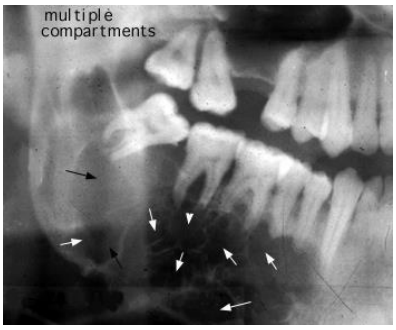


Poorly defined border

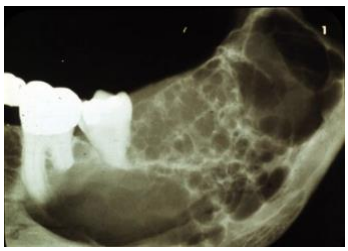


Well defined border





Multilocular radiolucency



Multilocular radiolucency – honey comb appearance

Radiographic surveys and localization techniques

Surveying :

- general scanning of all teeth + their supporting structures to detect hidden pathologies / abnormalities
- done **every 5 years** - individual radiographs are done on need

Adults	Children
12 PA radiographs [size 2] 4 bitewings [size 2] 1 upper occlusal 1 lower occlusal **If the patient has severe gagging or trismus you can take those alternatives :** 4 bitewings [size 2] OPG Lateral oblique [left] Lateral oblique [right]	6 PA radiographs [size 2 or size 1] 2 or less bitewings [size 2 or size 1] 1 upper occlusal [can be taken by size 2 PA film] 1 lower occlusal [can be taken by size 2 PA film] **If the patient has severe gagging or trismus you can take those alternatives :** 2 or less bitewings [size 2 or size 1] OPG Lateral oblique [left] Lateral oblique [right] ** in children **exposure time is reduced** because of smaller teeth and lesser bony calcification compared to adults. **[Child Exposure = ¼ Adult Exposure]**

Radiographs are a 2 dimensional image of a 3 dimensional object [in order to visualize the missing 3rd dimension (depth) – localization techniques are used]

Localization techniques:

SLOB [same lingual opposite buccal]: take 2 PA films with the same vertical angulation but change the horizontal angulation either mesial or distal. [if the object in question moves in the same direction as the horizontal tube shift → it is located on the lingual side , if the object moves opposite to the tube shift → it is located on the buccal side]

Known object rule: choose a known object [genial tubercles, buccal cusps, mental foramen etc] and take 2 radiographs with diff horizontal or vertical angulation then compare the movement of the unknown object to the known object

- if the unknown object and known object move in the same direction→ they are located on the same side [if the known object was buccally located then the unknown object is also buccaly located]
- if the unknown object and known object move in opposite directions → they are located on opposite sides [if the known object was buccally located then the unknown object is lingually located]
- if the unknown object does not move → it is in the center of the jaw

Parallax: SLOB

- The image of the object FAR from the x-ray tube moves in the SAME direction of the tube movement
- The image of the object CLOSE to the x-ray tube moves in the OPPOSITE direction of the tube movement
- If object does not move, then it is on the same of the reference point

If you move the tube head without changing the direction of the beam → the object in question will not change location + the xray will have a cone cut

Objects closer to film appear sharper!

Right angle technique: Take 2 radiographs at right angle to each other to get a 3D image , examples:

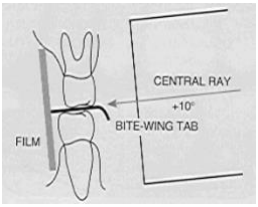
- Perapical + occlusal
- OPG + occlusal
- PA skull + OPG
- PA skull + occlusal

Radiographic interpretation of caries

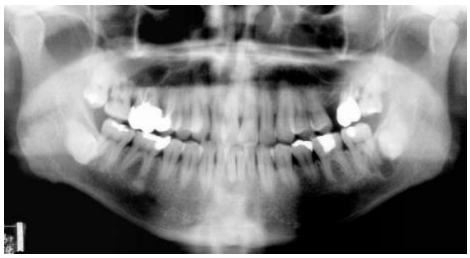
views:

A. **Periapical radiographs:**
The parallel technique [using film holders] is better than angle bisecting technique because the xray passes perpendicular to the tooth [minimizes the amount of tooth structure the xray needs to pass through]
In angle bisecting technique small lesions can be superimposed by the dense radio opacity of sound tooth structure

B. **Bitewings:**
the view of choice to **detect proximal caries** [the parallel technique is applied here even when film holders are not used] – **the beam is direct at +10° to the horizontal**



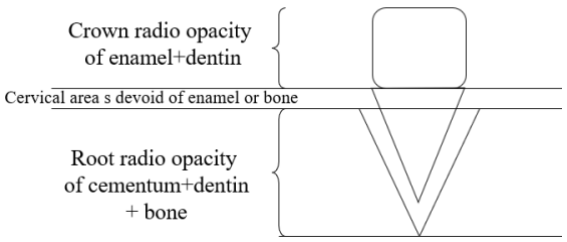
C. **Panoramic radiograph [OPG] :** for egenral assesment of teeth + supporting structures
Not indicated for detection of incipient carious lesions due to : **Decreased image resolution** + inherent **overlapping of upper premolars**



Radiographically, other conditions that may resemble caries :

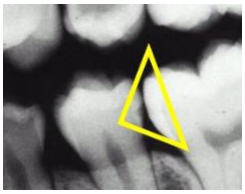
1- Abfraction/ Abrasion / erosion
2- Enamel hypoplasia
3- Older radiolucent cements
4- Cervical burnout seen at the **cervical of anterior teeth**, the **distal of canines,** and **upper 1st and 2nd molars**
5- **Mach band effect** seen in the dentin immediately beneath enamel and disappears when the enamel is covered with an opaque material

Cervical burn out : this area is devoided of bone and enamel
→ appears radiolucent



Radiographical apperance of caries:

Enamel caries: follow the direction of enamel prisms

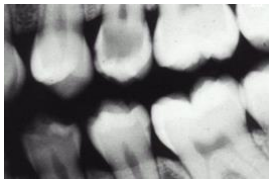


A. **Proximal surfaces:** Triangular radiolucency located below the contact point [Apex facing towards pulp & Base facing towards the outer surface of the tooth]
B. **Occlusal surface :** Triangular radiolucency located in the fissure [Apex of towards the outer surface & Base facing towards the pulp]
Due to superimposition of sound hard tissue, initial carious lesions can not be detected radiographically - Best method to detect **early lesions is by clinical examination

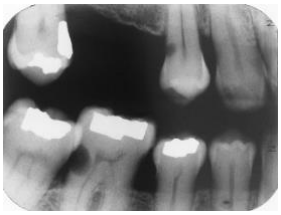
Dentine caries : follow the direction of dentinal tubules

Proximal & occlusal surface: Triangular **(U-shaped) radiolucency** located **medial to Dentino-Enamel junction** [Apex towards pulp & Base facing towards the outer surface]

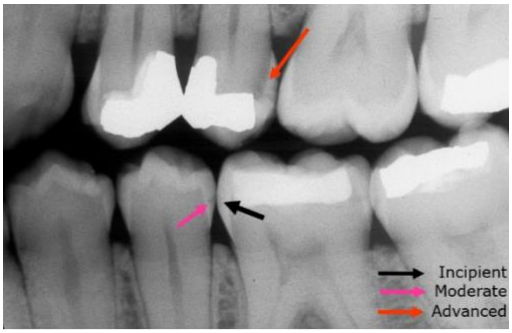
Smooth surface caries : best detected by clinical exmaination - in radiograph **they appear magnified** giving a radiolucent lesion that covers the crown



Cemental / root caries : C- shaped radiolucency on exposed cementum [associated with perio disease]

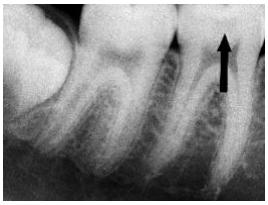


Proximal caries	
Moderate	More than half way through the enamel [up to the DEJ]
Advanced	From DEJ to halfway through the dentine
Severe	More than half way through dentine



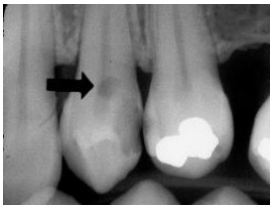
Occlusal caries:

- Must have penetrated into dentin to be detected on radiograph- Difficult to see on radiographs unless lesion is large
- Diagnosed from clinical exam
- May be seen as thin radiolucent line or cup-shaped zone underlying occlusal enamel



Buccal / lingual caries: [you can't say if it's buccal or lingual from radiograph]

- Should be identified from clinical exam
- May be seen as well-defined circular area in middle of tooth, although it is not very radiolucent.
- Depth can not be determined radiographically.



Radiography in periodontics

- Radiographs **do not demonstrate the soft tissue to hard tissue relationships**
- Radiographs typically show **less severe bone destruction than is actually present**
- The earliest (incipient) mild destructive lesions in bone do not cause a sufficient change in density to be detectable on radiographs
- Only the interproximal bone defect is clearly seen - Bony defects in the buccal and lingual sides may be hidden
- Films that are slightly light are more useful for examining cortical margins of bone
- A longer gray scale contrast provides better visualization of the extent of bony detail and tooth roots

The radiograph of choice to show incipient bone crest lesions or the level of the alveolar crest = bitewing

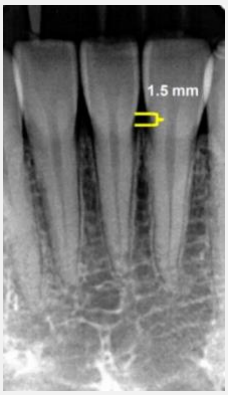
Normal periodontium in a radiograph:

Anterior region

Alveolar crests: Thin + Smooth + Pointed

1. Variations in the X-ray beam angulation can cause changes in the height of the alveolar bone
2. 1.5 mm = The distance between two parallel lines connecting the CEJ of two adjacent teeth and the crest of the alveolar bone
3. Even thickness of the PDL from the alveolar crest to the apex
4. A well-mineralized cortical outline of the alveolar crest indicates the absence of periodontitis activity or c=success of perio Tx

Lack of a well-mineralized alveolar crest may be found in patients with or without periodontitis

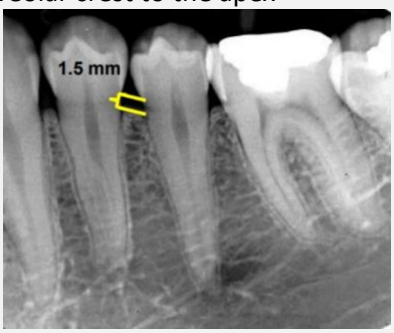


Posterior region

Alveolar crests : Relatively thick + Smooth + Flat to rounded

1- 1.5 mm = The distance between two parallel lines connecting the CEJ of two adjacent teeth and the crest of the alveolar bone [the distance between the 2 parallel lines may not be parallel to the occlusal plane]

2- Even thickness of the PDL from the alveolar crest to the apex



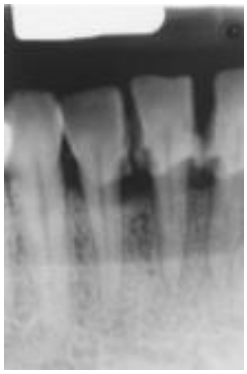
Radiographic signs of diseased periodontium:

- blunting of the alveolar crests and slight loss of alveolar bone height
- Initial periodontal disease is seen as a **loss of cortical density and a rounding of the junction between the alveolar crest and the lamina dura**
- **In gingivitis → no radiographical changes , because gingivitis is only soft tissue change**

- Loss of attachment may be present for 6 to 8 months before radiographic evidence of bone loss appears

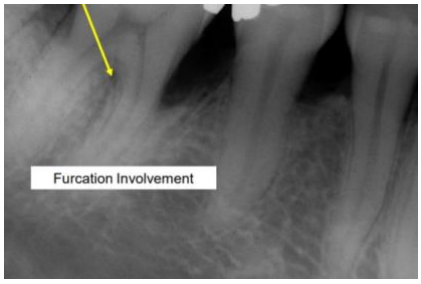
Horizontal bone loss	
Mild	more than 1 mm of the normal distance
Moderate	more than 2 mm of the normal distance or involvement of furcation areas
Severe	bone level **apical to midpoint of the length of the roots** with involvement of furcation areas

Vertical VS. horizontal bone loss



Calculus around the cervical region + horizontal bone loss

Widening of the periodontal ligament space at the apex of the interradicular bony crest indicates furcation involvement.



Radiography of the apical tissues

If lamina dura shadow is not be visible, this does not mean that the bony socket margin is not present clinically

Radiolucent shadow effect	Radio opaque shadow effect
• **The maxillary sinus** • **The nasopalatine foramen** • **The mental foramina** Such cavities in the alveolar bone **decrease the total amount of bon**e that contributes to the final radiographic image → **The radiolucent line of the periodontal ligament may appear MORE radiolucent or widened, but will still be continuous and well demarcated** **The radiopaque line of the lamina dura may appear LESS obvious and may not be visible.**	• The mylohyoid ridge • The body of the zygoma • Areas of sclerotic bone (also called dense bone islands) Such radiopacities → **obscure or obliterate the detailed shadows of the apical tissues**

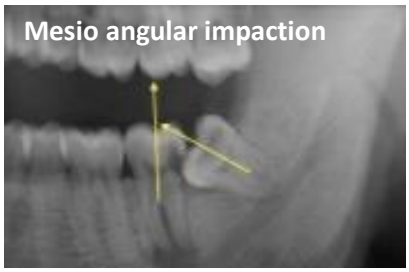
- PDL = radiolucent line surrounding the tooth
- Lamina dura = radio opaque line surrounding the PDL
- In the mandible: the trabeculae tend to be **relatively thick** and **close together**, and are often **aligned horizontally**
- In the maxilla : the **trabeculae tend to be finer**, and more **widely spaced**. There is **no predominant alignment pattern.**
- The radiopaque line of the lamina dura appears intact around the radicular papilla in mixed dentition

CONDITION	RADIOGRAPHICAL APPEARANCE
ACUTE APICAL PERIODONTITIS	Widening of the PDL space OR No changes
PERIAPICAL ABSCESS	Loss of the radiopaque line of the lamina dura at the apex
SCLEROSING OSTEITIS	dense sclerotic bone evident around the tooth apex
PERIAPICAL GRANULOMA OR RADICULAR CYST	Circumscribed, well-defined radiolucent area of bone loss at the apex, surrounded by dense sclerotic bone

Warning signs if you see a radiolucency associated with:

1- A vital tooth with minimal caries
2- Irregular root resorption
3- Irregular radiolucent apical area with a ragged, poorly defined outline
4- Tooth mobility in the absence of generalized periodontal disease
5- Regional nerve anaesthesia
6- Failure to respond to good endodontic therapy

Radiographic interpretation of 3rd molars



NOTE:

- The exposure required for an edentulous ridge is approximately 25% less than that for a dentulous ridge
- In edentulous pt you can stabilize the BW using cotton rolls

survey for edentulous pt if you don't have an OPG as follows:

- **Central incisors 1 projection (midline)**
- **Lateral-canine 2 projections**
- **Premolar 2 projections**
- **Molar 2 projections**

Relationship of the 3rd molars to the IDC [inferior dental canal]:

The ID canal radiographically appears as two thin, parallel radio opaque lines [tramlines] surrounding the radiolucency of the canal .

Variations that indicate a possible intimate relationship:

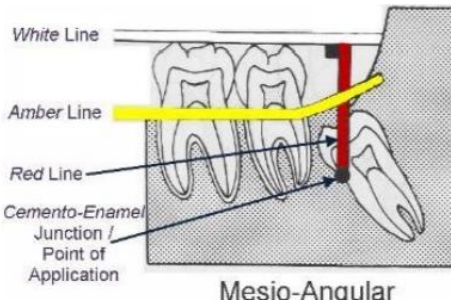
1. Loss of the tramlines
2. Narrowing of the tramlines
3. A sudden change in direction of the tramlines
4. A radiolucent band evident across the root if the tooth is grooved by or contains the ID bundle

The depth of the Tooth in the Alveolar Bone assessed by:

- Winter's lines
- Using the roots of the second molar as a guide

Winter's lines: Three imaginary lines -

1- The first [white line] is drawn along the **occlusal surfaces of the erupted first and second molars**
2- The second [amber line] is drawn along the **crest of the interdental bone between the first and second molars, extending distally along the internal oblique ridge** [indicates the margin of the alveolar bone surrounding the tooth]
3- The third **[red line]** is a **perpendicular line dropped from the white line to the point of application for an elevator**, **but is measured from the amber line to this point of application**. [measures the **depth of the third molar within the mandible**]



- if the red line is 5 mm or more in length, the extraction is considered difficult

Using the Roots of the Second Molar as a Guide:

> The roots of the adjacent second molar are divided horizontally into thirds
> A horizontal line is then drawn from the point of application for an elevator to the second molar
> If the point of application lies opposite the coronal, middle or apical third, the extraction is assessed as being easy, moderate or difficult, respectively

- Buccal obliquity — the crown of the wisdom tooth is inclined towards the cheek
- Lingual obliquity — the crown of the wisdom tooth is inclined towards the tongue

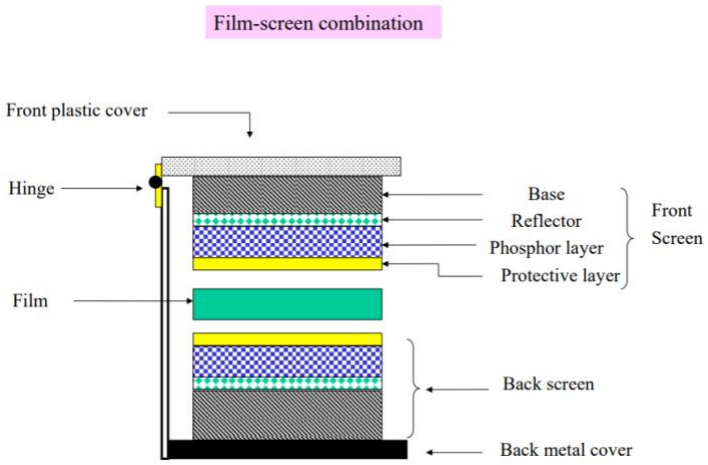
Assessed by: Lower oblique occlusal OR Lower 90° occlusal, centred on the side of interest

Extraoral radiographs

Extraoral films: Used with **screen- film cassettes** which require **lesser amounts of exposure to x- rays**

Extra oral radio graphs are mainly done due to size limitations of intra oral films

- Sensitive to light more than X-ray that's why they are placed in light – tight cassests
- Exposed by light emitted from **intensifying screens when struck by X-ray**
- Faster than intra-oral films (considering object thickness and density)

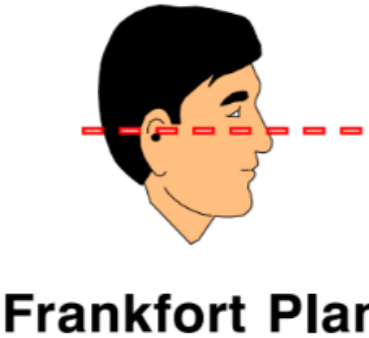


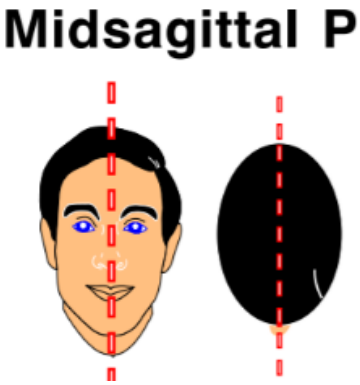
Indications of extra oral radiographs:

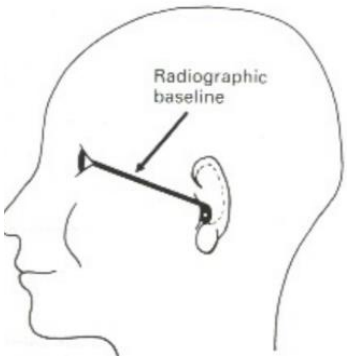
1- Fractures of the maxillofacial skeleton
2- Fractures of the skull
3- Investigations of Para nasal sinuses
4- Diseases affecting the skull base & vault
5- TMJ disorders

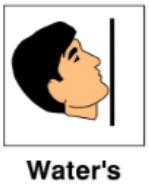
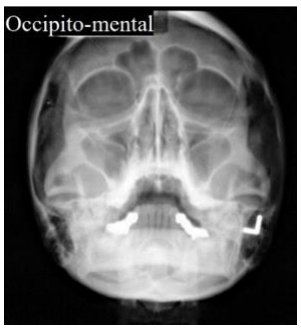
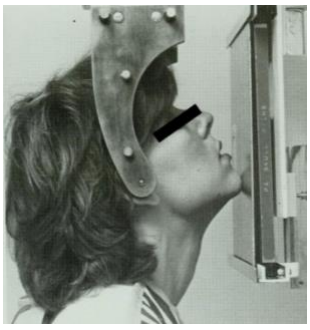
Positioning the pt for all extra oral radiographic view depends on : Radiographic base line.

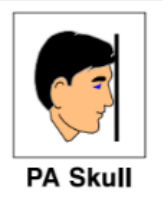
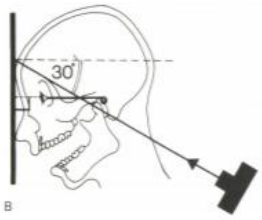
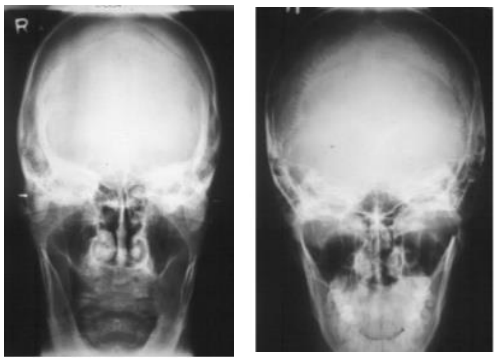
Radiographic Base Line (cantho-meatal line) : Represents base of the skull - Extends from the outer canthus of the eye to the external auditory meatus

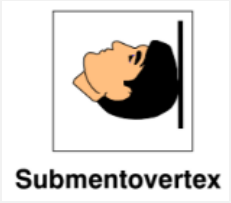
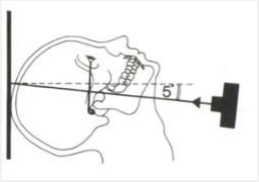
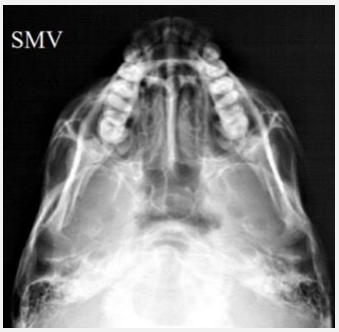
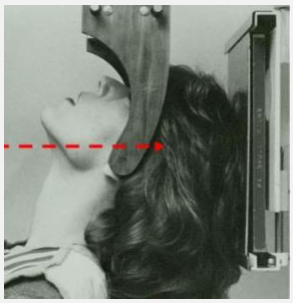
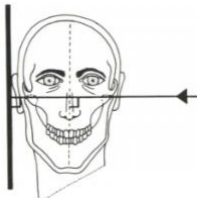
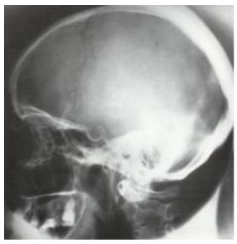






EXTRA ORAL RADIO GRAPH	INDICATIONS	HOW IT IS DONE
LATERAL OBLIQUE	Shows **angle, ramus and body of one side of the mandible.** 1- Presence and location of Unerupted teeth 2- Cysts/ tumors affecting the jaw 3- Detect mandibular fractures 4- **Alternative to intra oral radiographs in cases of severe gagging, limitation of mouth opening, unconscious patient** 5- Specific in sialography or TMJ investigation    	Cassette is placed **parallel to mid-sagital plane** supported between check bone and the palm of the patient Pt tilts the head **15° toward the cassette** The patient is then asked to **rotate the head 15° away from the X-ray beam** The X-ray enters **1 inch behind and below the angle of the mandible of the opposite side**
WATER'S VIEW [STANDARD OCCIPITO-MENTAL] 	Shows **facial skeleton** , **parananasal sinuses**, It **<u>avoids superimposition of the dense bone of the base of the skull</u>** 1- Investigations of the paranasal sinuses 2- Detecting middle 1/3 fractures ,Zygomatic complex , Naso-ethmoidal complex fractures 3- **Orbital blow out fractures** 4- **<u>Coronoid process fractures</u>**  	The patient is positioned **facing the film** with the **head tipped back** so **the radiographic base line is at 45° to the film** (nose-chin position) The x-ray beam passes in the center of the occipital bone at 0°. 

EXTRA ORAL RADIO GRAPH	INDICATIONS	HOW IT IS DONE
POSTERO-ANTERIOR OF THE SKULL (PA SKULL)  PA Skull	Shows the **skull vault**, mainly **frontal and jaw bones** 1- Fractures of the skull vault 2- Conditions affecting the cranium 3- **Progressive changes in medio-lateral dimension of the skull** 4- Intracranial calcifications 5- Frontal and ethmoidal sinuses , Nasal fossa and orbits 	The patient is **positioned facing the film** with the **head tipped forward** so that the **forehead and tip of the nose touch the film**, the so called **forehead-nose position** The radiographic base line is horizontal and **at right angle to the film**, this position **<u>allows the vault of the skull to be seen without superimposition.</u>** The **x-ray beam passes** through the **center of the occiput at 0**°. 
REVERSE TOWNE'S  Reverse Townes 	Shows **condylar heads and necks** and **the occipital region** **1- <u>High fractures of the condylar necks</u>** **2-** Fractures of the TMJ **3-** Investigation of the TMJ **4-** Condylar head deformities (hypoplasia or hyperplasia) 	The patient is in the PA position (head tipped forwards in the forehead-nose position, radiographic base line is horizontal, but in addition the **mouth is opened.** **<u>Opening the mouth takes the condylar heads out of the glenoid fossae so they can be demonstrated radio graphically</u>** The **x-ray beam** passes through the **center of the condyles from below the occiput at 30°** to the horizontal 

EXTRA ORAL RADIO GRAPH	INDICATIONS	HOW IT IS DONE
SUBMENTOVERTEX   	Shows the **base of the skull, sphenoidal sinus and facial skeleton <u>from below</u>** 1- Lesions affecting palate, pterygoid or base of skull 2- Investigation of the **sphenoidal sinus** 3- Fractures of **the zygomatic arch <u>(taken with low exposure)</u>** **4- Assessment of the thickness of the posterior part of the mandible before osteotomy ****  	The patient is positioned **facing away from the film**. The **head is tipped backwards as far as is possible**, so the **vertex of the skull touches the film**. **radiographic base line is vertical and parallel to the film**. The x-**ray beam is centered through an imaginary line joining the lower first molars at 5° to the horizontal from below the chin**. **CAUTION: This position is contraindicated for patients with suspected <u>neck injuries</u>** 
TRUE LATERAL SKULL  	Shows the **skull vault and facial skeleton from lateral aspect** 1- Fractures of the cranium and the cranial base 2- Middle 3rd fractures 3- Investigations of the **frontal, sphenoidal and maxillary sinuses** 	The patient is positioned with the **head turned through 90° so the side of the face touches the film**. In this position the **sagittal plane of the head is parallel to the film**. The **x-ray beam passes horizontally (0°) through the center of the external auditory meatus** where it will be perpendicular to the sagittal plane and the film

EXTRA ORAL RADIO GRAPH	INDICATIONS	HOW IT IS DONE
CEPHALOMETRIC LATERAL SKULL	Shows the **skull vault and facial skeleton from lateral aspect, this view is reproducible and standardized by the use of the cephalostat** Orthodontics (main indication) **Determine facial and skeletal abnormalities and monitor tx progress**	

OPG – Orthopantomograph

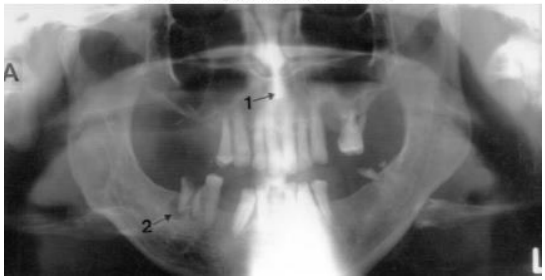
Indications:

1- Note the **presence & position of developing permanent teeth +** Wisdom teeth (presence & position)
2- Note **presence, site & size of lesions cysts, tumors & developmental anomalies**
3- **Jaw fractures**
4- Periodontal evaluation (alveolar bone level)
5- Pre- operative assessment in **complete & partial denture construction**
6- Pre & post-operative assessment in **implant construction**

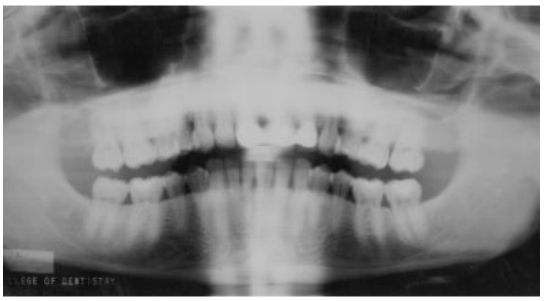
Advantages	Disadvantages
1- All teeth and supporting structures **are shown even mouth is closed**	**1- Structures out of focal trough are not seen**
2- Simple **technique**	**2- Soft tissue & air shadows & ghost images may overlie hard tissue images**
3- Rapid assessment **of underlying disease**	3- **Overlapping of premolars**
4- Allows direct comparison of both sides **of examined tissues (sinuses, TMJs, etc.)**	4- **Less image quality** compared to intra oral films
5- Low radiation dose	5- **Motion unsharpness in children & elderly** due to long exposure cycle
	6- Distortion & magnification of the image.(approx.x 1.3)

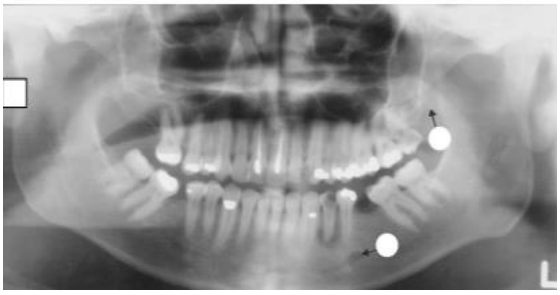
- **Tomography = the x-ray tube head & the cassette-film combination rotate at the same speed**
- **<u>For OPG - No lead aprons with a thyroid collar [it will cause a ghost image]</u>**
- **The focal trough line should pass between tooth no. 22 and 23**
- **Instruct patient to bite on the groove in the bite block and put their tongue against the palate**

Patient's head tilted down
Exaggerated smile
Decreased inter-condylar distance
Superimposition of the cervical spine
Using a lead apron with a thyroid collar
Ghost image of the thyroid collar

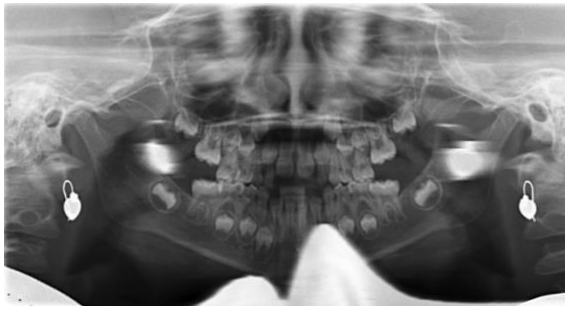


Patient's head tilted back
Reversed smile
Increased inter-condylar distance
Superimposition of the cervical spine





Pt rotated their head to the right side

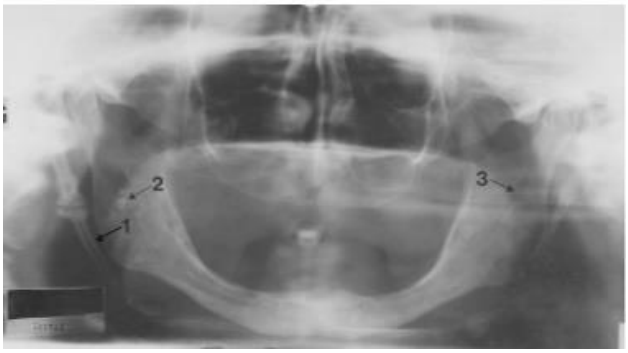


Ghost images because the patient did not remove the earrings

Patient's head tilted down
Exaggerated smile
Decreased inter-condylar distance
Slumping of the patient
Superimposition of the cervical spine

Patient's head tilted back
Reversed smile
Patient biting before the incisal groove
Codyles image cut off on both sides

Patient's head tilted to left side
Uneven level of the condyles
Slumping position of the patient
Superimposition of the cervical spine



Failure to remove lower denture before exposure

Failure to remove ear rings before exposure

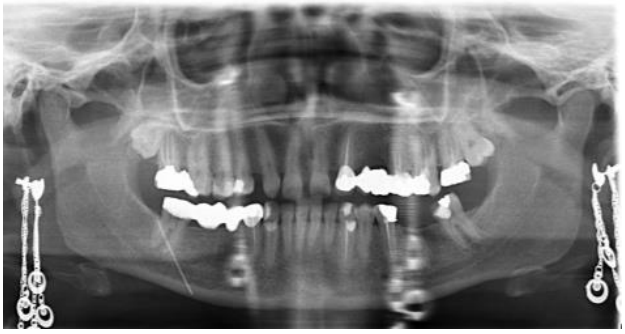
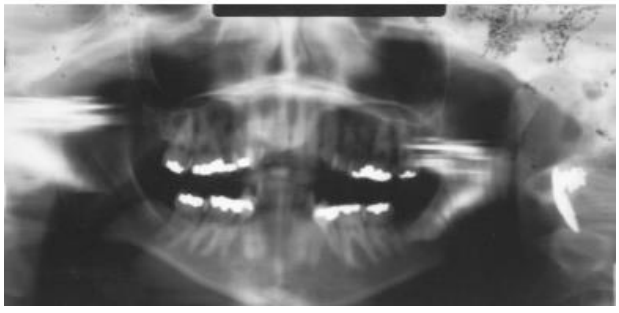


Image of a necklace

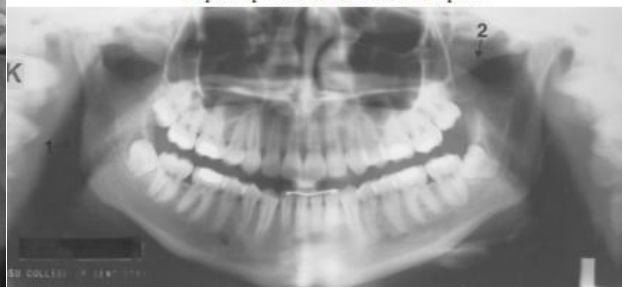
Failure to remove metal objects from the oral cavity before exposure

Failure to remove ear rings before exposure resulting in ghost images
Slumping position of the patient
Superimposition of the cervical spine



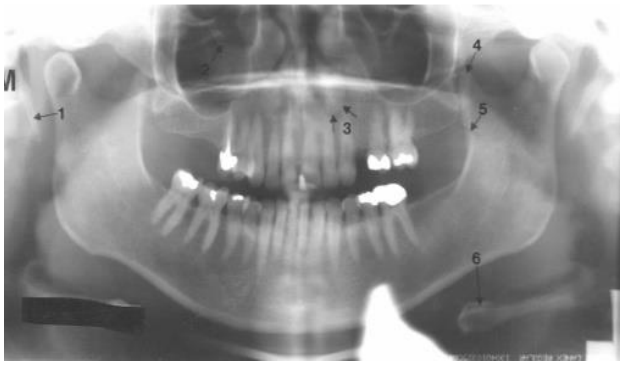
Failure to remove eye glasses before exposure

Patient's head tilted to left side
Uneven level of the condyles
Patient's head tilted down
Exaggerated smile
Reduced inter-condylar distance
Slumping position of the patient
Superimposition of the cervical spine



Exaggerated smile
Reduced inter-condylar distance
Slumping position of the patient
Superimposition of the cervical spine
Superimposition of the patient's phalanges over the image

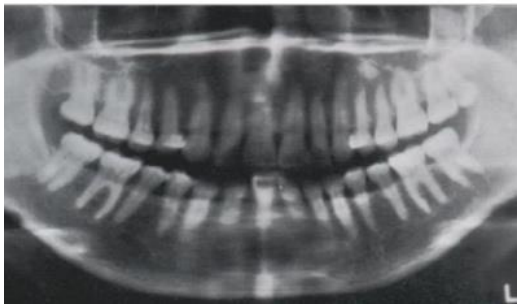
Using a lead apron with a thyroid collar results in ghost image of the collar



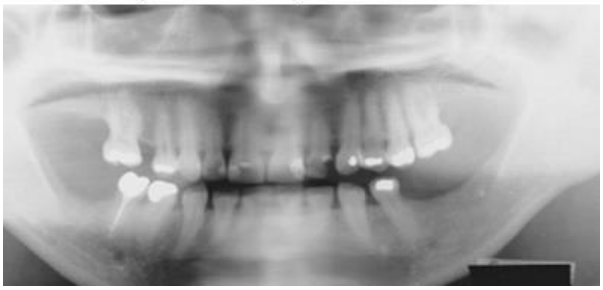
Patient's head tilted to left side
Uneven level of the condyles

Patient's head tilted down
Exaggerated smile
Slumping position of the patient
Superimposition of the cervical spine

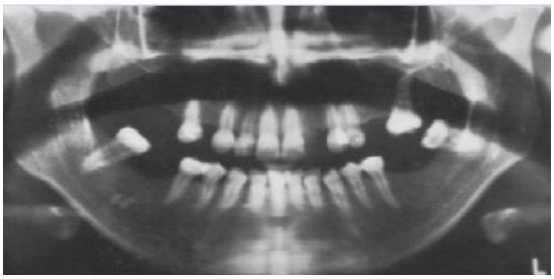
Patient's biting before the incisal notch
Wide separated anterior teeth
Left condyle cut off
Right condylar head cut off



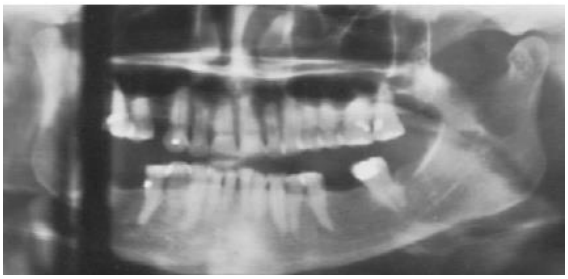
Patient's biting before the incisal notch
Wide separated anterior teeth
Chin cut off
Right and left condylar head cut off



Tongue not touching palate
Radiolucent shadow covering apices of upper anterior teeth

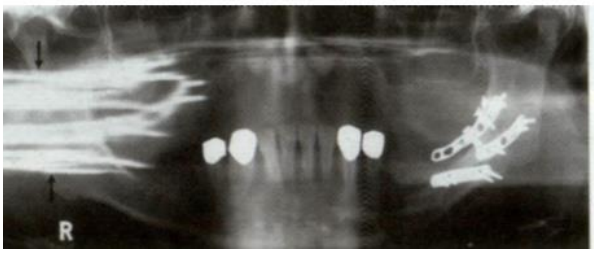


Patient moved during exposure



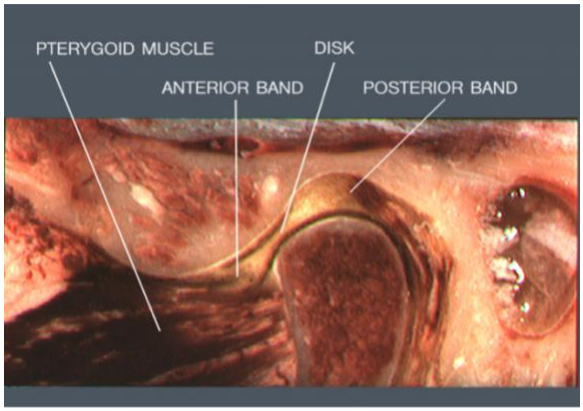
Patient moved during exposure

Ghost images of metal objects in the mandible

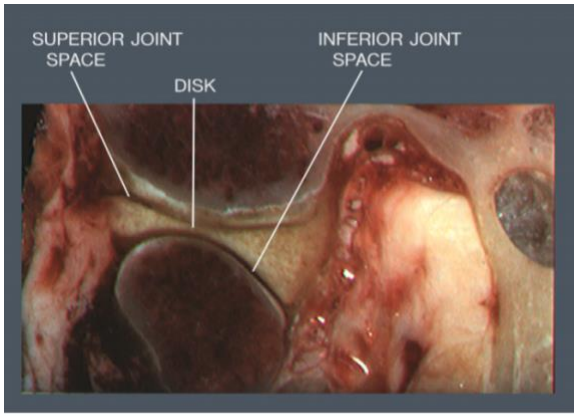


Radiographical imaging of the TMJ

Q: why is it difficult to capture a good view of the condyle ? The condyle is elliptical with the long axis oriented mediolaterally , you need to take more than one view .

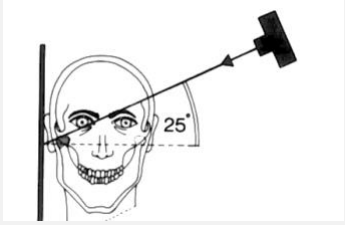
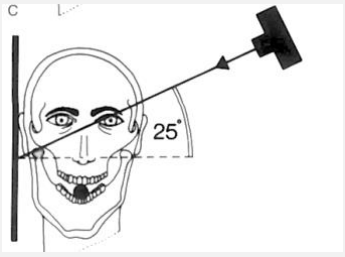
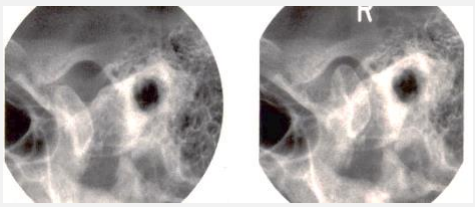


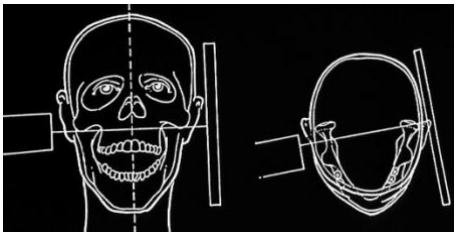
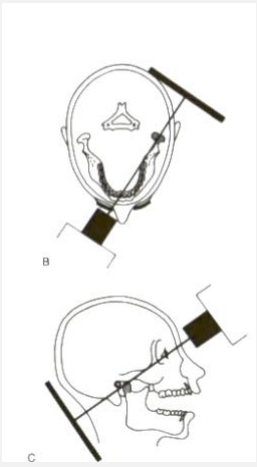
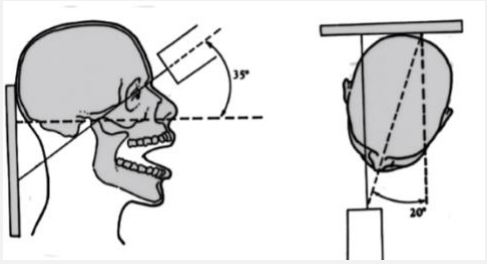
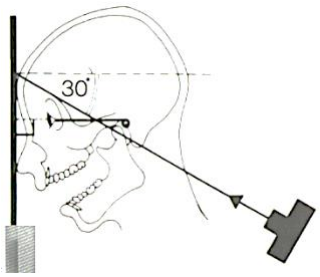
Mid-sigittal section through the TMJ
Mouth closed



Mid-sigittal section through the TMJ Mouth opened

- In most cases of TMJ disorders you won't be able to detect anything on the radiograph unless there are bony changes
- If you want to see the soft tissue of the TMJ → take an MRI
- If you want to see the hard tissue of the TMJ → take a CT / CBCT

TMJ RADIOGRAPHIC PROJECTION	INDICATIONS	HOW IT IS DONE
TRANSCRANIAL PROJECTION   	1- Myo-facial pain dysfunction syndrome 2- Investigate the size and position of the disc 3- Displacement of the condyle 4- Tumors, ankylosis or erosion of the condyle **5- Shape of the eminence** 6- **Investigate the range of movements of the joint**  Mouth open mouth closed	Patient sits with the side under examination is nearest to the film + Mouth CLOSED + Mid sagittal plane parallel to the film Beam is directed at an angle of 25 degrees downwards to the horizontal, across the cranium, entering through TMJ of interest **Procedure repeated with mouth OPENED** **Procedure repeated for the opposite joint** **** you take a total of 4 exposures [R and L open and closed]** In **closed view** will show the **LATERAL aspect of the condyle and glenoid fossa** + comparison of both sides **In open view** will show **range of movement + comparison of both sides**

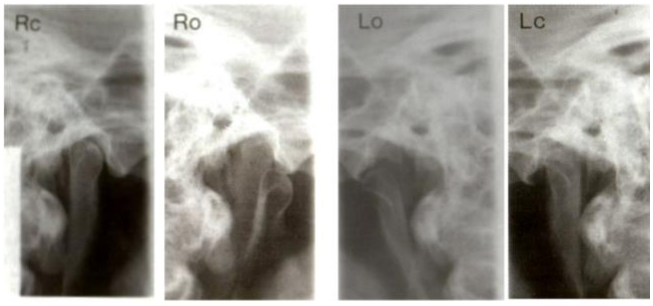
TRANSPAHRYNGEAL PROJECTION	1- Myo-facial pain dysfunction syndrome 2- Investigate the size and position of the disc 3- Displacement of the condyle 4- Tumor, ankylosis or erosion of the condyle. **5- Hyperplasia and hypoplasia of the condyles**** 	The film and Mid sagittal plane are parallel to each other and both are perpendicular to the floor Beam is directed **5 degrees upwards and 5 backwards** towards the joint *The patient opens his/her mouth widely to prevent the superimposition of the condyle on the temporal components* It will show the **LATERAL aspect of the condyle and the articular surface** + comparison of both sides You do a total of 2 exposures [R & L both mouth opened]
TRANSORBITAL PROJECTION 	1- Erosion, pseudocysts or osteophytes on the **superior surface of condyle** 2- Trauma of condyle 3- Hypoplasia/ hyperplasia of condyle **4- Displacement of the zygomatic arch*** 	Very similar to reverse towne's , but in reverse towne's the beam comes from behind – in trans orbital the beam comes from the front Film behind the patient's head, located behind the TMJ of interest Head should be rotated 20° + Mouth opened Beam directed with an angle of 30° - 35° downwards to the horizontal through the orbit directed at the TMJ of interest It will show the **ANTERIOR ASPECT** of the condyle and the articular surface
REVERSE TOWNE'S 	1- Fractures of the condylar head and neck 2- Hypoplasia/ hyperplasia of condyle	The patient is in the **PA position** (head tipped forwards in the forehead-nose position, radiographic base line is horizontal+ mouth is opened The x-ray beam passes **through the center of the condyles from below the occiput at 30°** to the horizontal It will show the **POSTERIOR ASPECT** of the condyle and the articular surface + ALLOWS DIRECT COMPARISION OF THE CONDYLES

Q: what is the rationale behind opening the mouth in some TMJ radiographs? Opening the mouth takes the condylar heads out of the glenoid fossae so they can be demonstrated radio graphically

Dental panoramic tomograph:

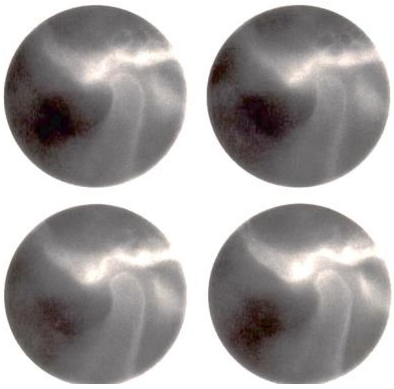
Shows the **LATERAL ASPECT** of the condyle and articular surface + Allows direct comparison of both condyles

Specific field limitation programs can give an image in both open and closed positions of the condyles : The machine exposes the R TMJ then stops the exposure then exposes the L TMJ , then you ask the pt to open their mouth and repeat → the result is one film that contains all 4 radiographs [R & L open and closed]



Specific field limitation

Tomography: used to investigate condyles, articular fossa if the **patient can't open the mouth**



- **Tomography** = the xray beam and the film move together at the same speed in opposite directions
- **The advantage of tomography → no superimposition of structures**
  It will show the **medial and lateral aspect of the condylar head** + information on all aspects of the joint

Arthrography:

Indications:

1- Longstanding MPDS irresponsive to treatment
2- Persistent history of locking
3- Limited mouth opening of unknown etiology

- A non-ionic contrast medium is injected into the **lower joint space**, aided by fluoroscopy [series of xrays taken while you inject , both the doctor and the pt are exposed to radiation] for accurate positioning of the needle
- Several views are recorded using fluoroscopy in open and closed mouth positions.

The disc itself will not show but when the pt opens their mouth you will follow the contrast medium to see if it moves uniformly or not.

It will show:

- **Dynamic position of the joint components and disc as they move in relation to each other** + Static images of the joint components with mouth open/close
- Any **disc displacement or perforation**

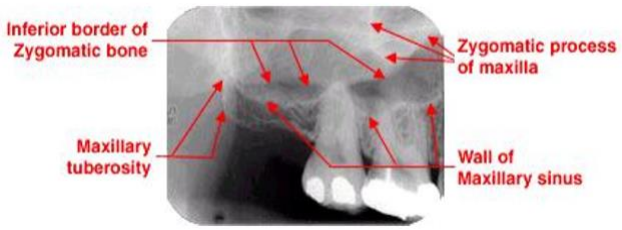
Radiography of the maxillary sinus

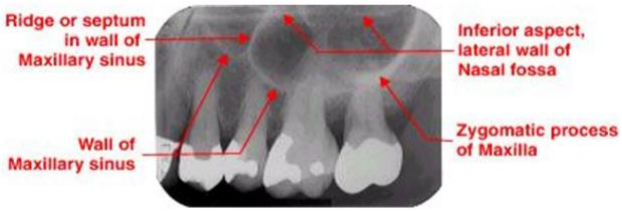
Normal maxillary sinus = pyramidal , air filled [radiolucent]

Note : the number of teeth associated with the maxillary sinus depends on **the size of the sinus** itself not the absence or presence of teeth

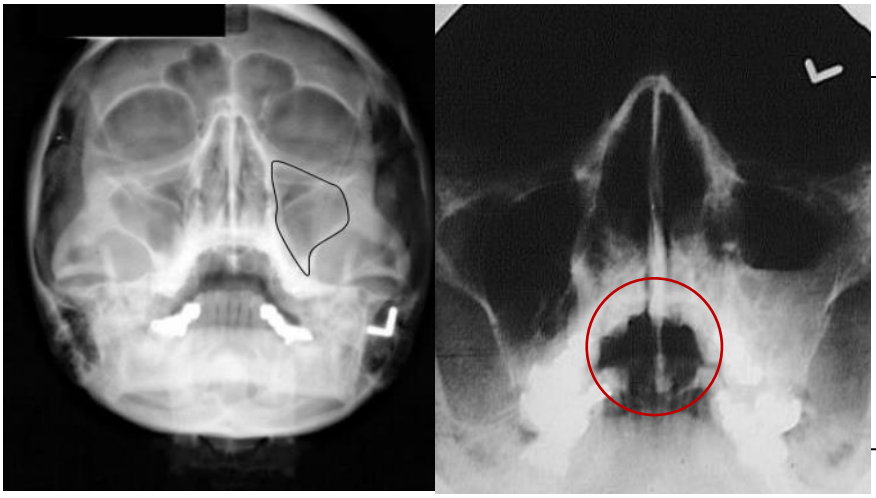
Different views for the maxillary sinus:

Periapical / upper oblique	Floor of the sinus and the relationship with the teeth
OPG	Floor + **posterior wall** of the sinus +relationship with teeth + allows comparison of both sinuses
Water's view	Floor, roof , medial walls + main cavity + comparison of both sinuses
True lateral skull	Main cavity + posterior and anterior walls [sinuses are superimposed over each other]
Linear tomography	All walls + main cavity + allows comparison
CT / MRI	All walls + main cavity + surrounding structures





NOTE: the location and the relationship between the roots and the maxillary sinus changes according to anatomical variations and changes in beam angulation- moving the beam up or down can reposition the floor of the maxillary sinus



In water's view , if you ask the pt to open their mouth you'll see the **sphenoid sinuses on the palate.**

But if they close their mouth , the mandibular symphysis blocks the image of the sphenoid sinuses

Q: why does fluid appear radio opaque in radiographs? Due to the difference in absorption of xrays between air and fluid, [fluid absorbs more xrays → more radiopaque – air absorbs less xrays → more radiolucent]

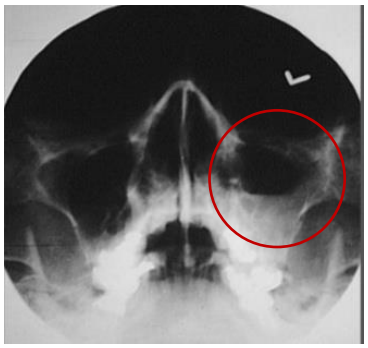
Q: why does a normal maxillary sinus appear radiolucent but not completely homogeneous? It appears radiolucent because normally it should be filled with air, it is not uniformly radiolucent because of the superimposition of structures

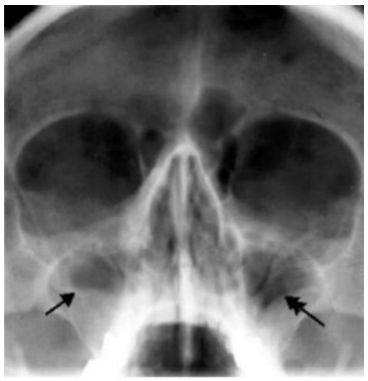
CAUTION: if the pt comes complaining of pain in the upper posterior teeth → ask if the pain changes with posture change , if yes → it is a fluid problem in the maxillary sinus and not the teeth.

TRICK: to know if this is fluid or solid in the max sinus , take 2 radiographs in different positions if the radioopacity remains flat → fluid

CAUTION: you CAN'T diagnose from radiographs you can only describe appearance.

ACUTE SINUSITIS: total or partial radio opacity **<u>with the base upwards</u>** [due to fluid collection in the sinus]



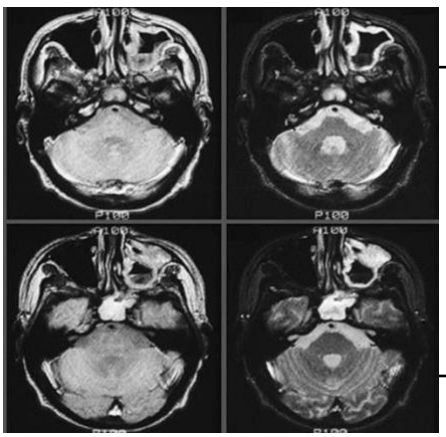


Chronic Maxillary Sinusitis

CHRONIC SINUSITIS:

- Radio opacity at the walls due **to mucosal thickening**
- Radio opacity at the base due to **fluid accumulation**
- Radio opaque **mucosal polyp**

CT SCAN **MRI**

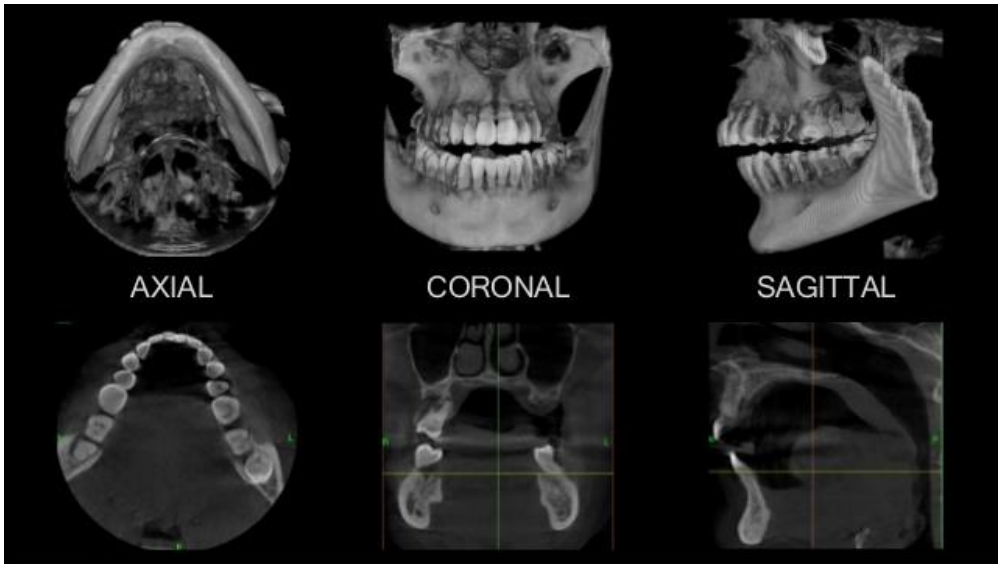


Quick way to know if the image is CBCT/ CT or MRI:

If the bone appears black → MRI

If the bone appears white → CBCT/ CT scan

Different sections of CBCT



Oro- antral communication appearance:

- Discontinuity of the floor of the max sinus
- Sometimes you will see displaced root

Q: the characteristic feature of Orbital blow out fractures is:

Tear drop radio opacity

Maxilla – facial skeleton fractures:

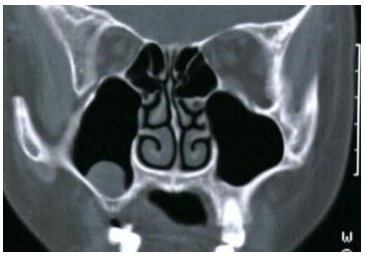
- Discontinuity in one or more walls
- Total/partial opacity due to fluid (hemorrhage)
- **Tear- drop opacity in orbital rim fractures**

Antrolith – calcification in the maxillary sinus

BEST 2D VIEW FOR THE MAXILLARY SINUS = WATER'S VIEW

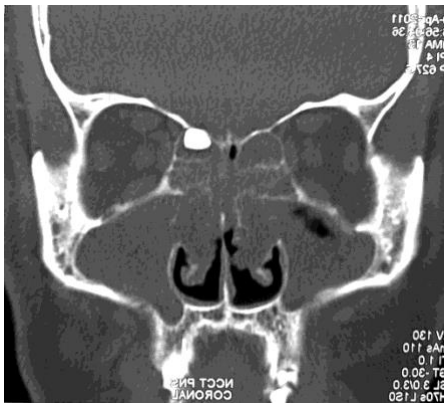
NOTE: to differentiate between sinus pain from dental pain : sinus pain is affected by postural changes but is NOT affected by thermal stimuli

Well defined, round / dome shaped radio opacity → maxillary sinus Cyst



In CT scans the maxillary sinus appears completely radiolucent because you are only viewing a " slice" – there is no superimposition of other structures

Ivory osteoma = very radio opaque , well defined homogenous dense mass in the FRONTAL SINUS



Carcinoma of the maxillary sinus

Maxillary sinus malignant tumors:

- **Total opacity of antrum**
- Invasion of soft tissues and hard tissues
- Displacement / resorption of teeth

Osteosarcoma

Sun burst appearance of osteosarcoma

Radiography in trauma to teeth and facial skeleton

CUATION: fracture lines can only be detected if the fracture is within the line of xray beam

Q: How does trauma appear on radiograph?

1- A radio lucent line (usually sharply defined) within the anatomic boundaries of the structure or between broken fragments
2- A change in the anatomic outline of the structure
3- A change in the occlusal plane at the location of the fracture
4- A defect in the outer cortical plate [Ex: step-like defect or increase in the radio opacity of bone due to overlapping of two fragments of bone]

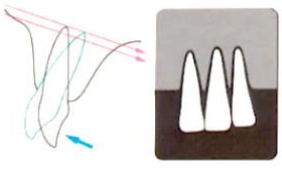
Q: does trauma always appear as radiolucent area? No, if the two broken bones overlap you'll see an area of increased radio opacity

In trauma you need to take multiple projections [at least 2] at right angles to each other [ex: OPG + PA skull]

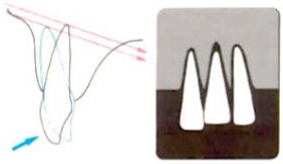
RADIOGRAPHS IN TRAUMA TO TEETH

TOOTH FRACTURE	1- OPG for general survey and not fine details 2- At least 2 PA with tube shift technique + occlusal film of involved tooth/teeth + teeth of the opposing arch [in cases of fractured teeth because there will be transmission of forces to the opposing arch and it might also be fractured] 3- Extra oral views are used to detect the extent of fracture to remote areas [ex: in cases of symphysis fracture always check the condyles as well]
TOOTH AVULSION / FRACTURED CROWN	1- Chest xray to rule out the tooth being aspired into the lung ** 2- In cases **of lip lacerations** → take soft tissue radiograph of the lip to exclude embedding of the tooth in the lip **(a periapical film is placed in the vestibule between the lip and the alveolar bone – you need to reduce exposure)** **3-** In cases of **tongue laceration** → standard **mandibular Occlusal projection** to exclude embedding of the fractured tooth in the tongue (the tongue may be protruded and imaged)

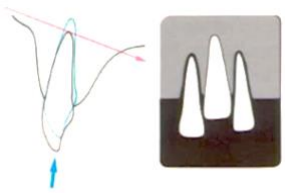
The ideal thing is to take 3D imaging like CBCT which will allow you to go through slice by slice, gives good detail in different views + allows you to do accurate measurements



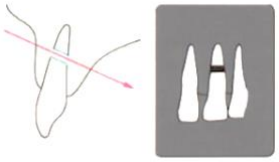
In cases of luxation where **the root goes palately → there will be no changes on the radiograph**



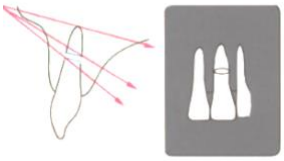
In cases of luxation where the root goes labially → there will be widening of the PDL apically



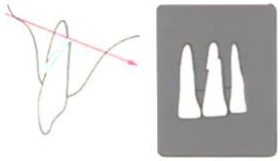
In cases of intrusion → the PDL is reduced apically



In case the x ray beam is at the line of the fracture → you'll be able to detect it and see the fracture line



If the xray is at an angle to the fracture line → it will appear as a ring



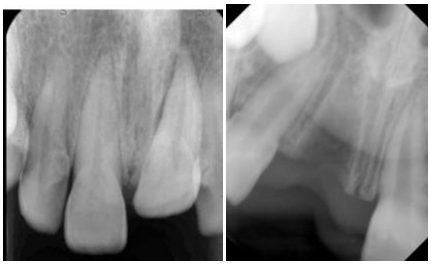
If the xray is above the fracture line → over lapping of the fragments

If the root of the tooth appears more radio opaque and sharper → the root is closer to the film → the root moved PALATELY

- Q: **Elevation of tooth out of the socket is seen in** → extrusion
- **Q: Widening of the apical portion of the PDL is seen in →** lateral luxation where the crown moves palately and the root moves buccally
- **Q: Partial or total obliteration of the PDL space apically is seen in** → intrusion

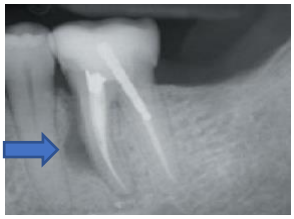
The crown is more radio opaque and sharper → the crown moved palately [closer to the film] - to confirm this take an occlusal radiograph

intrusion avulsion



The ability of the radiograph to show a fracture depends on:

A. Degree of separation of the fragments
B. Whether or not the X-ray is aligned with the fracture **[if the xray is not in the line of the fracture → the fracture will appear as a grey shadow and sometimes a widened PDL will be the only sign of fracture- the PDL will be wider next to the fracture site]**



CAUTION: soft tissue shadows like the lips and the Ala of the nose might overlay the root giving the image of a root fracture + **Fractures of the alveolar process that cross the root may give a false image of root fracture**

- **vertical root fractures → Horizontal tubeshift technique**
- **horizontal root fractures → vertical tube shift technique**

Alveolar bone fracture

NOTES:

- Teeth with posts or large restorations that are subjected to trauma are at higher risk of fracture
- **The width of the fracture line increase with time, due to resorption of the fractured part**
- **Calcification and obliteration of the pulp chamber and canal may be seen**

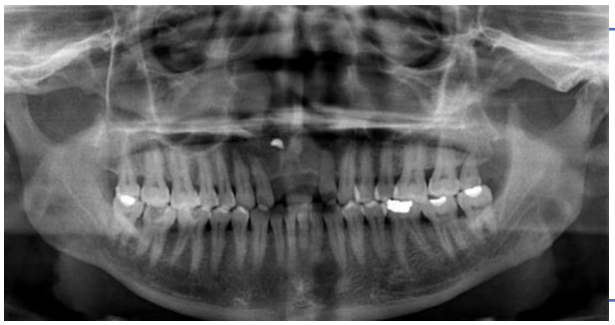
TRICK: to know if the radiolucency is related to the tooth or not → follow the outline of the PDL , if you **can trace the PDL all over** → the RL is **not related to the tooth** , if the PDL widens or changes → the RL is related to the tooth

- Crown fractures are detected clinically then you take a radiograph to see if there are any root fractures
- ***Fractured cusps in molars are the hardest to detect on radiographs because of the superimposition of the bulk of the crown on the fracture line.***

Signs of root fracture:

1- Changes in the PDL [widening]
2- Changes in the course of the root
3- Fine radio lucent line
4- Widening of the bi furcation / trifurcation area in multi rooted teeth

- PA radiograph will show you mesio distal direction only → in order to know bucco lingual direction take an occlusal film
- ***If the pt comes in without the fractured piece of the tooth and with lacerations in the mouth you need to R/O it being embedded in the ST by taking radiographs of the tongue, cheek, and lips . if you can't find anything → take a chest X ray***



Normally teeth should not be occluding in an OPG.

But in case of trauma to the anterior teeth → nothing to bite on the incisal notch of the OPG machine → teeth will be occluding and not separated

Mandibular fractures:

- Fracture of **the body on one side** is commonly associated with fracture of the **condylar process on the other side**
- Trauma to the anterior mandible may result in unilateral or bilateral fracture of the condylar process

CUATION: trauma to the symphysis region → always check the condyles for fractures

- **A "condylar notch" on the radiograph indicates a fracture**
- If you can't tell if the buccal and lingual plates are fractured or not → take an occlusal radiograph
- **Condylar fractures are always displaced Antero- medially because of the action of the lateral pterygoid muscle – because they are displaced medially they will appear more radio opaque & sharper [because they are closer to the film]**

Ante gonial angle is increased in cases of long standing condylar fractures due to the excessive muscular contraction needed to open the mouth

Fracture of the alveolar process :

Fracture line is commonly **horizontal** + the buccal plates are more prone to fractures than palatal plates

Healing of fractures:

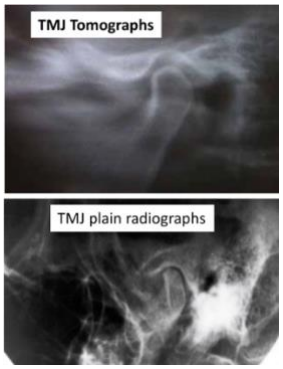
- Remodeling and re-mineralization of the fracture site cannot be always detected because the calcification is not always dense enough to be detected radiographically [not every RL around a fracture indicates malunion or failure]
- During normal healing the radiolucent fracture line increases in width about **2 weeks after reduction, due to resorption of the fracture ends**
- **Evidence of re-mineralization occurs 5-6 weeks after treatment**
- **Complete remodeling of the fracture line may take several months or years**

Complications of fractures:

- Osteomyelitis of the fracture site
- Malalingment of the fracture segments
- Inflammatory lesions of non-vital teeth near the fracture site [teeth that are non restorable and might be a source of infection should be extracted before the reduction]
- Non-union of the fractured segments

Specialized radiographical techniques

Tomography:



- simultaneous movement of the xray beam and the film at the same speed in opposite directions
- The area of intrest [**focal trough] will be in maximum sharpness** while images outside the focal plane are blurred.
- The main advantage of tomography = **reduce superimposition of structures**
- OPG = is a type of tomography

- ➢ In an OPG the area of max sharpness is the teeth and associated structures, if you change the speed of rotation the location of the area of max sharpness [focal trough] changes
- ➢ When you minimize the thickness of tissues that the xray beam has to pass through → scattering radiation will be reduced

Scanograhy = using a fan shaped xray beam to scan an area of interest

Scanograph has better details and higher contrast due to less scattering radiation [because it passes through less tissues] – but it has higher radiation DOSE than OPG.

Contrast media : The use of a **<u>radio opaque contrast medium</u>** to **visualize the soft tissues** that can not be seen radio graphically

- ➢ Sialography → studying the salivary glands
- ➢ Angiography → studying the blood vessels
- ➢ Arthrography → studying the joints
- ➢ Barium swallow → studying the GIT

Contrast media have high atomic number → they absorb the xrays and can be seen on radiograph

Fluoroscopy / cinematography:

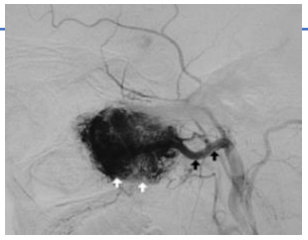
- Obtaining **"live" X-ray images of a living patient** [dynamic images , you can't see them later unless you save them during the procedure]
- **How it works:** xray strikes a **fluorescent plate** that is coupled with an **image intensifier** that is also coupled **to a monitor**
- Used to observe the upper GIT (Barium Swallow) or the lower GIT (Barium Enema)
- used during many **diagnostic and therapeutic procedures, to observe the action of instruments**
- **exposes both the pt and the doctor to high radiation – because multiple radiographs are taken when the contrast medium is inside the tissue [both need lead aprons]**

Invasive procedures use ionizing radiation [either xrays or Gamma rays]

Ultrasonography :

- **Non invasive because you are using soundwaves to view images of internal structures [no ionizing radiation is used]**
- **How it works**: Ultrasonic scanners generate **electrical impulses** that are converted into **high-frequency sound waves by a transducer** [thin piezoelectric crystals vibrate and change electricity to sonic energy]
- Tissues have different **acoustic impedance** – tissue will either absorb, reflect , refract, or diffuse the ultrasonic energy
- Sonic waves that are **reflected back (echoed) toward the transducer** → changes it back to electricity → image displayed on a monitor
  DISADV: only shows soft tissues , since bones completely absorb the soundwaves and will not show
  NOTE: the transducer is a device that changes the electrical energy to sonic energy [it is a receiver and a transmitter at the same time]

Not all dyes are radio opaque , some are radiolucent



Radioisotopes Imaging:

- **Intravenous injection of radioactive isotopes (Radiotracers)** that are **absorbed by body organs** then disintegrate and emit Gamma rays that will be registered by a Gamma camera
- measurement of **tissue function** only **does not show tissue anatomy****
- An **increased uptake of the tracer in a certain tissue [hot spot] indicates hyperactivity of that organ**
- ***All glandular tissues have high affinity to radio isotopes***
- Pt should stay for 3 hours in the hospital

Magnetic Resonance Imaging MRI

- Depends on the **hydrogen atoms that are available in different body tissues** [H2 atoms (water content) in each tissue is different → different electromagnetic waves are emitted → different images are produced]
- All **H2 atoms spin RANDOMLY around an axis of rotation which creates a magnetic field**
- **How it works:** MRI uses a very high magnetic field to align the H2 atoms in a single direction of rotation → Then applies radiofrequency and then removes it → this will cause movement of the hydrogen atoms and emitting electromagnetic wave that will be captured by a computer and displayed as an image.
- **Shows soft tissues and hard tissues in 3D , but shows Soft tissue more**
- **Advantages:**
  1- high ability to display soft tissues
  2- No ionizing radiation
  3- 3D images of tissues
  4- Safe for pregnant women

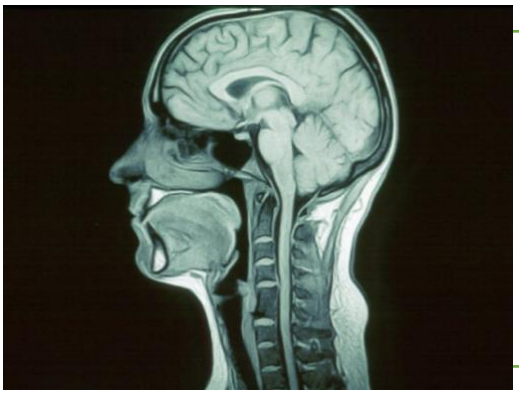
  Disadvantages:

  1- Long imaging times [45 minutes]
  2- Metal objects affected **
  3- Claustrophobia from the machine

CUATION: You cannot take an MRI for a pt with metal screws or prosthesis → MRI will cause them to loosen or move from their place!!

You need to remove all metals from the pt and form the room.

Implants are okay because they are made from titanium



Tissues with more water content (more hydrogen content) like the brain will appear **white.**

Tissues with less water content like bone will appear **black**

Cone bean computerized tomography [CBCT]

SYNONYMS FOR CBCT

- Cone Beam Computed Tomography (CBCT)
- Cone Beam Volumetric Imaging (CBVI)
- Cone Beam Volumetric Tomography (CBVT)

True 1:1 display of the dentition and related structures – very accurate measurements because there is no magnification

- **useful to evaluate bone density – but fails to show images of soft tissues**
- **Radiation dosages is up to 15 times lower than those of conventional CAT scans**

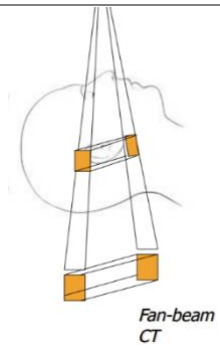
Computerized tomography can be divided into two categories based on geometry of X-ray beam:

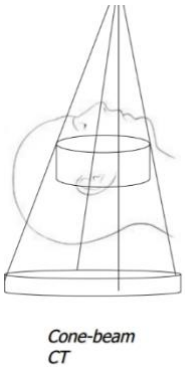
A. Fan beam (CAT) – scan the whole body
B. Cone beam (CBCT)

CAT SCAN	CBCT
Xray beam = **fan shaped** **Helical rotation** Scans **the whole body**	Xray beam = **cone shaped** **Single rotation [arc shaped 180 – 360 °]** Scans the **craniofacial region only**

Hounsfield unit measures bone density

The images from CAT scan and CBCT are not captured directly in 3D format, they are captured in 2D format and collected together in the image reconstruction unit to form the 3D image.


Fan-beam CT


Cone-beam CT

In CAT scans – the principle of tomography is obtained by rotation in a HELICAL PATTERN around the pt.

- **Majority of CBCT systems scan the patient in a seated position**
- Scan times typically take between **10–40 seconds**, depending on the scanner used and the exposure parameters selected
- **The actual exposure time is only about 2–5 seconds (pulsed scan)**

- The data acquired by CBCT are captured in terms of **volume, which are made up of voxels [3D]**
- CBCT Voxels are **isotropic**, which means that they are **equal in all 3 dimensions**
- CAT scan voxel are anisotropic, not equal in size – longest dimension is in the axial slice
- Objects captured **within the volume can be accurately measured in various directions**

- Images can be displayed in the 3 orthogonal planes: • axial • sagittal • and coronal

- Most CBCT use an image intensifier tube (IIT) charge-coupled device (Sirona) a recent advancement is - flat panel imager (FPI)
- Images produced with an **IIT generally result in more noise than images from an FPI**
- FPI need to be preprocessed to reduce geometric distortions
- **Noise in a radiograph = black spots that are not related to the tissues [image noise decreases the ability to interpret the image]**

CBCT advantages	Disadvantages
1- Image accuracy 2- Dose reduction 3- Xray beam collimation 4- Rapid scan time 5- Reduce image artifacts **6-** Has modes unique to the maxillo facial region	Less ability to display ST Not all softwares are capable of 3D color dispaly

CAT scan of the skull = 2,000 microseiverts
CBCT = 75 microseivert
If you want to decrease the expsoure even more → take MRI
OPG = 1/5 of CBCT exposure

Imaging of salivary glands

- CT scan = shows soft and hard tissue [but has high radiation dose]
- CBCT= shows only hard tissues in 3D image
- MRI = shows soft and hard tissues but compact bone appears black it lacks water [hydrogen content]

Salivary gland radiography:

Plain Film Radiography:

- Can demonstrate **calcifications** [sialoliths] and involvement of adjacent osseous structures
- Identify pathoses unrelated to salivary glands **[but does not show the gland itself]**
- Relatively inexpensive + Simple
- **Occlusal projection** → Shows the **anterior 2/3rds of the submandibular ducts**
- **Periapical films** → Show the **anterior part of the Stensen's duct** [An intra oral film is held with a hemostat, against the cheek, as high as possible in the buccal sulcus, over the parotid papilla X-ray is directed perpendicular on the film – *you need to reduce exposure because not all sialolith are calcified enough to be detected radiographically + it is only ST there is no bone or teeth*]

Sialoliths

You need to reduce exposure

Extra oral view: [don't show the gland itself, mostly used with sialography]

1- PA skull / PA skull rotated
2- Occipito mental
3- Lateral oblique
4- OPG

CT scan :

- Shows intrinsic and extrinsic gland swellings
- Can be used with contrast media [sialography] to show the gland in 3D

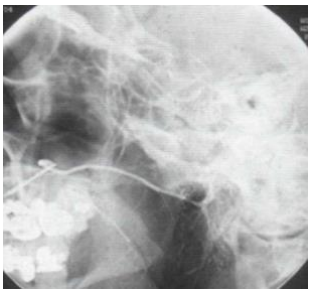
Radioisotope Imaging Scintigraphy: [injecting technetium 99- all glands will uptake Tc99]

- Indicated in **dry mouth** due to salivary gland diseases
- If there is uptake → gland is functional , no uptake → gland is not functional
- In case of an acute infection → you'll see a hot spot [indicating increased uptake of the radio isotope]
- Assessment **of salivary gland function does not indicate anatomy** [bilateral evaluation of salivary glands]
- **Can be performed in cases of acute salivary gland infections**
- High radiation dose

In active infections → you cannot use sialography [it will cause the infection to spread] But you can use scintigraphy

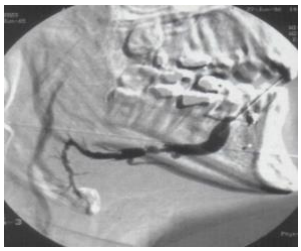
No uptake in the left side – left parotid is not functional

Digital Fluoroscopy



Sialography + digital fluoroscopy = direct visualization (real time image) → This helps to **eliminate over filling and/or underfilling** + the radiologist can see the duct and gland as the contrast medium is injected, and adjust the patient's position to demonstrate any abnormality.

Digital subtraction:



An image taken before to the introduction of contrast will be electronically subtracted from subsequent images, after contrast is injected. [the computer will only show what has changed and will delete anything similar between the 2 images]

Ultra Sound

- Excellent in differentiation between **solid and cystic masses**
- **Identification of radio lucent stones**
- Limited use in areas surrounded by bone, as the sound waves are blocked by bone
- **No indication of salivary gland anatomy**

MRI : [Gold standard]

- Excellent soft tissue detail and gland anatomy
- No information about salivary gland function

Sialography:

- Shows stone in the salivary ducts / Duct strictures and fistulae / Autoimmune diseases
- **Contraindications of Sialography**
  A. Active salivary infection [chronic infection is OK]
  B. Known sensitivity to contrast media (Iodine containing compounds)
  C. Anticipated thyroid function tests [wait 2 months after administration of contrast media before doing thyroid function test]
- **If you want to empty the contrast medium faster → give the pt lemon juice [this will stimulate the glands to evacuate the contrast medium]**
- **You need at least 2 radiographs at right angles during the filling phase of the glands**
- **After 1-5 mins of emptying an oblique lateral is taken to make sure the gland is emptied**

Sialography injection techniques:

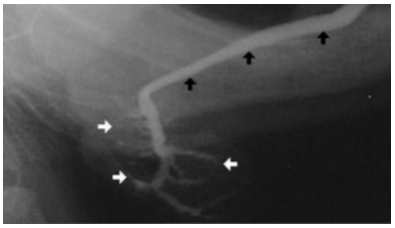
A. **Simple injection technique :** arbitrary pressure is applied , might cause under or over filling , you rely on pt's response , might damage the gland
B. **Hydrostatic technique :** controlled injection , less likely to damage the gland , but you still rely on pt's response **[you can't use this technique with OPG because the pt has to be laying down for this technique]**
C. **Continuous infusion technique - monitored technique :** BEST – does not depend on pt's response [depends on negative feedback] and does not cause overfilling.

Normal parotid gland in sialography:

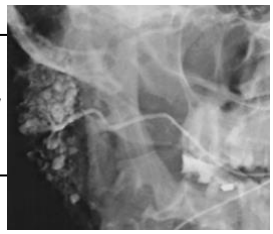
The main duct is of even diameter (1-2 mm wide) and should be filled completely and uniformly. The duct branches and tapers gradually towards the periphery of the gland, the so-called **" tree in winter" appearance**

Normal submandibular gland in sialography:

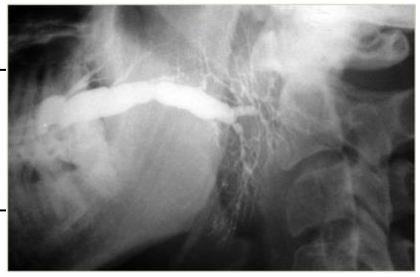
The main duct is even (3-4 mm wide) and should be filled completely and uniformly. branching duct + tapering gradually towards the periphery, the so-called "**Bush in winter " appearance**



Sjögren syndrome: **snowstorm or cherry blossom apperance**



Sialodochitis : sausage link appearance



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