Radiology

Lec 1. **Physics of Radiation** **د.اريج احمد**

Topics of lecture:

1. Physics of radiation (introduction, definitions and types of radiation).
2. Production of radiation (x-ray machine, generation and interaction of x-ray with matter).

Introduction

- Radiology is the science that deals with diagnosis, therapeutic and researches application of high energy radiation.

- Dental radiography is a process of image production for an object through the use of x – radiation.

- Radiologic examination is an integral component of the diagnostic procedure. Dentists often make radiographic images of patients to obtain additional information beyond that available from a clinical examination or their patient's history. Information from these images is combined with the clinical examination and history to make a diagnosis and formulate an appropriate treatment plan.

Nature of Radiation

Radiation is the transmission of energy through space and matter. It may occur in two forms: (1) electromagnetic and (2) particulate

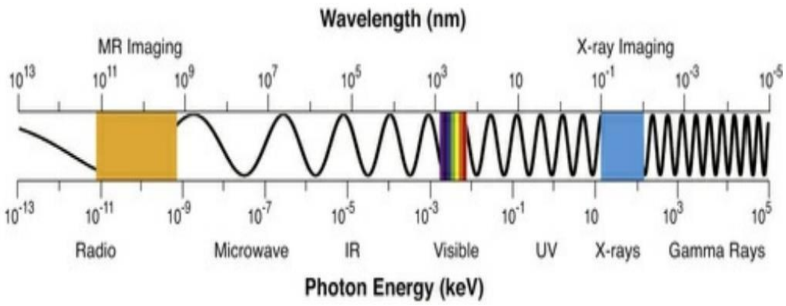


Fig 1. Electromagnetic spectrum showing Photons used in dental radiography – x-ray *(blue)* have energies of 10 to 120 keV. Magnetic resonance *(MR)* imaging uses radio waves *(orange)*.

- X – Ray was discovered by (Roentgen) in 1895,it travels in a form of pure energy and the basic unit is x – ray photon or (quantum).
- X – Ray photons travel with a wave motion called (sine – wave) and the distance between the crests of these waves called (wave – length) which measured by a unit (A˚). The X – ray photons wave length used in diagnostic radiography is ranged between 0.1 – 0.5 A˚ , and the amount of

energy contained in each photon called (photon energy) which depend on Wave length and Frequency of x – ray.

The high frequency of X – ray the shorter wave length photons this shorter wave length photon has more energy than a low frequency long wave length type of X – ray photons.

Comparison between x – ray and light

1. Both belong to the same electro – magnetic radiation family.
2. Both travel in straight lines at the same speed which is 186,000 miles per seconds.
3. Both affected the photographic films and made them black.
4. Both not affected by magnetic fields
5. X-ray and light cast the shadows of the objects in the same manner
6. X-ray has the ability to penetrate objects that the light cannot pass through
7. X-ray has the ability to ionize atoms
8. X-ray has the ability to produce light (blue light) when it hits some objects and this phenomena called (fluorescence).
9. X-ray is invisible

Components of X-ray machine and generation of X-ray

X- ray machines produce x-rays that pass through a patient's tissues and strike a digital receptor or film to make a radiographic image. The primary components of an x-ray machine are the x- ray tube and its power supply, positioned within the tube head. A control panel allows the operator to adjust the duration of the exposure, and often the energy and exposure rate, of the x- ray beam. An electrical insulating material, usually oil, surrounds the tube and transformers. Often, the tube is recessed within the tube head to increase the source-to-object distance and minimize distortion.

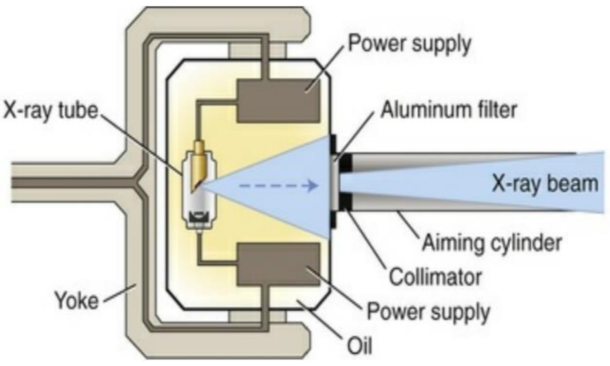


Fig 2: most important components of x-ray machine

X–ray tube is composed of **a cathode and an anode** situated within an evacuated glass envelope or tube .The glass of the tube is leaded to prevent (the generated X – ray) from escaping in all directions. While the window is of unleaded glass so that X – ray exist out through this window.

The cathode consists of a filament and a focusing cup. **The filament** is the source of electrons within the x-ray tube. It is a coil of tungsten wire approximately 2 mm in diameter and 1 cm or less in length, and typically contains approximately 1% thorium, which greatly increases the release of electrons from the heated wire. The filament is heated by a low-voltage source and emits electrons at a rate proportional to the temperature of the filament.

The filament lies in a **focusing cup**, a negatively charged concave molybdenum bowl. The electrons emitted by the filament into a narrow beam directed at a small rectangular area on the anode called the **focal spot**. The x-ray tube is evacuated to prevent collision of the fast-moving electrons with gas molecules, which would significantly reduce their speed. The vacuum also prevents oxidation, or "burnout," of the filament.

The anode in an x-ray tube consists of a tungsten target embedded in a copper stem .The purpose of the **target** in an x-ray tube is to convert the kinetic energy of the colliding electrons into x-ray photons. The conversion of the kinetic energy of the electrons into x-ray photons is an inefficient process, with more than 99% of the electron kinetic energy converted to heat. The target is made of tungsten, an element that has several characteristics of an ideal target material, including the following:

1. **High atomic number** (74), allows for efficient x-ray production.
2. **High melting point** (3422°C), to withstand heat produced during x-ray production.
3. **High thermal conductivity** (173 W m−1 K−1), to dissipate the heat produced away from the target.
4. **Low vapor pressure** at the working temperatures of an x-ray tube, to help maintain vacuum in the tube at high operating temperatures.

The tungsten target is typically embedded in a large block of copper which functions as a **thermal conductor** to remove heat from the tungsten, reducing the risk of the target melting.

To produce x-rays, electrons stream from the filament in the cathode to the target in the anode, where the energy from some of the electrons is converted into x-rays.

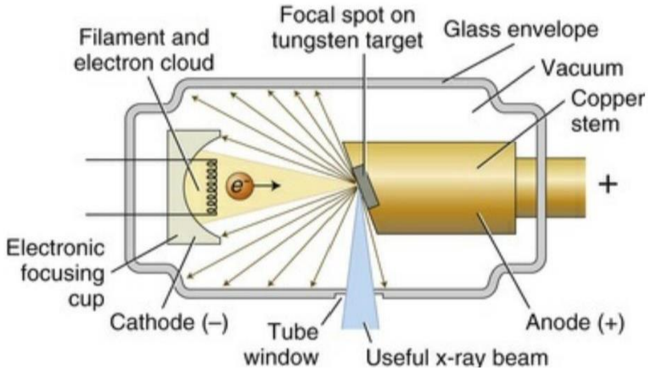


Fig 3: x-ray tube head and production of useful x-ray beam

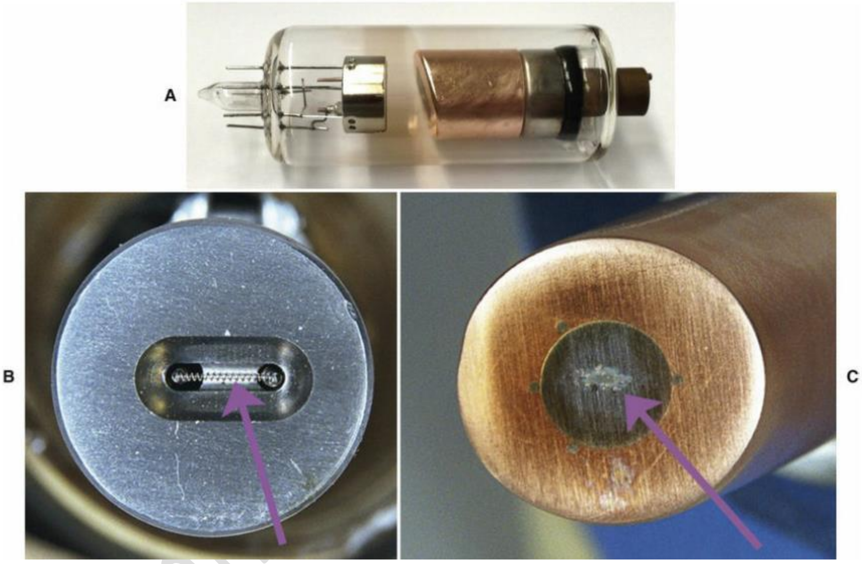


Fig 4: (A) Dental x-ray tube with cathode on left and copper anode on right. (B) Focusing cup containing a filament *(arrow)* in the cathode. (C) Copper anode with tungsten inset.

Types of radiation

1. **Central ray**: is X– ray photons that traveling in very center of the cone of radiation (radiation beam), and it's commonly used to fix and locate the position of X – ray beam.
2. **Bremsstrahlung radiation**: radiation produced when projectile electron is slowed by the electric field of target atom nucleus.
3. **Characteristic radiation**: radiation produced when an outer shell electron fills an inner shell void (empty orbital).
4. **Primary radiation**: Radiation emerging from the X – ray machine in form of collimated useful X – ray beam
5. **Secondary radiation**: Radiation result from interaction of primary beam with matter
6. **Leakage radiation**: x-ray that escape through the protective housing and result in unnecessary exposure of the patient and radiologic technologist and have no value in diagnostic radiology.

Definition of terms used in X – ray interaction:-

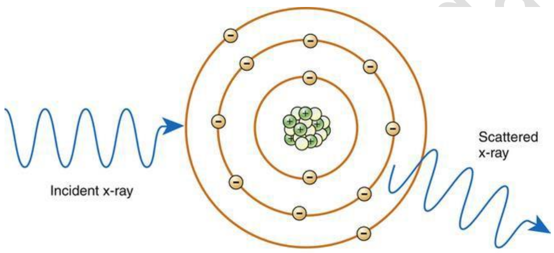
- Scattering: - change in direction of photon with or without a loss of energy.
- Absorption: - deposition of energy i.e. removal of energy from the beam.
- Attenuation: - reduction in the intensity of X – ray beam caused by absorption and scattering attenuation = absorption + scattering.
- Ionization: - removal of an electron from neutral atom.

X-ray interaction with matter (Absorption of X – ray)

x – Ray absorbed by any form of matter (solid, liquid, and gas) when photons reach an atom, different types of interaction may occur depends on photon energy:

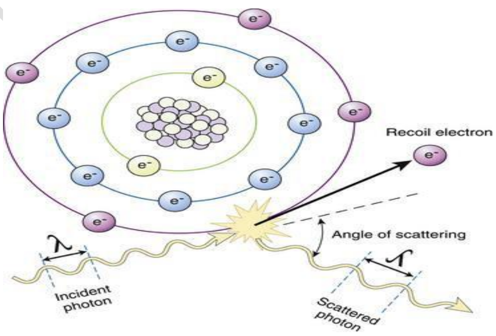
1. X – Ray photons can pass through the atom without any change occurred to both of them.

2. **Coherent scattering** sometimes called classical scattering or Thompson scattering occur by interaction of low energy x-ray photon and atom. there is no loss of photon energy only changes in direction (photon of scattered radiation) .



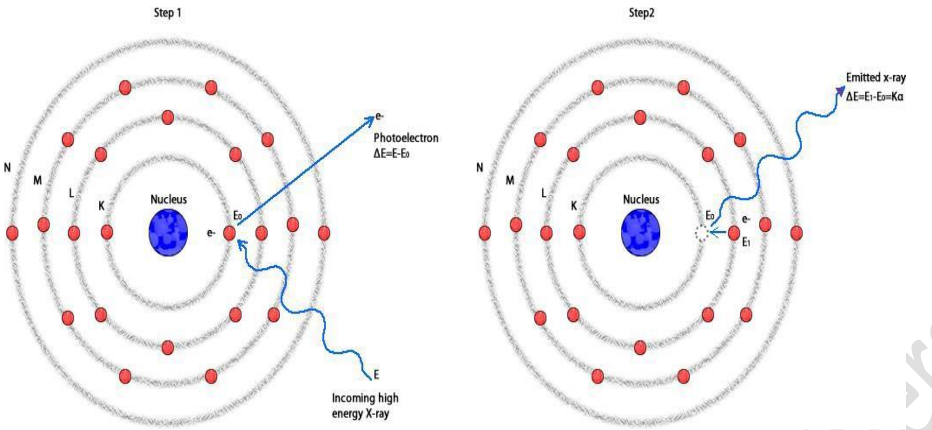
Classical scattering

3. **Compton Effect**: occur between moderate energy x-ray photon and free or loosely bound outer shell electron of atom. It result in ionization of atom (ejection of Compton recoil electron) , reduction of photon energy (there is some absorption of photon energy by ejected electron which undergoes further ionization interaction within the tissue) , and change in x-ray direction (scattered radiation).



4. **Photoelectric effect**: occur by X – Ray photon interaction with inner – shell electron of the tissue atom (ex. From k shell) , the X – ray photon disappears and deposits all its energy this process is pure absorption. Now the inner – shell electron is ejected with considerable energy (now called a photo – electron) in to the tissue for further interaction with other electrons of other tissue atoms. So this high – energy ejected photo electron behaves like the original high energy X – ray photons interact and eject other electrons as it passes through the tissues, these ejected

electrons are responsible for the majority of ionization interactions within the tissue and the possible resulting damage attributable to the X – rays.



When k electron removed out of its orbital, an electron from L shell falls in to k shell and release energy in the form of x-ray photon. This photon has definite wavelength of a particular element, this phenomena is used to identify elements and the radiation is called characteristic radiation.

There are two other types of interaction Pair production (between high energy x-ray photon and nuclear force field) and photodisintegration (between high energy photon and nucleus) but both of them not occur in diagnostic radiology.

Filtration

X – ray used in dentistry must be able to penetrate dental hard tissues (teeth and bone). The longer wave length X – ray (soft X – ray) are not useful in diagnostic radiology thus removal of these long wave length photons from the beam by passing the beam through a filter made from Aluminum which absorb most of long wave length photons (soft X – ray), the resulting X – ray beam will consist mainly of X – ray photons with short wave length, high energy photons and high penetrating power that's why they named (hard X – ray beam).

Types of filtration:

1. Inherent filtration: done by filter built-in to the X – ray machine by manufacturer (as glass wall, the insulating oil and the metal housing of the tube). The inherent filtration tends to increase with age because some of tungsten metal of both target and filament is vaporized and deposited on the inside of the tube window.
2. Added filtration : done by using aluminum sheet as extra filter.

*[total filtration = inherent filtration + added filtration]

fig 3: aluminum filter attached to the tube head

Collimation

Is a process used to control the size and shape of X – ray beam. In diagnostic radiography its essential to get the diameter of circular X – ray beam at patients skin surface is not great than 2.75 inches, while for Rectangular X – ray beam the dimensions at the skin should be approximately 1½ × 2 inches.

Types of collimators:

1. Diaphragms (round or rectangular shape).
2. Metal cylinders, cones and rectangular tubes.

Diaphragm Consists of a metal plate or disk made from lead with a hole in the center of the disk which allow the beam to pass through it only.

The shape of X – ray beam determine by the shape of the diaphragm hole such diaphragm is placed over the opening in the head of X – ray machine.

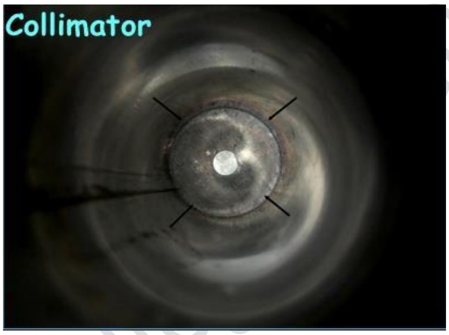


fig 4: collimator attached to the end of tube head

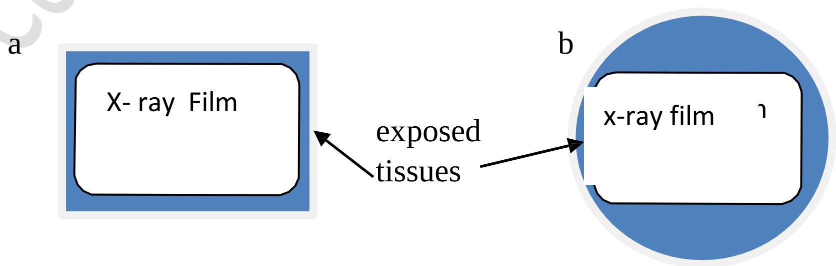


Fig 5: comparison between exposed tissues with (a)rectangular and (b)round collimators

Half – value layer:

It's a method of monitoring the penetration quality of the X – ray beam. Determination of half – value layer is done by placing thin filtering material such as aluminum filter in front of the beam so we continue increase the thickness of filtering material until we have a thickness that reduce the number of X – ray photons in the beam passing through it to (one half) this will representing a half – value layer for such beam of radiation.

High half value layer the high penetrating ability of the beam. In oral diagnosis the acceptable value is approximately 2 mm of aluminum.

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X-ray measuring units:

1. Traditional Units

- Roentgen (R) is the basic unit of radiation exposure for the amount of X-radiation or gamma radiation which will produced in one cc of air ions carrying one electrostatic unit of either sign.
- rad (roentgens absorbed dose) is a measure of the amount of energy absorbed by an organ or tissue.
- rem (roentgens equivalent man) is a measure of the degree of damage caused to different organs or tissues.
- Curie (Ci) : is the unit of quantity of radioactive material and not the radiation emitted by that material.
- RBE: is a relative biological effectiveness dose.

2. International system of units SI Units

- Coulomb per kilogram (C\kg) : 1 C\kg = 3876 R
- Gray (Gy) : 1 Gy = 100 rad
- Sievert (Sv) : 1 Sv = 100 rem
- Becquerel (Bq) : 1 Bq=2.7 *x* 10*11 Ci

Ref. White and Pharaoh's. Oral radiology principles and interpretation. 8th edition 2019.

Radiology

Lec. 2 X – Ray Films د. اريج

Radiograph: Is the image of an object made with use of X- ray instead of light.

Dental x- ray film: Is a recording media on which image of the object was made by exposing this film to X- ray.

Types of X- ray film

a- Intra oral X- ray film.

b- Extra oral X- ray film.

a- Intra oral X- ray film

Chemical composition of X- ray film:

It consists of a sensitized emulsion present on both sides of transparent base.

The base is the foundation of the radiographic film , made from cellulose acetate. Its primary purpose is to provide a rigid structure onto which the emulsion can be coated. Its flexible and fracture resistant to allow easy handling but rigid enough to be placed on the viewer.

The emulsion is the heart of the x-ray film , it's the material with which the x-ray or light photons interact and forming the image. It consists of homogenous mixture of silver halides crystals (mainly silver bromides) suspended in gelatin. The silver bromide crystals are sensitive to both light and X- ray photons.

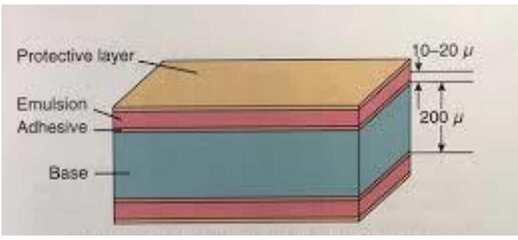


Fig. 1: Diagram showing the cross-sectional structure of radiographic film.

The intra oral film is wrapped by opaque material to prevent light from reaching the film because light photons can activate the silver halides crystals. Also a thin sheet of

(Lead foil) is usually placed behind the film to prevent most of secondary radiation that originated in the tissue of the patient behind the film from reaching it.

Therefore this lead foil reduces secondary radiation and minimizes film fog. In addition the lead foil absorbs X- ray that have passed through the object and the film so it reduce the exposure of the tissue behind the film. This foil has a design of (herring bone pattern).

Fig. 2: The contents of a film packet.

Intra oral film types

Classified on numerical basis into:

A - Type I
Called **periapical** film used to examine the apical area of the tooth and the surrounding structures (record the crowns, roots, and surrounding bone). Film packs come in three sizes

•Size 0 for small children (22 mm × 35 mm)

•Size 1, which is relatively narrow and used for views of the anterior teeth (24 mm × 40 mm)

•Size 2, the standard film size used for adults (30.5 mm 40.5×mm)

So the available sizes are (1.0, 1.1 and 1.2)

B – Type II
Is called **bitewing** film it used to detect the inter proximal caries and the height of alveolar bone between 2 adjacent teeth. Bite-wing films often have a paper tab projecting from the middle of the film on which the patient bites to support the film. Size 2 film is normally used in adults; the smaller size 1 is preferred in children. In small children, size 0 may be used. A relatively long size 3 is also available. So the size include (2.0, 2.1, 2.2 and 2.3)

C – Type III

Is called **occlusal** film that used to demonstrate area larger in dimension than area appearing in periapical film. the size is (3.4) only.

Fig 4: types of x-ray films (manual and self-developing)

Intra oral film speed

Speed means the sensitivity of X- ray film silver bromide crystals (Ag Br) to X- ray photon.

There is direct relation between the speed of the film and the size of the crystals, the larger crystal size the faster film speed. the faster mean it need less amount of radiation to produce radiographic image so less radiation dose absorbed by patient.

The classification of film speed based on alphabetical basis so from A to F, film speed A is the slowest while speed F is the faster one. Only films with a D or faster speed rating are appropriate for intraoral radiography. E/F-speed film is preferred because it requires approximately half the exposure time and thus half the radiation dose of D-speed film. In the United States the most widely used films are ULTRA-speed (D-speed) and INSIGHT (E/F speed).

b- Extra oral film

The purpose of using such film is to make a radiographic image able to examine an area in and around the jaw that can't be seen by intra oral film, such as panoramic , cephalometric and other skull radiograph

Types of extra oral film

1. Screen
2. Non screen

❖ Non screen film

1. Film emulsion is more sensitive to X- ray than to light.
2. The film has double emulsion like intra oral film but the emulsion is thicker.
3. Increased thickness of emulsion make the non screen film need less amount of radiation so it need less exposure time.
4. The size of the film used include: 5×7 and 8×10 inches.

❖ Screen film

1. Film emulsion is more sensitive to visible light and more specifically to blue light in the visible light spectrum.
2. The size include: - 5×7, 8×10 and 10×12 inches.

❖ The screen film placed between 2 fluorescent screen in cassette. These 2 fluorescent screen made from (tiny calcium tungestate crystals). When these crystals exposed to X- Ray , the result of this exposure is a creation of light , this light in turn exposes the screen film to produce the image.

Fig4: screen film

Film properties

These include density, contrast and details or definition.

A. **Density**: Is the degree of blackness present in the processed film it measures in terms of light transmission on a percentage or logarithmic scale.

Film density used in diagnostic radiograph is ranged from 0.25 to 2.

Sensitometry is the study of the relationship between the intensity of exposure of the film and the blackness after film processing.

Film density measured by sensitometer or densitometer, and its relationship with radiation exposure is represented by H & D curve (Hurter and Driffield). the more film exposure to X- ray the blacker it becomes when processed.

The optical density OD of unexposed film are due to base density and fog density (background fog density). The base density is the OD inherent in the film base and its due to the composition of the base and the tint added to it to make the radiograph more pleasing to eye (it's about 0.1), while fog density is related to the development of silver grains that contain no useful information, it results from exposure of film during storage, undesirable chemical contamination, improper processing (should not exceed 0.2).

Factors affect film density

1. Exposure time: increase exposure time increases the film density.
2. Milliampere: increase milliampere value (mA) which is usually ranged from 10 – 15mA, cause increasing film density.
3. Kiolvoltage: increase Kilovoltage value (kV) cause increasing film density.
4. Developing time: developing time usually range from 4 – 5 minutes. increase developing time cause increasing film density.
5. Distance: increase the distance between x- ray tube and the film during exposure cause decrease film density.

B. **<u>Contrast</u>:** It means the graduation of differences in film density at different areas of a radiograph.

Type of contrast:

1. Long – scale or low contrast:- when many different film densities can be seen between totally clear and totally black areas of the radiograph.
2. Short – scale or high contrast:- when few different film densities can be seen between totally clear and totally black areas of the radiograph.

The stepwedge or penetrometer: Is an object used to show the radiographic contrast .it's usually made of aluminum and is constructed so that there is a constant increase in thickness of aluminum between the X- ray tube and the film.

❖ **Factors affect contrast**

1. Kilovoltage: increase kilovoltage cause increase the contrast scale
2. Processing solution temperature: increase the temperature cause decrease of contrast scale.

C. **<u>Details or definition</u>**: Is the ability to reproduce sharp outlines of the object.

Factors affect details

1. Focal spot size: size of focal spot must be as small as possible in order to produce sharp image.
2. Film grain size (film crystals): increase the size of film grain produce less sharp image.
3. Movement of patient head or X- ray tube or the film during exposure causes unsharp image.
4. Target object distance: which should be as great as possible, otherwise the image will be unsharp.
5. Object film distance: should be as small as possible to produce sharp image.
6. Screen – film contacts: poor contact cause un sharp image.

- <u>**What will happen during exposure of X- ray film exposure to radiation?**</u>

x- ray photons interact with electrons of the atoms of the chemical emulsion in the X-ray film so the result is analog image, analog means the image appears identical to the original.

Latent image formation

The Ag Br crystals in the film emulsion are changed whenever they absorb X- ray photons, the result of absorption is precipitation of speck of silver in each exposed Ag Br crystal to X- ray, collectively these specks are called Latent image which is invisible and in order to convert to visible image X- ray film must be processed.

Film processing

Its either manual or automatic processing.

Processing cycle include: Developing, rising, fixing, washing and drying.

- **Developing:** is the stage of processing during which the latent image is converted to a visible image.

X- ray film is placed in alkaline developer solution ,the action of developing agents are on exposed Ag Br crystals to continue the process of precipitating the specks of silver until all silver is deposit at the site of crystal and the bromine is released into the developing solution causing softening of the X- ray film emulsion .

- **Rinsing:** by water for 30s to terminates the developer action and remove chemicals from emulsion.

- **Fixing:** by using a fixer solution .its action is:

1. Re harden the film emulsion
2. Removed all the unexposed or undeveloped crystals.

After fixing the film washed in running water & finally drying.

Dark Room

The darkroom or processing room is a place where the necessary handling and processing of radiographic films can be carried out safely and efficiently without hazard of producing film fog by accidental exposure to light or x-ray. It may exclude all outside light and provides the artificial safelight only.

Size and location of darkroom

Whenever possible oral radiography darkroom should be designed when the dental office is planned and should be convenient and easy to work with.

The **size** of the darkroom depends on the followings:

1.Type & amount of the films to be processed , the greater workload need larger darkroom . Large films need large processing tanks , so it takes more space in the darkroom.

2.Extra space must be provided if more than one person works with ,9sq.ft. for one person is enough but it is advisable to have at least 20 sq. ft. of floor space for average dental office.

While for the **location** of darkroom, many requirements should be taken in consideration:

1. It can be conveniently reached from the rooms where the films exposed & examined.

2.Darkroom should be located where room temperature fluctuates as little as possible because the temperature of the processing solution must kept constant .It should be located in cool part of the clinic .

3. Humidity retards drying of the processed films and damages unused films stored in opened films boxes.

4. The darkroom should be accessible to plumbing & power lines.

5. The darkroom must also be well ventilated to provide a comfortable working environment

❖ Illumination of dark room

1. A ceiling light to provide ordinary illumination in the darkroom , its switch must be placed high enough on the wall to prevent the operator from accidentally turning it on during processing .

2. Safe light , it consist of a filtered light beam .this light is safe only when the correct watt-bulb is used and the fixture is placed at or beyond the recommended distance from the work area.

3. Red warning light which is placed outside the entrance to the room , it should be wired so that it is illuminated whenever the safelight is turned on

Film storage

1.Film must be stored away from excessive heat and humidity.
2.Chemicals must not be allowed to come in contact with stored films.
3.Objects should not be placed on top of stored films because pressure can cause film artifacts.
4.The boxes of stored films should be lead lined or made of steel to prevent stray radiation from fogging the films.

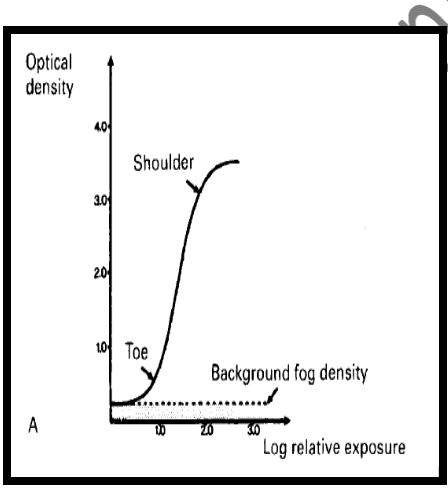


Fig. 5: typical characteristic curve of indirect-action radiographic film, showing the main regions of the curve including background fog density, toe and shoulder.

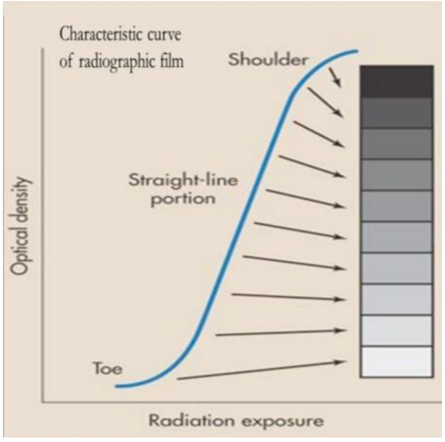


Fig. 6: characteristic curve of radiographic film is the graphic relationship between optical density (OD) and exposure.

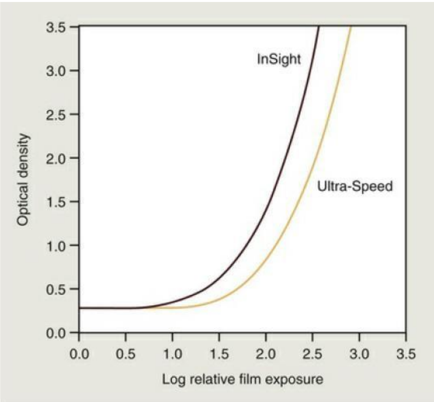


Fig. 7: comparison of speed between insight and ultra-speed film. insight film is faster .

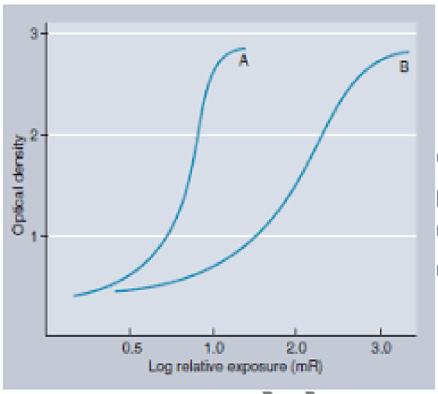


Fig. 8: comparison of contrast between film and B. film A is higher contrast than film (straight-line portion is greater for A).

Ref. White and Pharaoh's. Oral radiology principles and interpretation. 8th edition 2019.

Radiology

Lec. 3 Factors relating to the production of radiograph د.اريج

Topics of lecture:
1. Factors controlling x-ray beam , inverse square low
2. Projection geometry (sharpness, distortion and artifacts)

Radiation Quantity: is the number of x-ray photons in the useful beam. The factors affecting x-ray quantity are :

1. mAs: x-ray quantity is directly proportional to milliamper-seconds.
2. kVp: x-ray quantity is directly proportional to the square of kilovolt Peak.
3. Distance: x-ray quantity varies inversely with distance.
4. Filtration: x-ray quantity is reduced by filtration, which absorb the low- energy photon of the beam.

Radiation Quality: is the penetrating power of the x-ray beam, which is quantified by HVL. The factors affecting x-ray quality are:

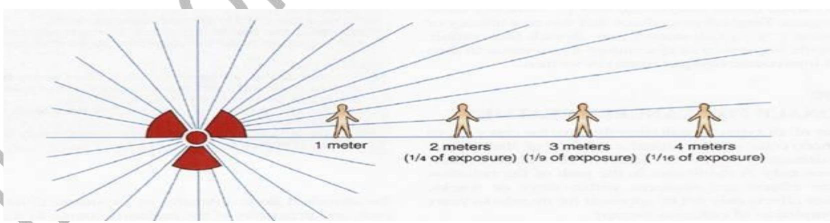
1. kVp: x-ray penetrability is increased as kVp is increased.
2. Filtration: x-ray penetrability is increased when filters added to the beam.

Inverse square law: the low stated that ((the intensity of radiation inversely proportional with the square of distance measured from the source of radiation to the point of measuring the radiation intensity.

I: intensity

D: Distance

$$I \times \frac{(D2)^2}{(D1)^2}$$



Factors relating to the production of radiograph

A/ Factors related to the radiation beam.

B/ Factors related to the object.

C/ Factors related to the X- ray film.

A/ Factors related to the radiation beam.

1. Exposure time: It's the interval during which X- rays are being produced. exposure time is directly related to the total photon production thus increase exposure time cause increase in the quantity of X- radiation that's why exposure time has direct effect on film density.

2. Milliamperage: Its related to amount of electricity pass through the filament circuit. So it's directly control the rates of X- ray photon production thus it has direct effect on film density.

3. Kilovoltage: kV it refers to the potential difference between cathode and anode in the x- ray tube the higher kVp the greater is the potential difference and the greater is the energy of X- ray photons.

4. Tube – film distance: this distance consist of (tube – object distance) and (object – film distance)
   - The tube – film distance affect the intensity of radiation (according to inverse square law
   - The tube – film distance affect the exposure time directly.
   - The distance proportion inversely with the intensity of radiation.
   - The distance affect the dose of radiation because decrease the tube – film distance make the X- ray beam more diverge behind the skin area and more tissue is irradiated. While increase the distance makes the beam less diverges and reduces the amount of tissue irradiated.

5. Focal spot size: the focal spot or called the source of radiation must be as small as possible to get best image quality. So any movement in the head of X- ray machine affect the focal spot size.

6. Collimation: collimator used to control the size and shape of the beam.

Effect of collimation:

- Reduce the amount of tissue irradiated
- Minimize the production of secondary radiation fog.

* **Fog:** is the unwanted film density (blackening) and thus reduce radiographic contrast.

7. Filtration: the effect of filtration is the absorption of long wave length X- ray photons that have low penetrating power (can't penetrate the hard calcified tissue). The result of filtration of X- ray beam is hardened beam (more short wave-length photon with high penetration power) so increase the half – value layer, also increase filtration affect the contrast and density but in different way, the contrast is decreased (long scale) like the effect of increase kV. While the density is decreased because when filtration increase the result is the absorption of not only long wave length photons but even some of short wave length photons so the number of X- ray photons or the quantity of radiation is reduced so the density is reduced.

8. Equipment efficiency: dental X- ray machine differ in construction and efficiency so the quality and quantity of X- ray beam vary from machine to another.

B – Factors relating to the object:

The object is basically an absorbing X- ray medium, so 2 points important about the object during exposure to X- ray:

1. Thickness of the object: Thick object required more radiation to make a radiographic image so it's often advisable to increase kV or mA and /or exposure time in order to increase the amount of X- ray photons.

2. Density of the object: density refers to weight per unit volume of the object . In dental radiography enamel of the tooth has highest density of all body tissues. increase the density of the object increase its ability to absorb X- radiation. So hard tissue like enamel absorb great amount of radiation when compared with absorption of soft tissue like pulp because of object density.

C – Factors relating to the X- ray film:

1. **Reduction of secondary radiation:**

Secondary radiation include scattered, stray leakage or any other radiation that not belong to primary X- ray . Secondary radiation is un desirable because it reaches all parts of the film and produces film fog. Several ways to minimizing this radiation like:-

- Using as small beam of radiation as possible.
- Proper collimation.
- In intra oral film a sheet of lead foil is placed behind the film in the film packet.
- In extra oral film a grid is placed between the object and the film. The grid is an extremely effective device for reducing the amount of scattered radiation that exiting an object and reaching the film. Its composed of alternating strips of a radiopaque material (usually lead) and strips of radiolucent material (often plastic). so the grid transmit only those x-rays whose direction is on straight line from the source to the film (image receptor) and absorb the remnant scattered radiation.

2. **Film and film storage:**

X- ray film must stored in light - tight containers because the Ag Br Crystals in the emulsion are sensitive to light as well as to X- ray. Also film must stored in lead - lined box to keep the films away from the stray radiation, also stored in place away from excessive temperature or humidity and we should used it before the expiration.

3. Intensifying screen:

Is a device that convert the energy of x-ray beam into visible light, which interact with x-ray film and forming the latent image. Intensifying screen used in extra oral film to reduce patient dose by converting the x-ray to light so one x-ray photon give rise to many light photons, the number of x-rays required to produce the same density on the film is markedly reduced.

4. Film processing:

The latent image is formed when silver halide grains are exposed to x-ray, then only the exposed grain will form the visible image by development. while the unexposed grains removed from emulsion by fixing and make a permanent image.

As mentioned in previous lecture, its either automatic or manual steps, the automatic processing is preferred because it faster and resulted in better image quality.

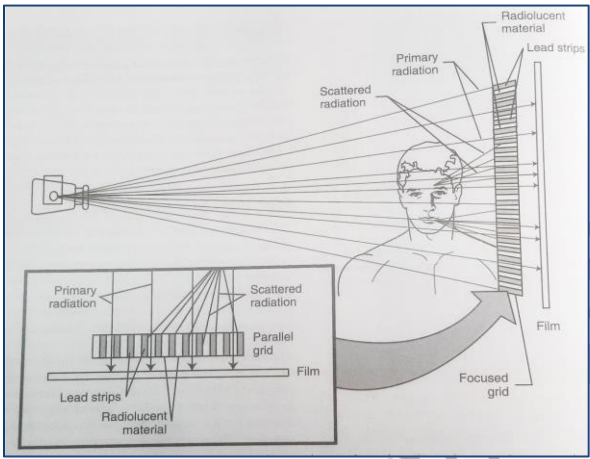


Fig. 1: extra oral grid demonstrating the lead strips and the scattered radiation elimination.

Ideal radiographic projection

The term image quality describes the subjective judgment by the clinician of the overall appearance of a radiograph. It depends on density, contrast, latitude, sharpness, resolution and other factors. Ideal radiograph demonstrates certain image qualities include:

A – Radiographic image that is sharp.

B – Radiographic image that is shaped like the object.

C – Radiographic image that is the same size as the object.

- ❖ **Sharpness :** is the ability of radiograph to define an edge precisely (like Dentino-enamel junction)
- ❖ **Image Size Distortion (magnification)** is the increase in size of the image on the radiograph compared with the actual size of the object**.**
- ❖ **Penumbra:** Is the amount of un sharpness of the image so penumbra is the area of partial shadow.
- ❖ **Umbra:** Is the area of total shadow and it exist only when the object absorb all of X – rays.

Penumbra is created by the size of focal spot (source of radiation), the larger the spot size the greater is the penumbra (the amount of un sharpness). penumbra not only affected by focal spot size but also affected by tube – object distance and object – film distance so the closer tube – object distance the greater is the penumbra while the closer object – film distance the lesser is the size of penumbra.

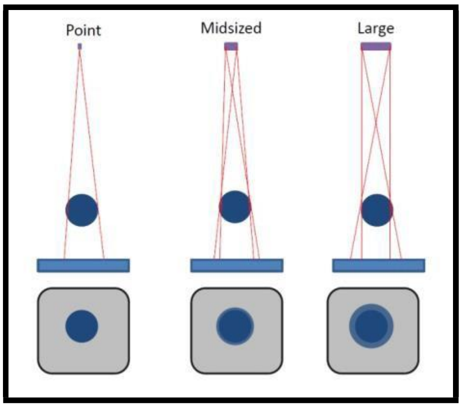


Fig. 2: effect of focal spot size on penumbra and umbra

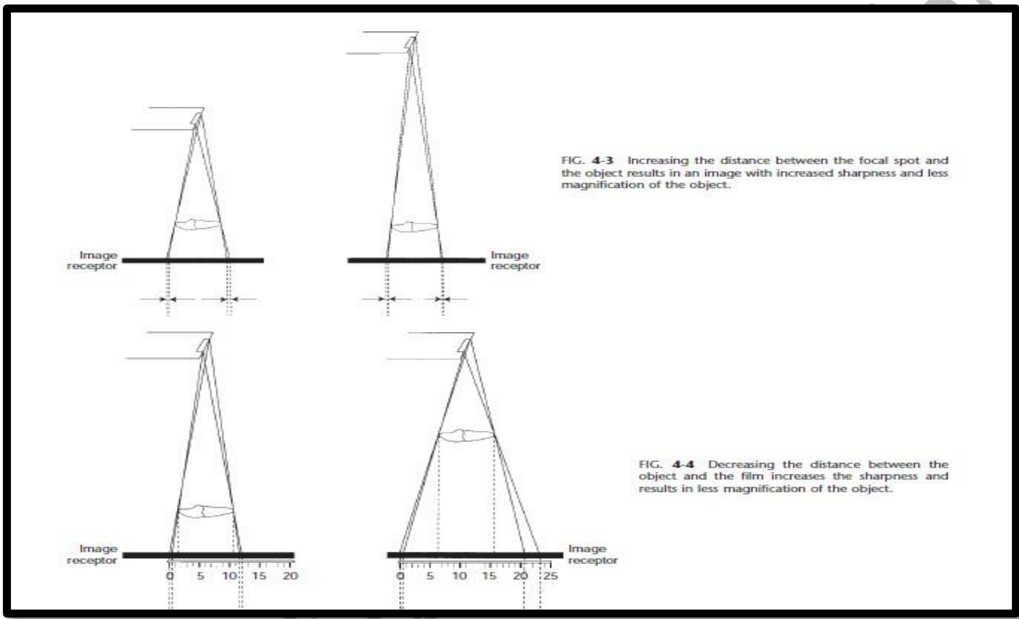


Fig. 2: effect of tube-object distance and object –film distance on umbra and penumbra.

Basic Principles of Projection Geometry for Radiography

1. Source of radiation should as small as possible.
2. Tube – object distance should be as great as possible.
3. Object – film distance should be as small as possible.
4. Film should be parallel to an easily identifiable plane of the object.
5. Central ray of the beam should be perpendicular to the film.

The first 3 principles deal with the image sharpness while the last 2 principles required during exposure as a technique.

Radiographic errors and Artifacts:

Classified into three categories:

A. **Technique and projection errors**
B. **Exposure errors**
C. **Processing errors**

1. **Cone cut**: is clear unexposed area result from positioning fault when the X- ray beam not completely cover the film during exposure.
2. **Back side exposure**: when the film placed in wrong position making the non-exposure side facing the beam, the result is the image with the pattern of the lead foil is evident.
3. **Double exposure**: when same film used and exposed twice to X- ray this result in excessive dense and blurred image .
4. **Elongated image**: vertical angulation of X- ray tube was too shallow.
5. **Shortened image**: vertical angulation was too steep.
6. **Over lapping of adjacent structures**: when horizontal angulation was incorrect.

Horizontal and vertical angulations

- Horizontal angulation: refers to X-ray beams direction in a horizontal plane.
- Vertical angulation: refers to X-ray beam direction in a vertical plane.

Plus vertical angulation: when the beam is tipped down ward

Minus vertical angulation: when the beam is tipped upward.

7. **Blurred film**: due to excessive bending of the film during placement for exposure.
8. **Pale X- ray film**: this due to either under exposure, or under developing.
9. **Dark X- ray film**: this is due to either over exposure or over development .
10. **Completely clear film**: when put the film in fixer before developer. or when the film didn't receive radiation
11. **Undeveloped area**: this appear as clear area caused by incomplete immersion of the film in developer (sometimes called developer cut-off) or sticking the film in the developer to the side of the tank.
12. **Scratched film**: when the film is processed in manual processor, the soft emulsion is easily scratched due to rough handling of the film , ex. scratched by holder, tank or nails.
13. **Developer spot**: black dots or dark spots on the film caused by drops of developer solution that was accidently spilled on the film before it was developed.
14. **Fixer drop**: white dots or light spots on the film caused by drops of fixer solution that was accidently spilled on the film before it was developed.
15. **Yellow or brown stain**: stain or discoloration of film due to contaminated solution or insufficient rinsing.

Cone cut

back side exposure

double exposure

Elongation

shortening

overlapping

Blurred image

Pale film

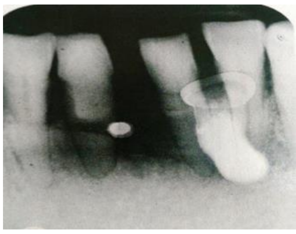
dark film

undeveloped area

scratched film

developer spot

Developer spot (occlusal film)



fixer spot

complete clear film

yellow or brown discoloration

Ref. White and Pharaoh's. Oral radiology principles and interpretation. 8th edition 2019.

Radiology

Lec. 4 Biological effects of radiation Dr. Areej

Topics of lecture:

1. Biological effects of radiation (direct and indirect effects, deterministic and stochastic effect)
2. Safety and protection (for patients and operators)

Types of radiation

1. Non-Ionizing Radiation: Radiation that does not have sufficient energy to dislodge orbital electrons. ex.: microwaves, ultraviolet light, lasers, radio waves, infrared light, and radar.
2. Ionizing Radiation: Radiation that has sufficient energy to dislodge orbital electrons. ex.: alpha particles, beta particles, neutrons, gamma rays, and x-rays.

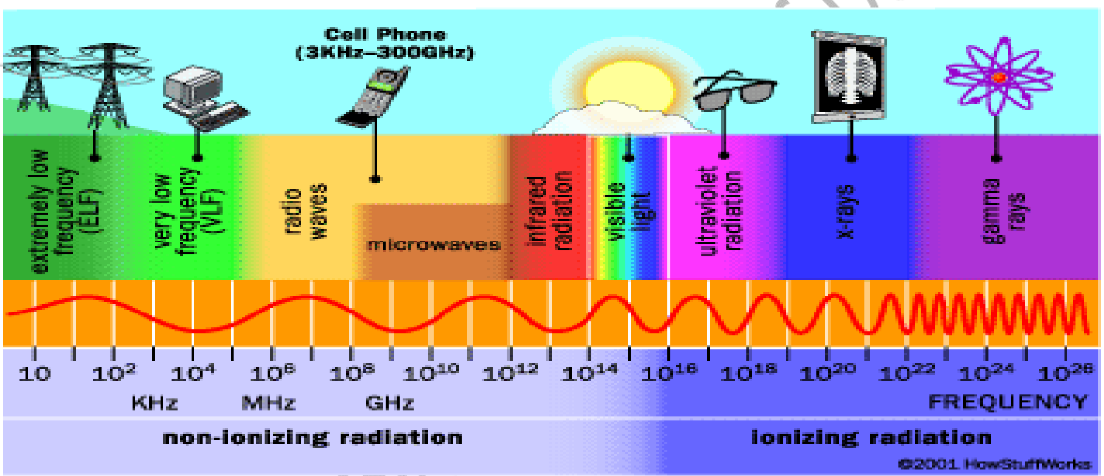


Fig. 1: types of radiation

All the atoms in human body has electrical stability when x- ray photon strikes a – ve electron in the atom of living subjects (tissues) it displace the electron leaving the atom electrically unbalance so the atom ionized such process called (ionization), this ionized atom has a strong tendency to seek its stability by accepting a –ve electron from somewhere else and by doing so a new chemical is form and the cell of which the atoms and molecules are parts can be altered. So that the basic effects of ionization are Molecular alteration and creation of new chemicals.

Radiation biology is the study of the effects of ionizing radiation on living systems. The initial interaction between ionizing radiation and matter occurs at the level of the electron within the first 10-13 second after exposure. These changes result in modification of biologic molecules within seconds to hours. In turn, the molecular changes may lead to alterations in cells and organisms that persist for hours, decades, and possibly even generations. They may result in injury or death of the cell or organism.

Effects of ionizing radiation

Radiation acts on living systems through direct and indirect effects

1. **Direct effect:** When the energy of a photon or secondary electron ionizes biologic macromolecules, the effect is termed direct. Those effects occurred in specific area of the body where all exposed cells in this area are altered directly by ionization process and death occurred at the time of mitotic cell division.
2. **Indirect effect:** It happened in several ways where new chemicals result from process of ionization are in compatible with body tissues ,ex: when photon absorbed by water in an organism, ionizing the water molecules. The resulting ions form free radicals (radiolysis of water) that in turn interact with and produce changes in the biologic molecules. Because intermediate changes involving water molecules are required, so conversion of water to H_2O_2 which cause cellular dysfunction also x-radiation can alter the chemical composition of hormones enzymes and other body secretions make them partially or totally in effective such indirect effects depend on the amount of exposure to X- ray. This series of events is termed indirect.

Fig. 2: ionizing radiation symbol

What are the stochastic and deterministic effects of radiation?

Comparison of Stochastic and Deterministic Effects of Radiation

	Stochastic Effects	Deterministic Effects
Caused by	Sublethal DNA damage	Cell killing
Threshold dose	No	Yes
	There is no minimum threshold dose. Effect can be caused by any dose of radiation	Effect occurs only when the threshold dose is exceeded
Severity of clinical effects and dose	Severity of clinical effects is independent of dose; all-or-none response—an individual either manifests effect or does not	Severity of clinical effects is proportional to dose; the higher the dose, the more severe the effect
Relationship between dose and effect	Frequency of effect proportional to dose; the higher the dose, the higher the risk of manifesting the effect	Probability of effect independent of dose; most individuals manifest effect when threshold dose is exceeded
Caused by doses used in diagnostic radiology	Yes	No
Examples	Radiation-induced cancer	Osteoradionecrosis
	Heritable effects	Radiation-induced cataract formation
	Radiation-induced skin cancer	Radiation-induced skin burns

Radio sensitivity of tissues and organs

Body tissues differ in their susceptibility to ionizing radiation. Cells are most sensitive to radiation when they are immature, undifferentiated, and rapidly dividing. As cells mature and become specialized they are less sensitive to radiation. The following tissue and organs are **listed in order to their susceptibility to x-ray**:

1.high radio sensitivity: lymphoid organs , Blood forming tissues (bone marrow), intestines , stem cells, lymphocyte and reproductive cells

2.intermediate radio sensitivity: Young or growing bone, Growing cartilage, glandular tissue , salivary glands , kidney, liver, lungs and epithelium of alimentary canal.

3. low radio sensitivity: Skin , muscle and optic lens.

4. the least effect seen in nerve tissue and adult bone.

Short term effects of radiation on tissue seen in the first days or weeks after exposure while long term effects seen months and years after exposure.

ALARA principle **(The law of radiation protection)** **A**s **L**ow **A**s **R**easonably **A**chievable: Radiographs should only be taken at the minimum dosage with reasonable information, so the benefit from radiograph should be weighed against the radiation dose and then decide to take radiograph or not.

Latent period: Is a period of time interposed between exposure and clinical symptoms such period varies with the dose. So the more is sever dose the shorter is the latent period. sometimes the latent period is as long as 25 years for some minimum doses.

Protection of patients from x-ray:

The dentist is responsible for all aspects of safe radiation exposure in the dental office. This done by several ways:

1. Using faster (film speed) because the faster the film the less is the amount of radiation required to produce a radiographic image so it need less exposure time.
2. Collimation: - this done by collimating device to prevent the un necessary beam divergence, especially rectangular collimator.
3. Filtration:- in order to absorb the long wave length X-ray photons (soft radiation) which have no diagnostic value.
4. Exposure and developing techniques: - in order to prevent exposure of patient to much more radiation, we should know the exposure time for each segment of the jaw. So for anterior teeth the exposure time is 0.36 seconds for premolars is 0.40 seconds while for molars is 0.50 seconds if higher Kv. technique is used, its possible to use a constant exposure time for whole dentition.

* exposure time required for child and old people may have be decreased as much as 50% while exposure time required for dense and thick objects may have to be doubled. Some time when we use excessive long exposure time we have to decrease the developing time to get acceptable quality of radiographic image

5. Distance and kV:- the purpose of using cylinders and cones in the X-ray machine is to [limit the path for X-ray] so X-ray beam hit only the examined area we have 2 cone length (8and 16 inches) the long cone mean increase tube film distance and when use higher kV With this cone we reduce the radiation dose absorbed by skin surface.

6. Film placement and angulations:- this is important to prevent retakes and get a radiograph with best diagnostic information.
7. Lined cylinder: - sometime lining the open cylinder by sheet of lead foil with 0.2 – 0.3 mm thickness result in elimination of scattered radiation.
8. Protective apron and thyroid collar: - sheet of lead used to cover chest and reproductive areas of the patient so must be used in pregnant and young adult also thyroid collar used for protection of thyroid gland. (lead apron used by operator also for protection).
9. Using intensifying screen in extraoral film to reduce radiation dose to patients.
10. Using digital radiography that provide Dose reduction of up to 90 per cent compared to E-speed film .

Protection of operator and dose limits:

Operator received secondary radiation and generally workers in X-ray clinic should not receive more than 5 rem of whole body radiation each year.

Operator received 3 types of radiation (source of exposure):

1. Scattered radiation from the patient.
2. Primary beam if he stands in its path.
3. Leakage radiation from the tube head.

To minimize the exposure of operator:

1. Position: operator must stand behind the patient because the head of the patient will absorb scattered radiation operator must stand with an angle of 90 - 135˚ to the radiation beam because in this area we have less scattered radiation.
2. Barrier: it interpose between the source of radiation and the operator it is the most effective method of providing safety to the operator and barrier is made of lead or steel or concert or barium plaster of 1/16 inch.
3. Distance: the intensity of radiation inversely proportional to the distance (inverse square law) so it's recommended for him to stand 6 feet away from the source of X-ray radiation.

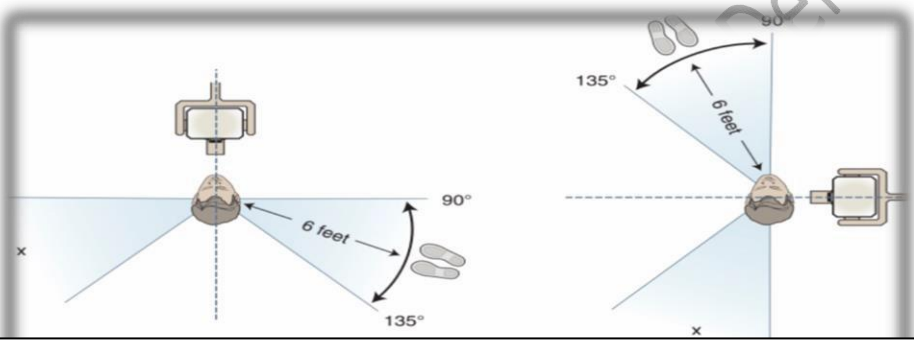


Fig 3: * position and distance rule: if no barrier is available, the operator should stand at least 6 feet from the patient, at an angle of 90 to 135 degrees to the central ray of the x-ray beam when the exposure is made.

Film badges

Is a blue plastic frame containing a variety of metal filters and a small radiographic film which exposed to X-ray. it provide a permanent record of the dose received by operators (radiographers and dentists) and it used for 1 – 3 months before being processed for monitoring of dose received by operator.

Fig 4: film badge

Typical Effective Dose From Radiographic Examinations

Examination	Median Effective Dose	Equivalent Background Exposure[a]
Intraoral[b]		
Rectangular collimation		
Posterior bite-wings: PSP or F-speed film	5 µSv	0.6 day
Full-mouth: PSP or F-speed film	40 µSv	5 days
Full-mouth: CCD sensor (estimated)	20 µSv	2.5 days
Round collimation		
Full-mouth: D-speed film	400 µSv	48 days
Full-mouth: PSP or F-speed film	200 µSv	24 days
Full-mouth: CCD sensor (estimated)	100 µSv	12 days
Extraoral		
Panoramic[b]	20 µSv	2.5 days
Cephalometric[b]	5 µSv	0.6 day
Chest[c]	100 µSv	12 days
Cone beam CT[b]		
Small field of view (<6 cm)	50 µSv	6 days
Medium field of view (dentoalveolar, full arch)	100 µSv	12 days
Large field of view (craniofacial)	120 µSv	15 days
Multidetector CT		
Maxillofacial[b]	650 µSv	2 months
Head[c]	2 mSv	8 months
Chest[c]	7 mSv	2 years
Abdomen and pelvis, with and without contrast[c]	20 mSv	7 years

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Ref. of lecture: White and Pharaoh's. Oral radiology principles and interpretation. 8th edition 2019.

Radiology

Lec. 5 Intra oral radiographic techniques Dr.Areej

This lecture discuss the intraoral projections (periapical, bitewing and occlusal radiography)

- **Periapical radiography**

Indications:

1. Detection of apical infection.
2. Assessment of periodontal status after trauma to the teeth and alveolar bone
3. Assessment of presence and position of un-erupted teeth.
4. Assessment of root morphology.
5. During endodontic.
6. Bone evaluation in pre surgical implant insertion.

There are two commonly used intra oral techniques

a/ Bisecting technique: Is the older and the easier of the two techniques.

b/ Parallel technique: It was originally developed by MC Cormack. The result of this technique is superior to those of bisecting one.

Theory of parallel technique

It called so because film and the tooth must be parallel to each other. The requirements of this technique are:-

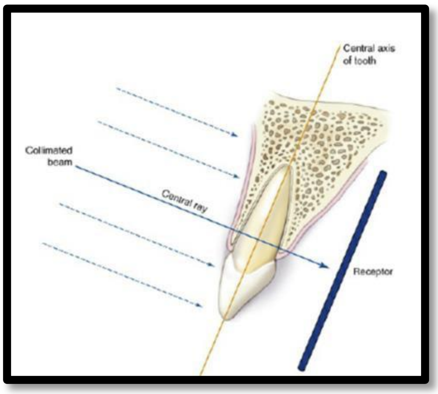
1. It requires the target object distance as long as possible and practical.
2. It requires the X-ray strike the object (tooth) and the film at right angle (90˚).
3. It requires the film to be placed in a position parallel with the plane passing through the long axis of all teeth being examined.

The last requirement necessitates fairly wide separation of the tooth and the film, which produce considerable distortion (magnification) if the short target – object distance were employed. However, the use of extended long cone of 16 inches will increase the target – object distance and compensates for the distortion and un sharpness that result from increasing object – film distance.

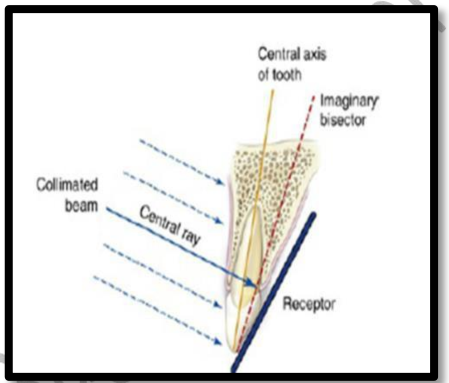
Theory of bisecting technique

1. Operator envisions an imaginary bisector of the angle formed by the long axis of the tooth and the long axis of the film, this angle is formed where the film contacts the tooth crown.
2. Operator direct the central ray of the beam through the apex of the tooth so central ray strikes the bisector at 90˚ , such angulations if properly employed results in a tooth image that is exactly the length of the object.

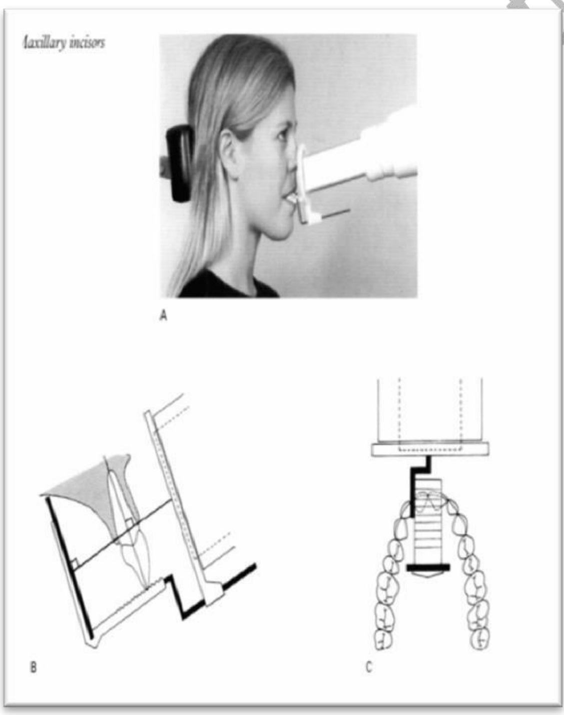
In this technique, as a result of lack of parallelism between the tooth and the film since the film is in contact with the tooth crown, we have all the areas below the apex of the tooth as well as above are distorted and the degree of distortion can reduced by the use of long cylinder because the longer distance between the source of radiation and the object the more is the parallel will be the rays.

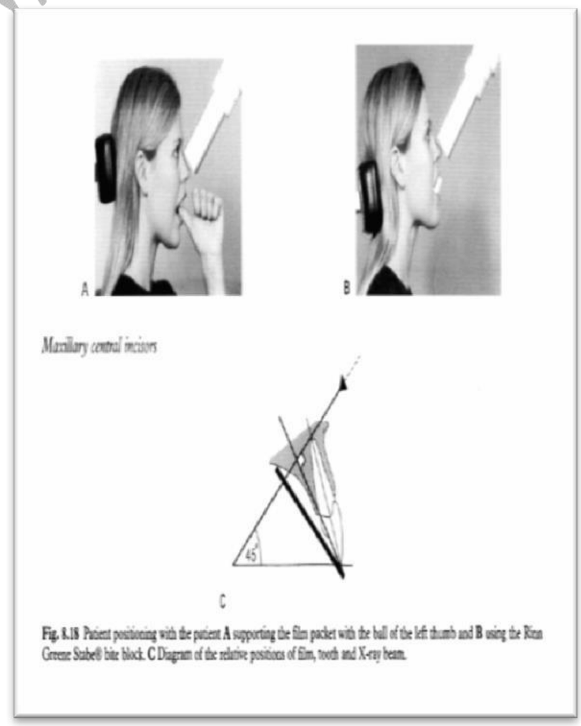


Parallel technique



Bisecting technique





Comparison between parallel and bisecting techniques

Identification dot: It's a round raising dot present in the corner of each film, allows rapid and proper film orientation and placement . The manufacturer orients the film in the packet so that the convex side of the dot is toward the front of the packet and faces the source of radiation. During film exposure , the film oriented to place the dot 2-3 mm away from the incisal or oclussal surface.

Horizontal and vertical angulations

1. **Horizontal angulation**: refers to X-ray beams direction in a horizontal plane.
2. **Vertical angulation:** refers to X-ray beam direction in a vertical plane.

Plus vertical angulation: when the beam is tipped down ward

Minus vertical angulation: when the beam is tipped upward.

❖ Film placement and angulations for periapical films:

The anatomical area and the apex of the tooth under investigation should be shown, as well as 2-3mm of surrounding bone to enable an assessment of apical anatomy.

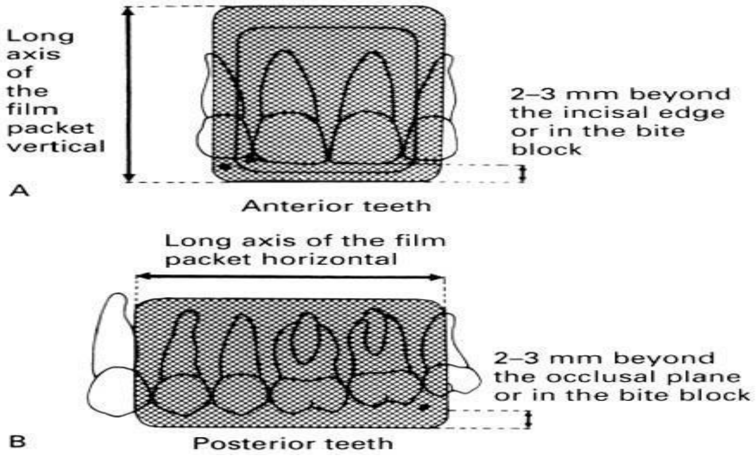
Angulations guidelines for bisecting angle projections

projection	Maxilla	mandible
Incisors	+ 40 degree	- 15 degree
Canines	+ 45 degree	- 20 degree
Premolars	+ 30 degree	- 10 degree
Molars	+ 20 degree	- 5 degree

*when occlusal plane is oriented parallel with the floor

The point of entry of central ray for each tooth

Area	Point of entry
central incisors	Direct the central ray high on the lip, in the **midline,** just below the septum of the nostril
lateral incisors	Orient the central ray to enter high on the lip about **1 cm** from the midline
canine	The point is at about the intersection of the distal and inferior borders of the **ala** of the nose.
premolars	This point is usually **below the pupil** of the eye
molars	should be on the **cheek below the outer canthus of the eye**



Diagrams showing the general requirements of the film packet position (periapical film) for A anterior and B posterior teeth.

❖ Film placement and angulations for bitewing films:

Bitewing X-ray film used to show the inter proximal caries and visualize the periodontal condition, in adult we need 2 bitewing film on each sides of the jaw at premolar and molar area while in children of 12 years old we need one film on each side.

* Patient is positioned with the occlusal plane horizontal and the tab of the film placed on the occlusal surfaces of lower teeth ask the patient to close the teeth firmly together on the tab the beam is aimed directly through the contact areas at right angles to the teeth and film in horizontal plane and at approximate 5˚ - 8˚ downward in vertical plane.

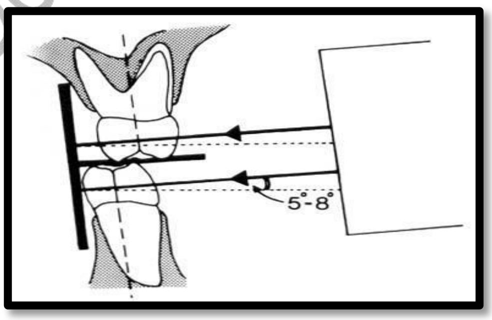


Diagram showing the ideal film packet position and the approximate 5°-8° downward vertical angulation of the X-ray beam compensating for the curve of Monson

❖ Occlusal film projection:

Diagnostic Objectives of Occlusal Radiography

1. To locate supernumerary, un erupted, and impacted teeth
2. To localize foreign bodies in the jaws and floor of the mouth

3. To identify and determine the full extent of disease (e.g., cysts, osteomyelitis, malignancies) in the jaws, palate, and floor of the mouth
4. To evaluate and monitor changes in the midpalatal suture during orthodontic palatal expansion .
5. To detect and locate sialoliths in the ducts of sublingual and submandibular glands

Types of occlusal projection

1. Maxillary occlusal projections
2. Mandibular occlusal projections

Maxillary occlusal projections include:

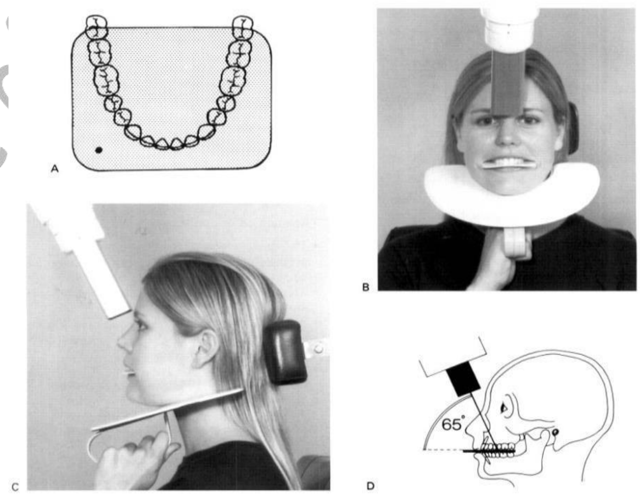
a- Upper standard occlusal
b- Upper oblique occlusal
c- Vertex occlusal.

A - Upper standard occlusal

This projection shows the anterior part of maxilla and upper anterior teeth.

The technique:

1. Patient position where the occlusal plane horizontal and parallel to the floor.
2. Film placed on to the occlusal surfaces of lower teeth and patient asked to bite together gently the film place centrally in the mouth (the long axis crossways).
3. X-ray tube positioned above the patient in the midline directed downward through the bridge of the nose at 65˚ - 70˚ to the film packet.



B – Upper oblique occlusal

This projection shows the posterior part of maxilla and the upper posterior teeth.

The technique:

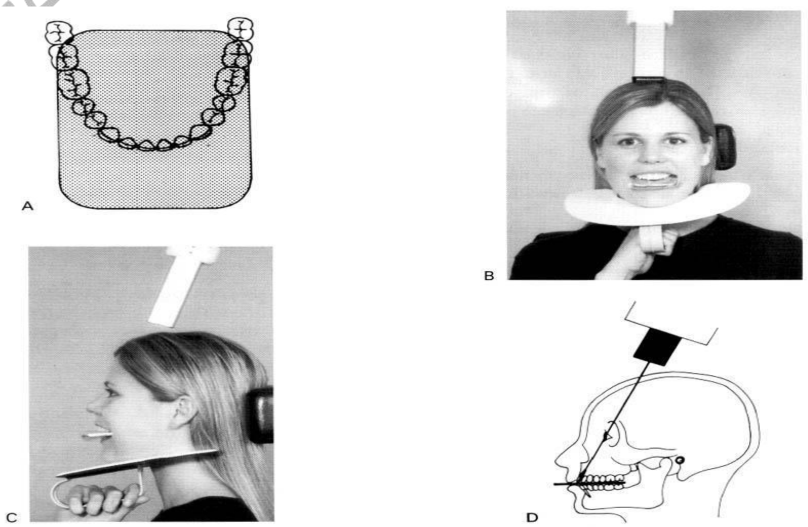
1. Patients position where the occlusal plane horizontal and parallel to the floor.
2. Film placed on the occlusal surfaces of lower teeth with long axis anterior posterior it placed to the side of the mouth under examination and patient asked to bite gently.
3. X-ray tube positioned at the side of patients face directed downwards through the cheek at 65 - 70˚ to the film.

C- Vertex occlusal:

This projection shows a plan view of teeth bearing area of maxilla from above to assess the bucco - palatal position of un erupted canines.

The technique:

1. The patient is seated with occlusal plane horizontal and parallel to the floor.
2. The film placed on the occlusal surfaces of lower teeth with its long axis anteroposteriorly and patient asked to bite on to it.
3. X-ray tube is positioned above the patient in the midline directed downwards through the vertex of the skull.



Mandibular occlusal projection:

a/ Lower 90˚ occlusal (true occlusal).

b/ Lower standard occlusal.

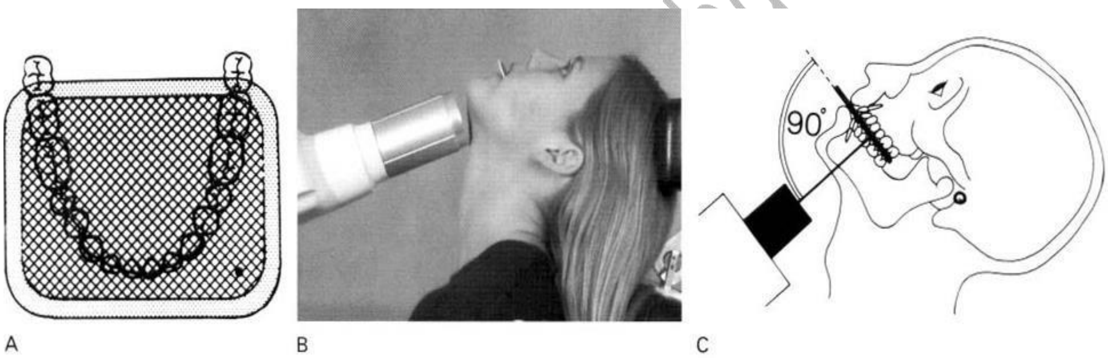
c/ Low oblique occlusal.

a/ Lower 90˚ occlusal (true occlusal):

This projection used to show a plan view of the tooth bearing area of mandible and the floor of the mouth.

* **The technique:**

1. Patient tips his head backward as far as comfortable, where it is supported.
2. The film placed centrally into the mouth on the occlusal surfaces of lower teeth with long axis crossways and patient bite gently on the film.
3. X-ray tube placed below the patients chin in midline centering on imaginary line joining the first molar at 90˚ to the film.

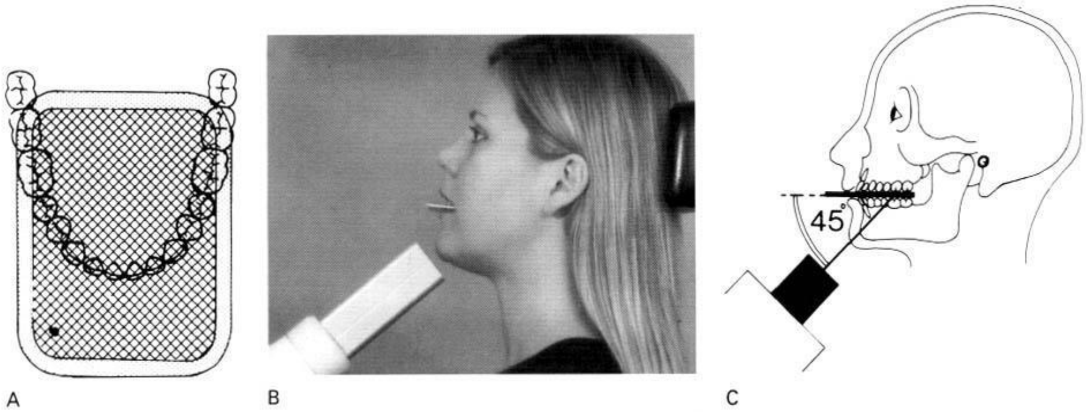


b/ Lower standard occlusal:

This projection is taken to show lower anterior teeth and anterior part of mandible.

*** Technique:**

1. Patient is seated with the head supported and occlusal plane horizontal and parallel to the floor.
2. Film placed centrally into the mouth and the long axis anterioposterior then asks him to bite on the film gently.
3. X-ray tube positioned in midline centering through the chin point at 45˚ to the film.

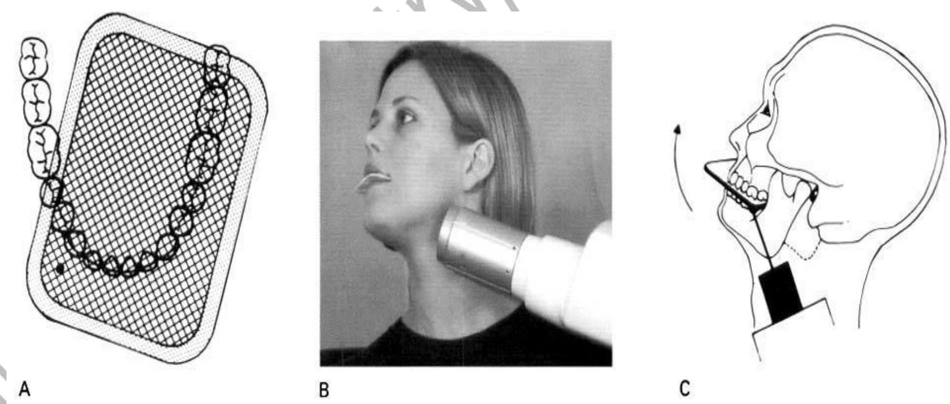


Lower oblique occlusal:

This projection shows the submandibular salivary gland on the side of interest.

* **The technique:**

1. Patients head is supported and rotated away from the side under investigation and raised.
2. The film placed on occlusal surfaces of lower teeth over to the side under investigation with long axis anterior posteriorly then he bite on the film gently.
3. X-ray tube directed upwards and forwards toward the film from below and behind the angle of mandible and parallel to the lingual surface of the mandible.



Ref. of lecture: White and Pharaoh's. Oral radiology principles and interpretation. 8th edition 2019.

Oral Radiograph Anatomical landmarks

Asst. prof

Zainab hasan AL-Ghurabi

A number of **anatomic landmarks** are visible in dental radiographs.

Knowledge of the location and normal appearances of these landmarks is important in identification and orientation of radiographs.

This knowledge is valuable to the dental officer in determining whether the area is normal or abnormal.

Radiolucent vs. Radiopaque

Structures that are cavities, depressions or openings in bone such as a sinus, fossa, canal or foramen will allow x-rays to penetrate through them and expose the receptor (dental film).

These areas will appear **radiolucent or **black** on radiographic images.

Structures that are bony in origin absorb or stop the penetration of the x-rays and, therefore, do not reach the receptor.

These areas appear **radiopaque or **white** on radiographic images. **Some structures partially absorb radiation and are represented in varying degrees of radiopacity**.

NORMAL TOOTH ANATOMY

Tooth structures that can be viewed on dental images include the following: enamel, dentin, the dentino-enamel junction, and the pulp cavity.

****Cementum is not usually apparent radiographlly because cementum layer is so thin.

Enamel is the densest structure found in the human body.

Enamel is the outermost **radiopaque** layer of the crown of a tooth

Dentin is found beneath the enamel layer of a tooth and surrounds the pulp cavity .

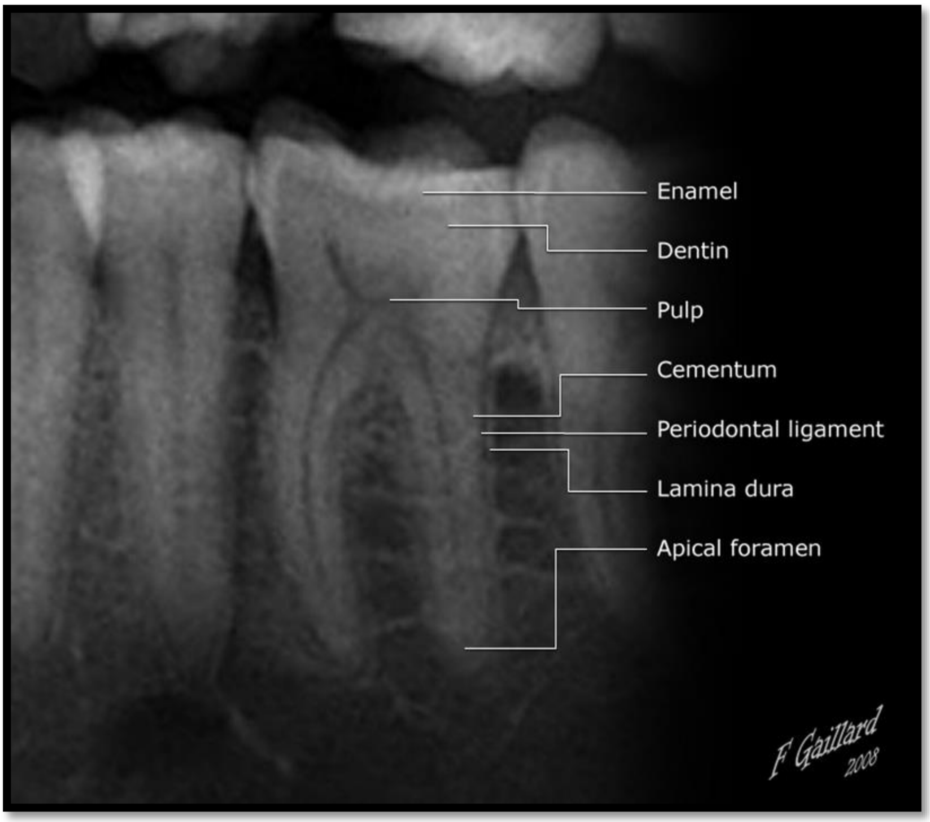
Dentin appears **radiopaque** and makes up the majority of the tooth structure.

Dentin is not as radiopaque as enamel.

Dentino-Enamel Junction (DEJ) is the junction between the dentin and the enamel of a tooth.

The DEJ appears as a line where the enamel (very radiopaque) meets the dentin (less radiopaque) .

Pulp Cavity The pulp cavity consists of a pulp chamber and pulp canals. It contains blood vessels, nerves, and lymphatics and appears relatively **radiolucent** on a dental image



Supporting Structures

The alveolar process, or alveolar bone, serves as the supporting structure for teeth.

Anatomy of Alveolar bone The anatomic landmarks of the alveolar process include the **lamina dura**, the **alveolar crest**, and **the periodontal ligament space** .

Lamina Dura Description. The lamina dura is the wall of the tooth socket that surrounds the root of a tooth.

The lamina dura is made up of dense cortical bone.

Appearance. On a dental image, the lamina dura appears **as a dense radiopaque line that surrounds the root of a tooth** .

Alveolar Crest Description. The alveolar crest is the most coronal portion of alveolar bone found between teeth.

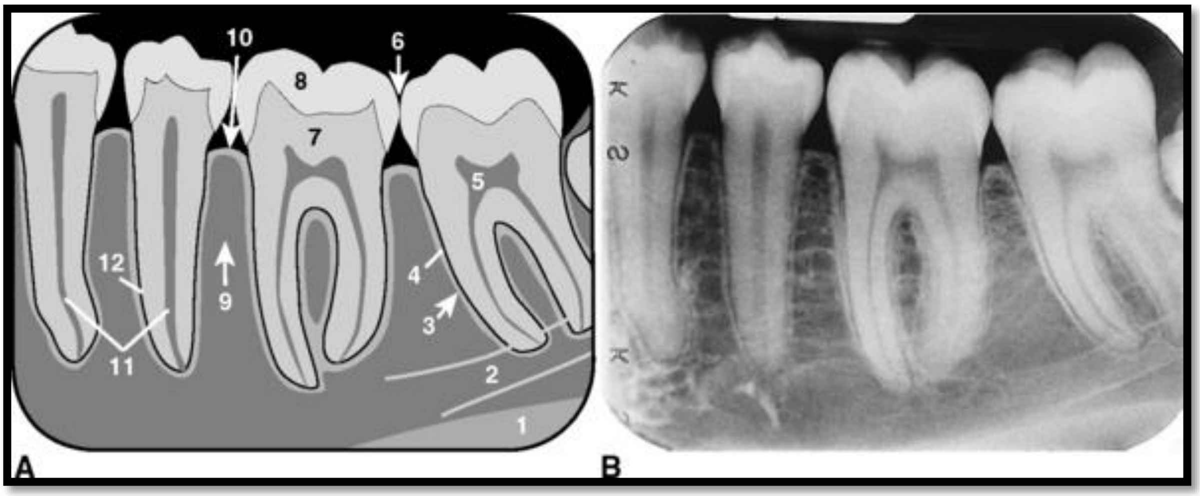
The alveolar crest is made up of dense cortical bone and is continuous with the lamina dura.

Appearance. On a dental image, the alveolar crest appears **radiopaque** and is typically located 1.5 to 2.0 mm below the junction of the crown and the root surfaces (the cementoenamel junction).

Periodontal Ligament Space Description. The periodontal ligament space (PDL space) is the space between the root of the tooth and the lamina dura. The PDL space contains connective tissue bers, blood vessels, and lymphatics.

Appearance. On a dental image, the PDL space **appears as a thin radiolucent line around the root of a tooth**.

In the healthy periodontium, the PDL space appears as a continuous radiolucent line of uniform thickness.



10=Alv. Cresrt

3=lamina deura

4=PDL

Types of Bone

The composition of bone in the human body can be described
as either **cortical or cancellous**

Cortical bone, also referred to as compact bone, is the dense outer layer of bone

Cancellous bone (also called trabecular bone) is the soft, spongy bone located between two layers of dense cortical bone the trabeculae in the **anterior maxilla** are typically thin and numerous in the **posterior maxilla** the trabecular pattern is usually quite similar to that in the anterior maxilla, although the marrow spaces may be slightly larger.

In the **anterior mandible** the trabeculae are somewhat thicker than in the maxilla, resulting in a coarser pattern, with trabecular plates that are oriented more horizontally

In the **posterior mandible** the periradicular trabeculae and marrow spaces may be comparable to those in the anterior mandible but are usually somewhat larger.

Some terms of dental radiographs

Prominences of Bone

Prominences of bone are composed of dense cortical bone and appear radiopaque on dental images.

***Process**: A marked prominence or projection of bone; an example is the coronoid process of the mandible

***Ridge**: A linear prominence or projection of bone; an example is the external oblique ridge of the mandible.

***Spine**: A sharp, thorn-like projection of bone; an example is the anterior nasal spine.

***Tuberosity**: A rounded prominence of bone; an example is the maxillary tuberosity

Spaces and Depressions in Bone

Spaces and depressions in bone do not resist the passage of the x-ray beam and appear radiolucent on dental images.

Four terms can be used to describe the spaces and depressions in bone viewed in maxillary and mandibular periapical images, as follows:

Canal: A tube like passageway through bone that contains nerves and blood vessels; an example is the mandibular canal

Foramen: An opening or hole in bone that permits the passage of nerves and blood vessels; an example is the mental foramen of the mandible.

Fossa: A broad, shallow, scooped-out or depressed area of bone; an example is the submandibular fossa of the mandible.

Sinus: A hollow space, cavity, or recess in bone; an example is the maxillary sinus

Miscellaneous Terms

Two other general terms can be used to describe normal landmarks viewed on a dental image, as follows:

Septum: A bony wall or partition that divides two spaces or cavities. An example is the nasal septum.

Suture: An immovable joint that represents a line of union between adjoining bones of the skull. An example is the median palatine suture of the maxilla

Normal anatomical landmarks

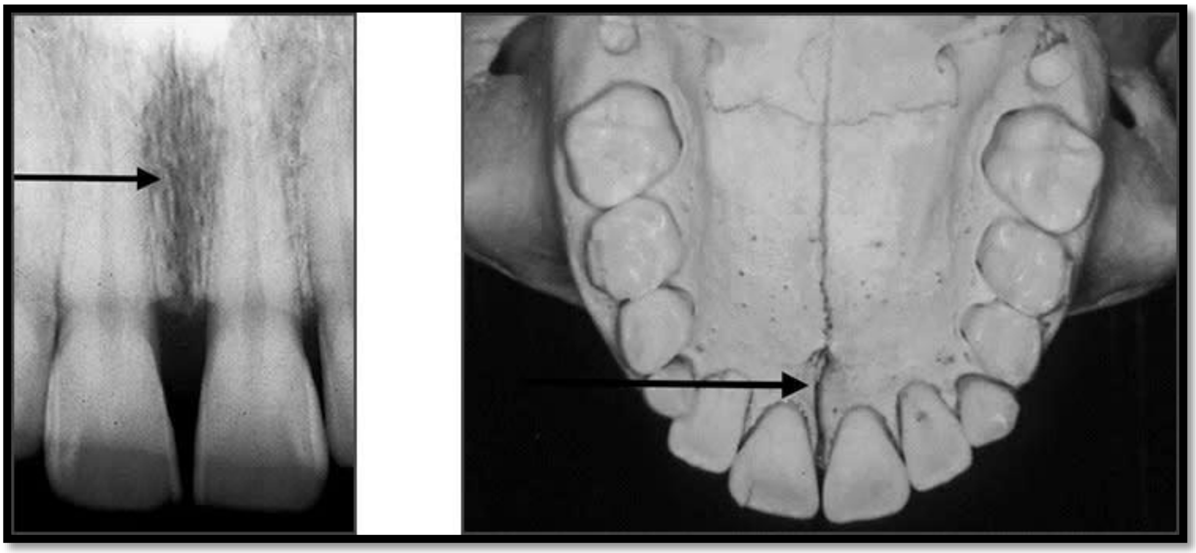
Bony Landmarks of the Maxilla

Incisive Foramen

Description. The incisive foramen (also known as the nasopalatine foramen) is an opening or hole in bone located at the midline of the anterior portion of the hard palate.

The nasopalatine nerve exits the maxilla through the incisive foramen.

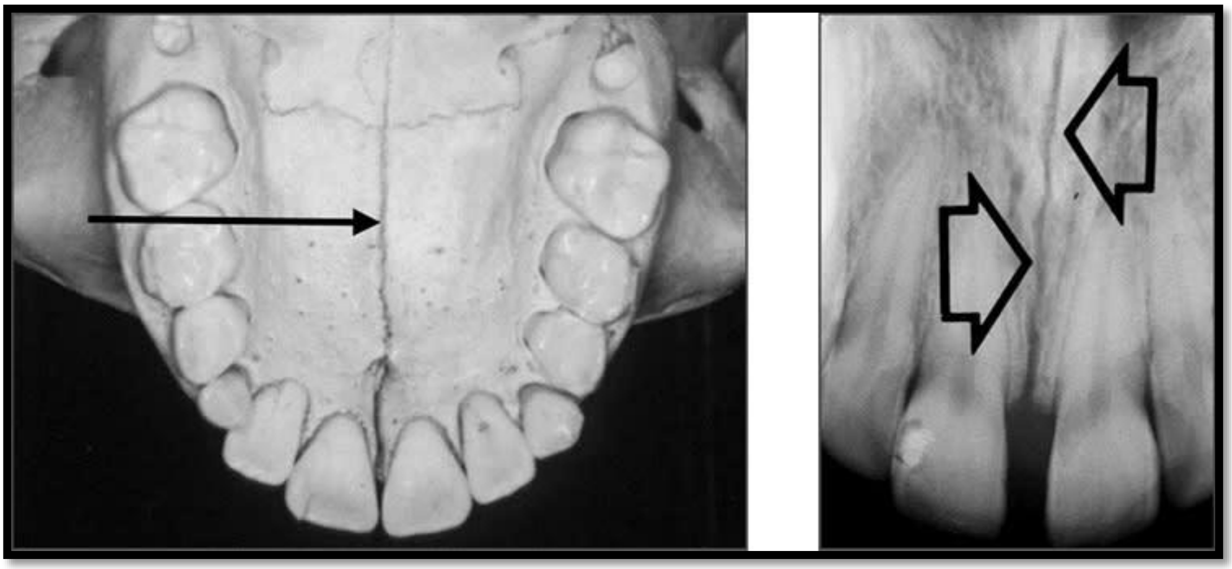
Appearance. On an anterior maxillary periapical image, the incisive foramen appears as a small, ovoid or round **radiolucent** area located between the roots of the maxillary central incisors.



Median Palatal Suture

Description. The median palatal suture is the immovable joint between the two palatine processes of the maxilla.

Appearance. On an anterior maxillary periapical image, the median palatal suture appears as **a thin radiolucent line** between the maxillary central incisors



Lateral Fossa

Description. The lateral ossa (also known as the canine fossa) is a smooth, depressed area of the maxilla located between maxillary canine and lateral incisors.

Appearance. On an anterior maxillary periapical image, the lateral fossa appears **as a radiolucent area** between the maxillary canine and lateral incisor

Nasal Cavity

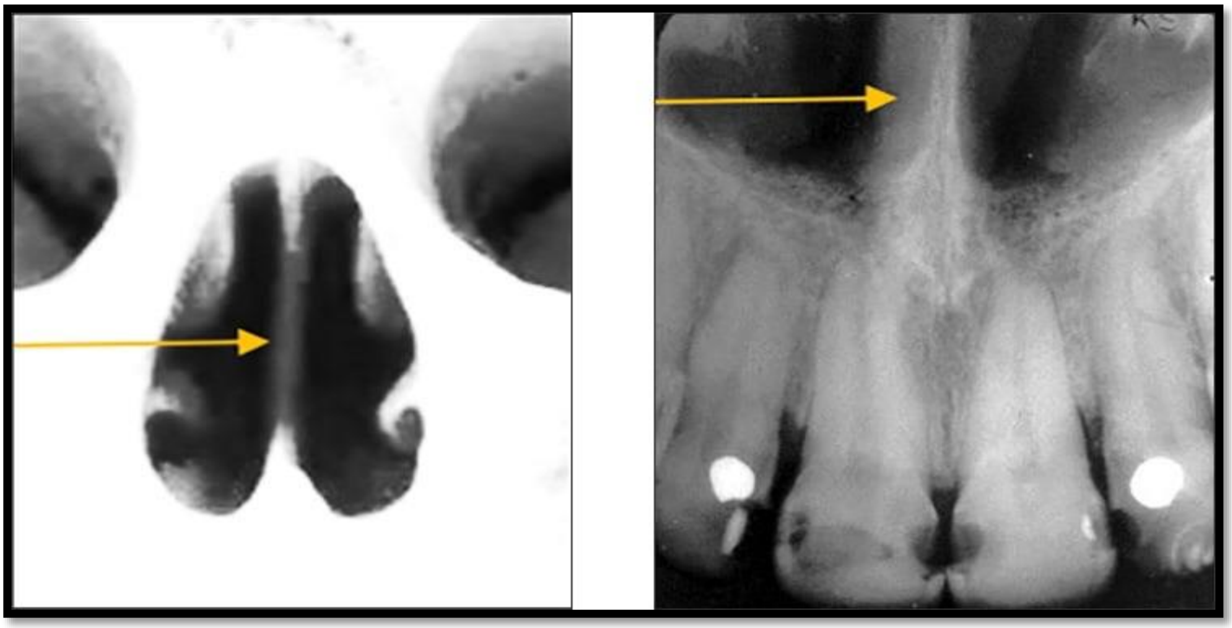
Description. The nasal cavity (also known as the nasal fossa) is a pear-shaped compartment of bone located superior to the Maxilla

Appearance. On an anterior maxillary periapical image, the nasal cavity appears as a large**, radiolucent area** superior to the maxillary incisors

Nasal Septum

Description. The nasal septum is a vertical bony wall or partition that divides the nasal cavity into the right and left nasal fossae (fossae is the plural of fossa)

Appearance. On an anterior maxillary periapical image, the nasal septum appears as a **vertical radiopaque** partition that divides the nasal cavity.



Floor of Nasal Cavity

Description. The floor o the nasal cavity is a bony wall **Appearance**. On an anterior maxillary periapical image, the floor of the nasal cavity appears as a **dense radiopaque** band of bone superior to the maxillary incisors .

Anterior Nasal Spine

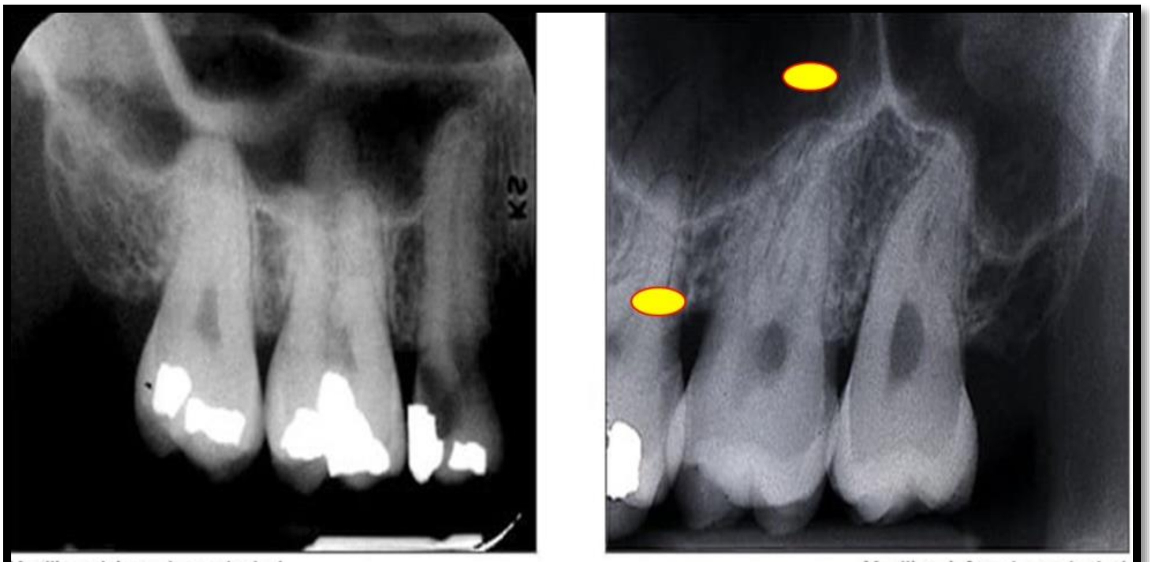
Description. The anterior nasal spine is a sharp projection of the maxilla located at the anterior and inferior portion of the nasal cavity.

Appearance. On an anterior maxillary periapical image, the anterior nasal spine appears as **a V-shaped radiopaque area** located at the intersection of the floor of the nasal cavity and the nasal septum.

Maxillary Sinus

Description. The maxillary sinuses are paired cavities or compartments of bone located within the maxilla

Appearance. On a posterior maxillary periapical image, the maxillary sinus appears as **a radiolucent area** located superior to the apices of maxillary premolars and molars.



Maxillary right molar periapical

Maxillary left molar periapical

Septa Within Maxillary Sinus

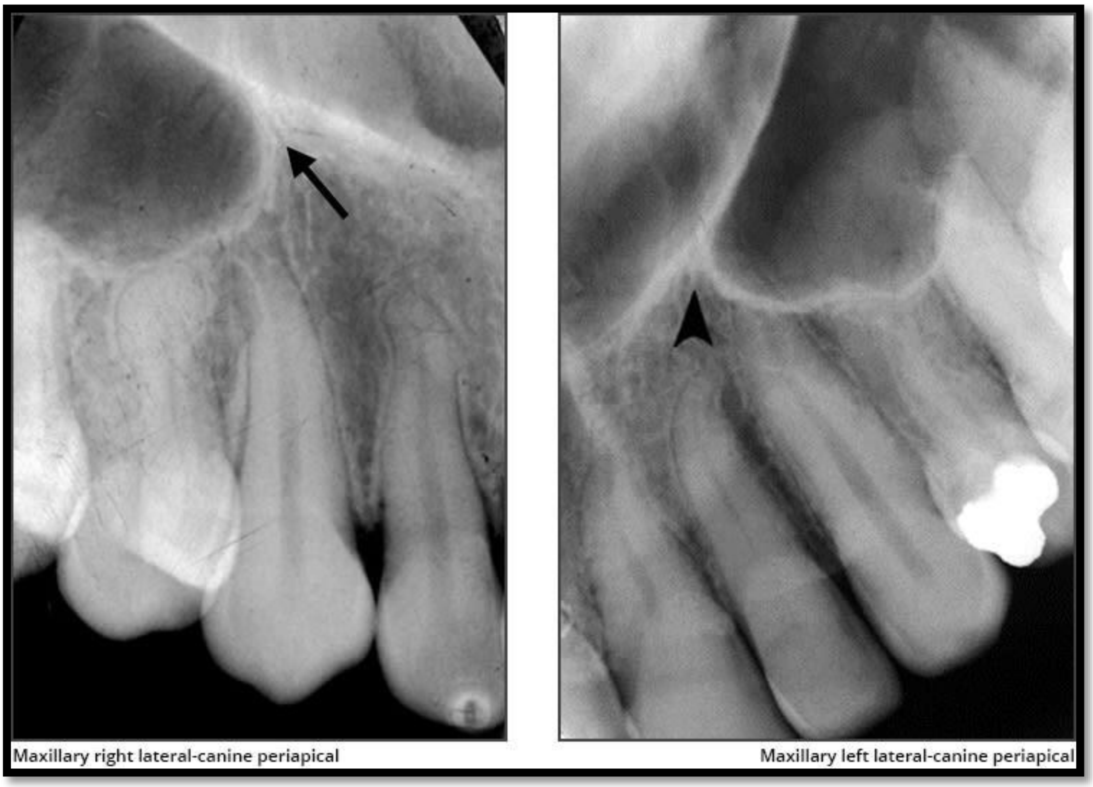
Description. Bony septa (septa is the plural of septum) may be seen within the maxillary sinus. Septa are bony walls or partitions that appear to divide the maxillary sinus into compartments.

Appearance. On a posterior maxillary periapical image, the septa **appear as radiopaque lines** within the maxillary sinus.

Inverted Y

Description. The term inverted Y refers to the intersection of the maxillary sinus and the nasal cavity as viewed on a dental image.

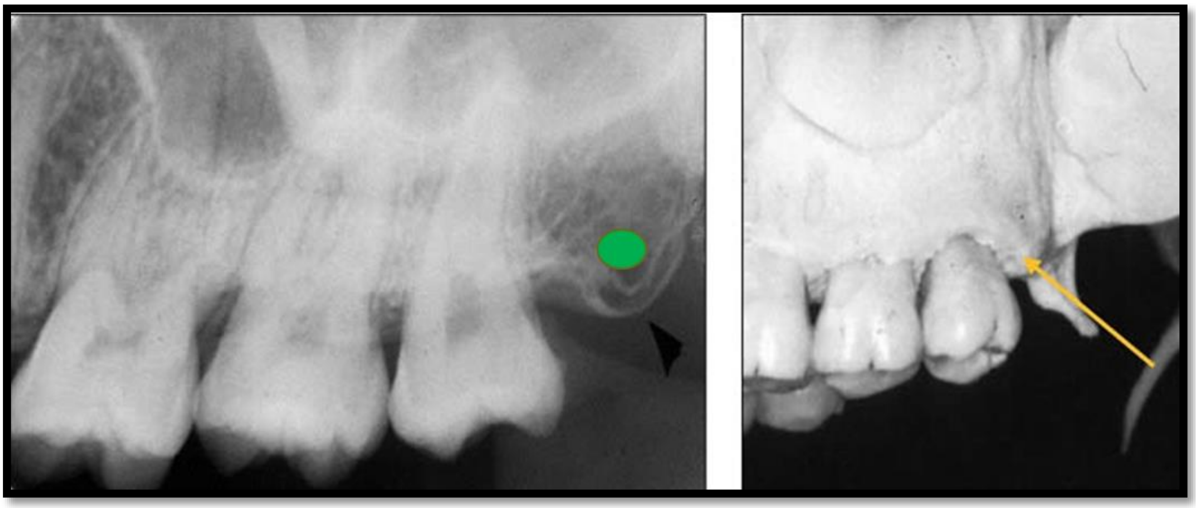
Appearance. On a maxillary canine periapical image, the inverted Y appears as **a radiopaque upside-down Y** formed by the intersection of the lateral wall of the nasal fossa and the anterior border of the maxillary sinus.



Maxillary Tuberosity

Description. The maxillary tuberosity is a rounded prominence of bone that extends posterior to the third molar region .

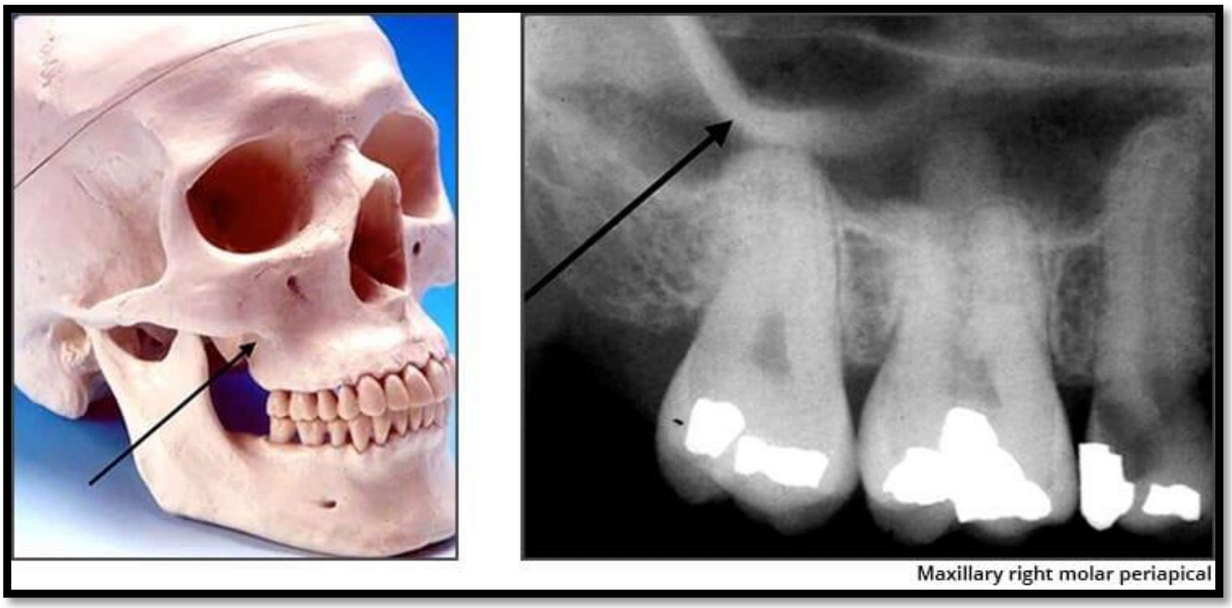
Appearance. On a posterior maxillary periapical image, the
maxillary tuberosity appears **as a radiopaque bulge distal to the third molar region.**



Zygomatic Process of Maxilla

Description. The zygomatic process o the maxilla is a bony projection of the maxilla that articulates with the zygoma, or malar bone. The zygomatic process of the maxilla is composed of dense cortical bone.

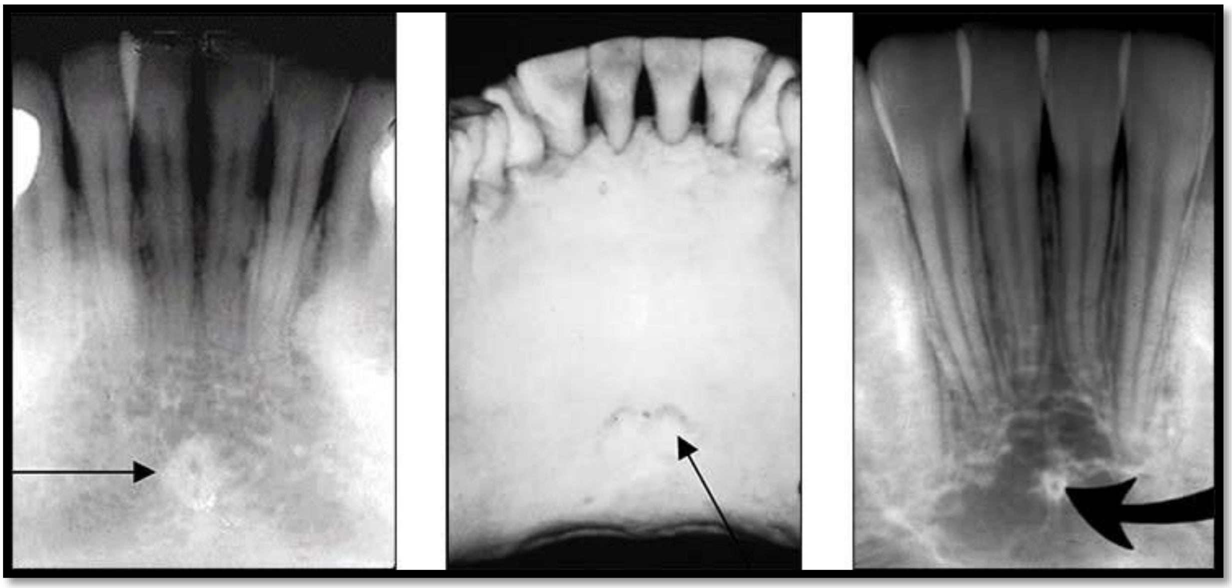
Appearance. On a posterior maxillary periapical image, the zygomatic process of the maxilla appears as **a J-shaped or U-shaped radiopacity** located superior to the maxillary rst molar region.



Bony Landmarks of the Mandibl

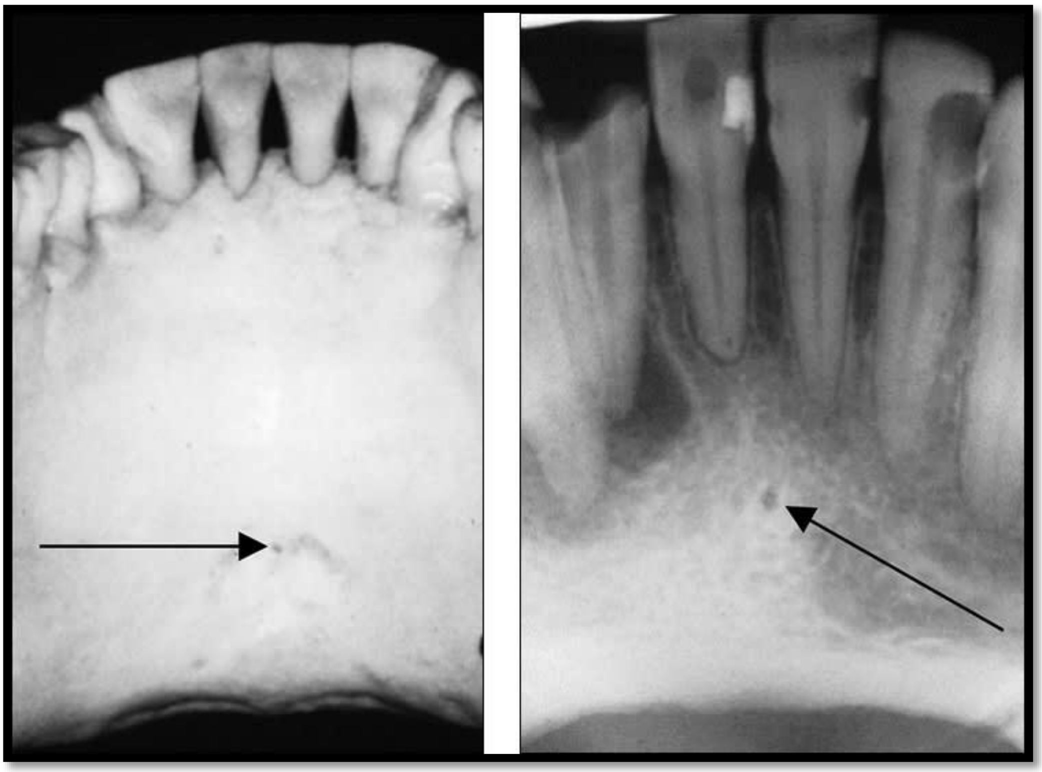
Genial Tubercles Description. Genial tubercles are tiny bumps of bone that serve as attachment sites for the genioglossus and geniohyoid muscles.

Appearance. On a mandibular periapical image, genial tubercles appear as a **ring-shaped radiopacity** inferior to the apices of the mandibular incisors.



Lingual Foramen Description. The lingual foramen is a tiny opening or hole in bone located on the internal surface of the mandible. The lingual foramen is located near the midline and is surrounded by genial tubercles.

Appearance. On a mandibular periapical image, the lingual foramen appears as a **small, radiolucent dot located inferior to the apices of the mandibular incisors.**

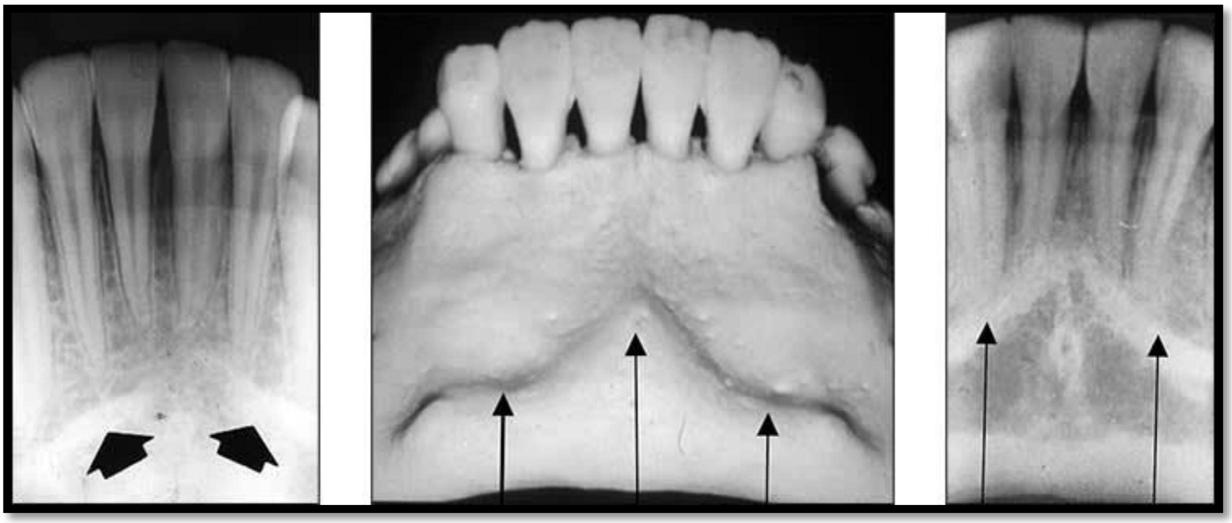


Mental Ridge Description. The mental ridge is a linear prominence of cortical bone located on the external surface of the anterior portion of the mandible

Appearance. On a mandibular periapical image, the mental ridge appears as a thick radiopaque band that extends from the premolar region to the incisor region

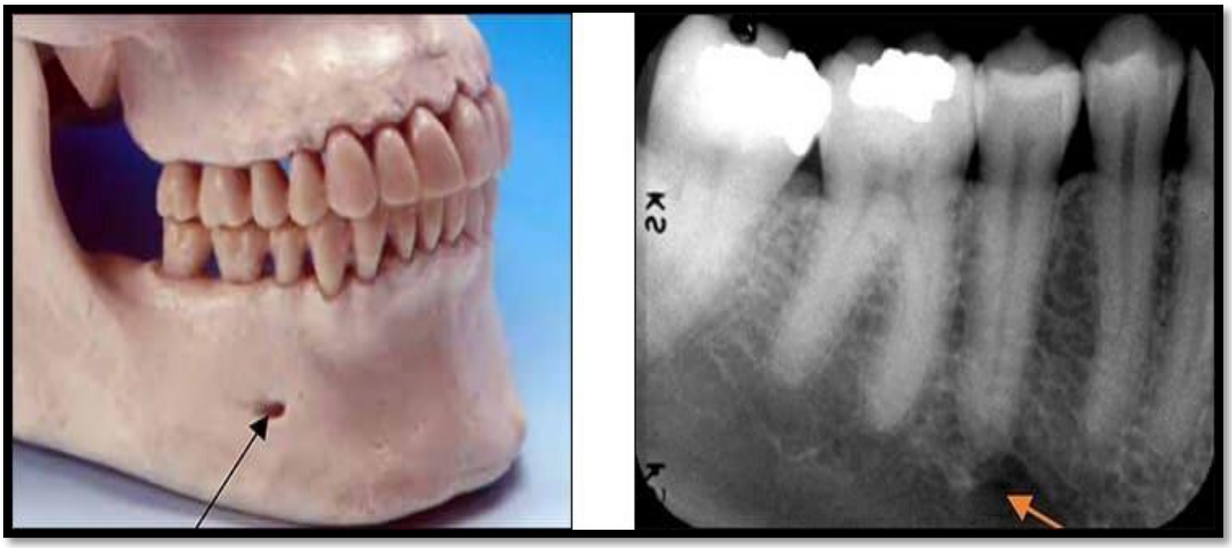
Mental Fossa Description. The mental ossa is a scooped-out, depressed area of bone located on the external surface of the anterior mandible

Appearance. On a mandibular periapical image, the mental fossa appears as a radiolucent area above the mental ridge



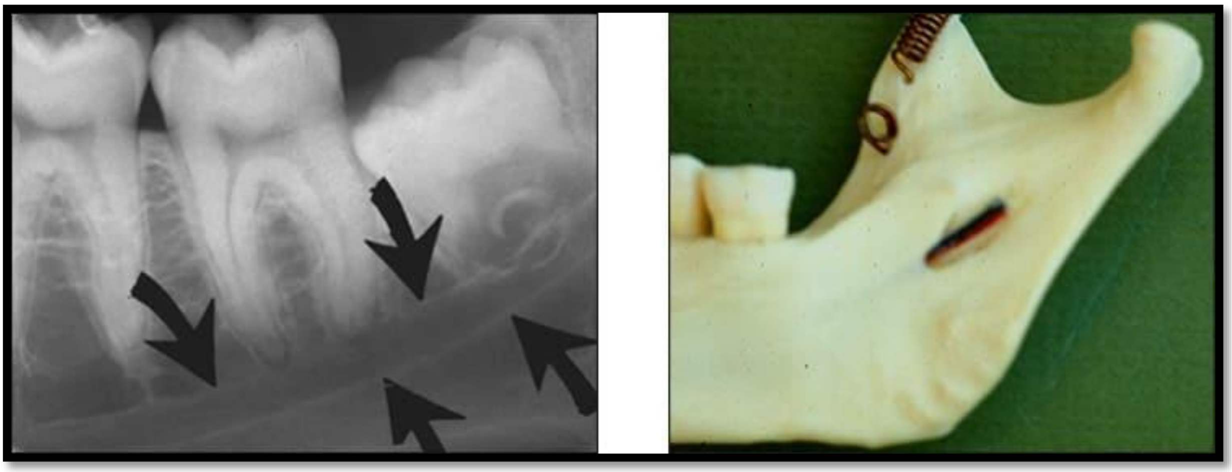
Mental Foramen Description. The mental foramen is an opening or hole in bone located on the external surface of the mandible in the region of the mandibular premolars. Blood vessels and nerves that supply the lower lip exit through the mental foramen.

Appearance. On a mandibular periapical image, the mental foramen appears as a small, ovoid or round radiolucent area located in the apical region of the mandibular premolars.



Mandibular Canal Description. The mandibular canal is a tubelike passageway through bone that travels the length of the mandible. The mandibular canal extends from the mandibular foramen to the mental foramen and houses the inferior alveolar nerve and blood vessels.

Appearance. On a mandibular periapical image, the mandibular canal appears as a radiolucent band. Two thin radiopaque lines that represent the cortical walls of the canal outline the mandibular canal. The mandibular canal appears below or superimposed over the apices of the mandibular molar teet.

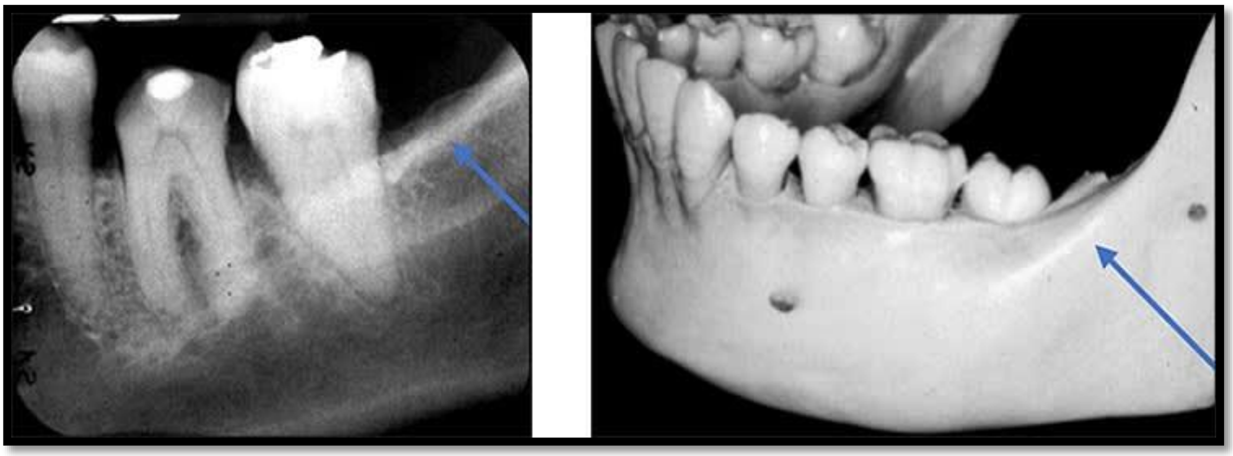


Mylohyoid Ridge Description. The mylohyoid ridge (also known as the internal oblique ridge) is a linear prominence of bone located on the internal surface of the mandible The mylohyoid ridge extends from the third molar region do and forward to the second premolar area. The mylohyoid ridge serves as an attachment site for a muscle of the same name.

Appearance. On a mandibular periapical image, the mylohyoid ridge appears as a dense radiopaque band that extends downward and forward from the third molar region at the level of the apices of the posterior teeth.

External Oblique Ridge Description. The external oblique ridge (also known as the external oblique line) is a linear prominence of bone located on the external surface of the body of the mandible. The anterior border of the ramus ends in the external oblique ridge

Appearance. On a mandibular molar periapical image, the external oblique ridge appears as a radiopaque band extending downward and forward from the anterior border of the ramus of the mandible.

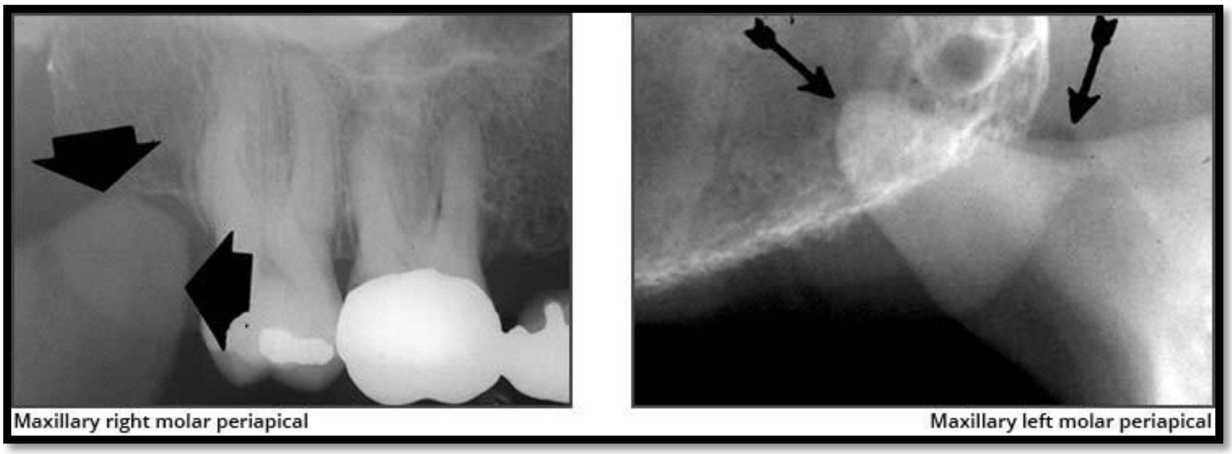


Submandibular Fossa Description. The submandibular ossa (also known as the mandibular fossa or submaxillary fossa) is a scooped-out, depressed area of bone located on the internal surface of the mandible inferior to the mylohyoid ridge. The submandibular salivary gland is found in the submandibular fossa.

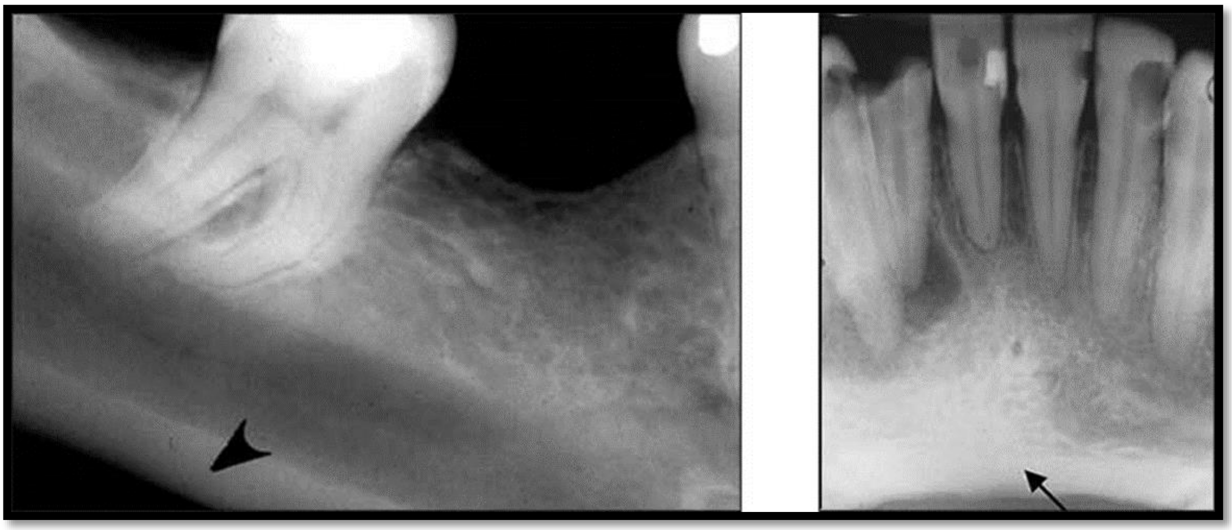
Appearance. On a mandibular periapical image, the submandibular fossa appears as a radiolucent area in the molar region below the mylohyoid ridge.

Coronoid Process Description. The coronoid process is a marked prominence of bone on the anterior ramus of the mandible . The coronoid process serves as an attachment site for one of the muscles of mastication

Appearance. The coronoid process is not seen on a mandibular periapical image but may appear on a maxillary molar periapical image. The coronoid process appears as a triangular radiopacity superimposed over, or inferior to, the maxillary tuberosity region.



Inferior border of mandible is the lower most part of the mandible. Appears as dense broad radiopaque band of bone.



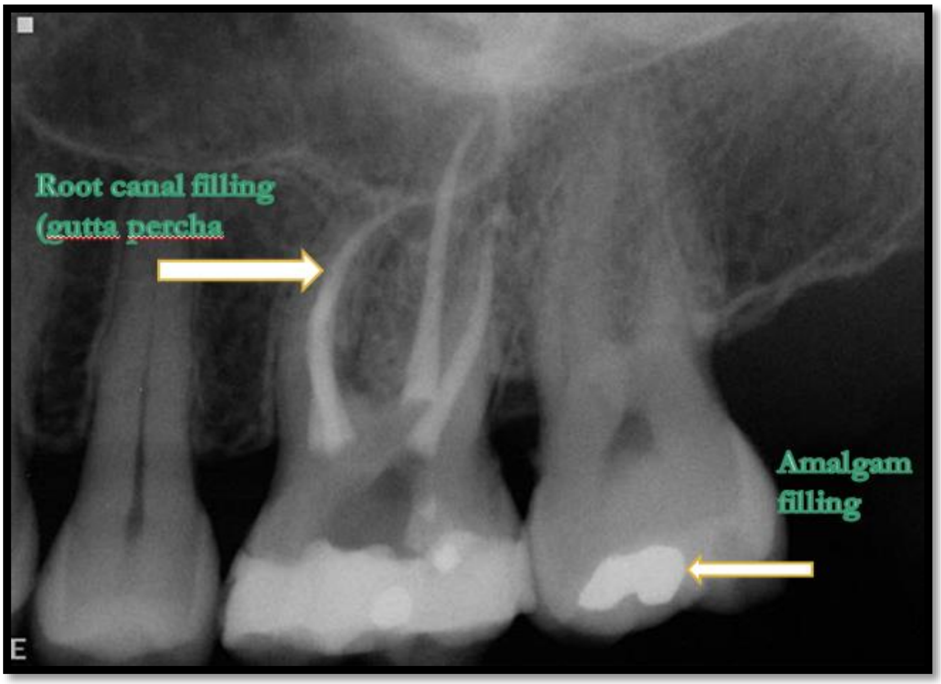
Radiographic appearance of restorative materials:

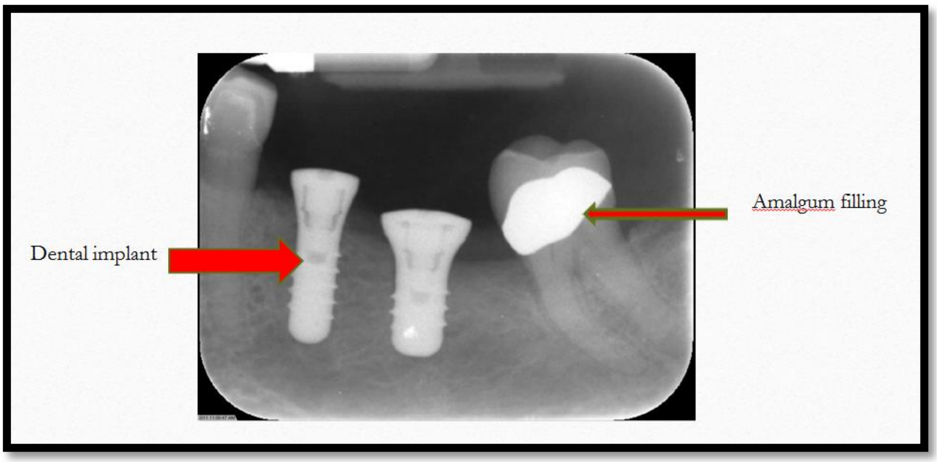
Radiopaque restorative materials:

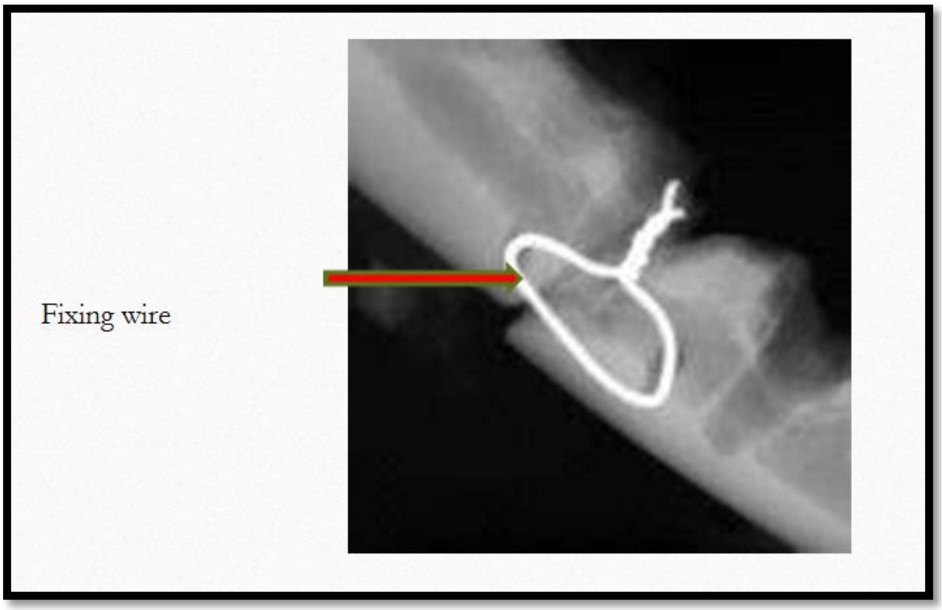
Gold , Silver amalgam , Zinc oxide – eugenol , Zinc phosphate cement , Gutta – percha , Silver points , Metal bands & crowns , Metal wires & dental implants

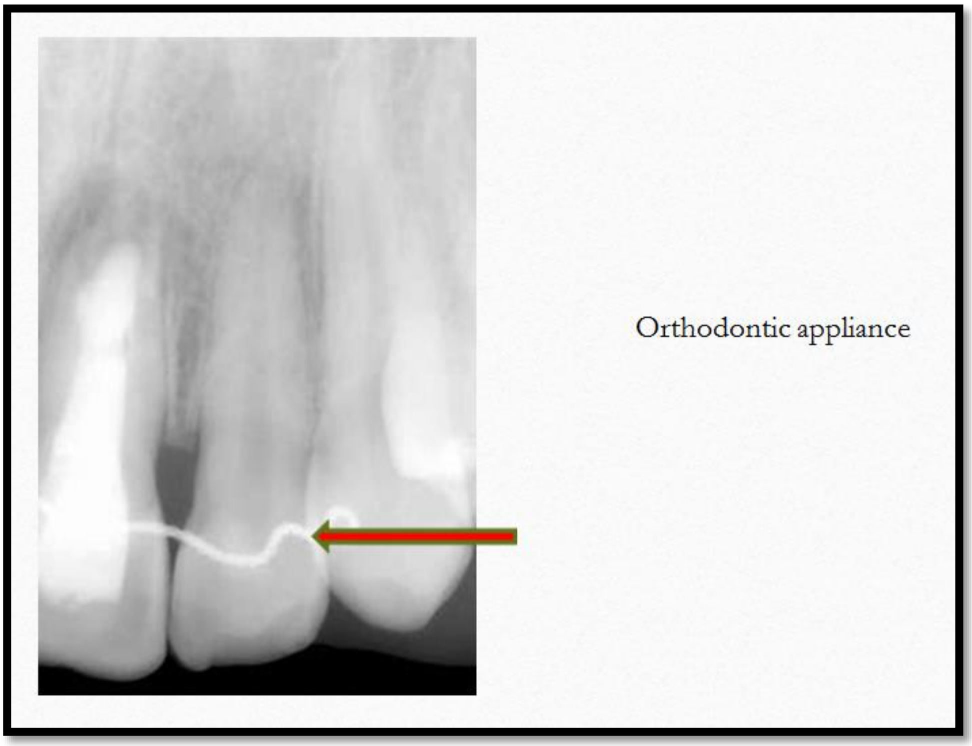
Radiolucent restorative materials:

Acrylic, Silicates, Calcium hydroxide pastes, & Porcelain.


Root canal filling
(gutta percha
Amalgam
filling


Dental implant
Amalgum filling


Fixing wire


Orthodontic appliance

Radiology

د. زينب البحراني

Dental and Craniofacial Anomalies

There are many developmental and acquired anomalies that can affect the teeth and facial skeleton so they classified into: Anomalies of the teeth **and** Craniofacial anomalies. The diagnosis of them based on both the clinical and radiographic findings.

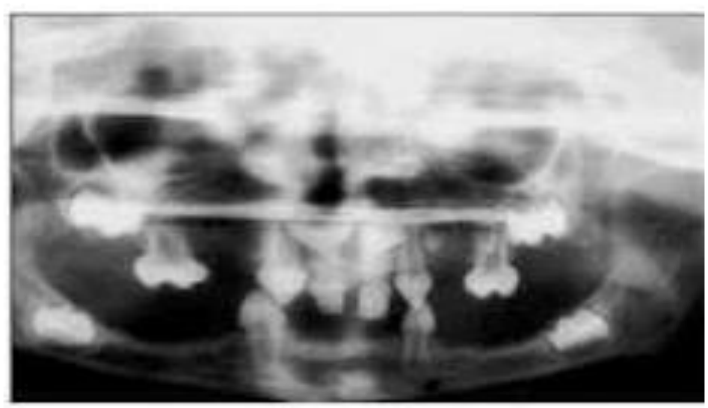
- ❖ **Anomalies of the teeth**

1- Developmental teeth anomalies: These include abnormalities of the teeth in: Number**,** Structure**,** Size**,** Shape (morphology)**,** and Eruption.

Abnormalities in number:

- **Missing teeth** (Hypodontia)

It's a condition at which the patient has missing one or few teeth as a result of their failure to develop. when numerous teeth are absent the condition called (oligodontia) and the failure of all teeth to develop called (anodontia). It could happen in Ectodermal Dysplasia. Imaging features of Missing teeth may be recognized by identifying and counting the teeth present.



- **Hyperdontia**

It's a condition of having supernumerary teeth, or teeth which appear in addition to the regular number of teeth. The most common supernumerary tooth is a mesiodens, which is a mal-formed, peg-like tooth that occurs between the maxillary central incisors, Fourth and fifth molars (paramolar, or distomolar) that form behind the third molars are another kind of supernumerary teeth. It could be associated with **Cleidocranial Dysplasia**.The imaging features of supernumerary teeth are variable. They may appear entirely normal in both size and shape or they may be smaller and conical shape.

Panoramic radiograph showing multiple Supernumerary premolars

Mesiodens

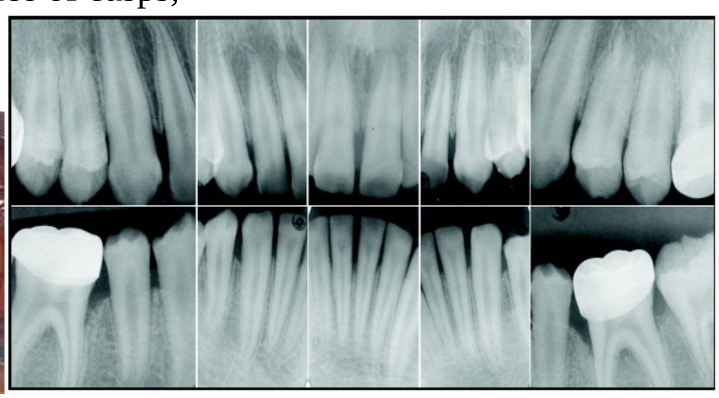
Abnormalities in structure:

The Abnormalities in teeth structures are subdivided into:

1- Genetic defect:

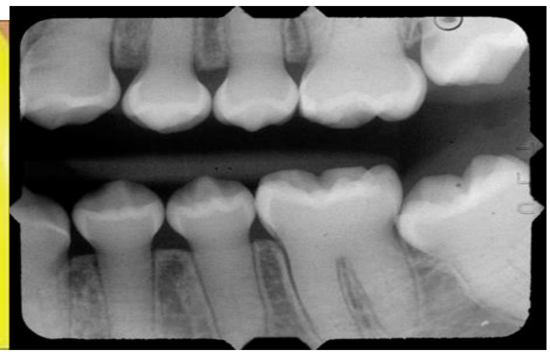
- **Amelogenesis imperfect**

Genetic disturbances in enamel formation leading to altered morphology of enamel. There is normal dentin and pulp formation. Imaging features shows square-shaped crown, thin enamel and absence of cusps,



- **Dentinogenesis imperfecta**

Is a genetic anomaly involving the dentin in both deciduous and permanent dentition Imaging features show a marked constriction at cervical region of the tooth crown with pulp champer obliteration and short blunt roots.
There is another genetically inherited abnormality that affects dentin called **Dentin dysplasia**



- **Regional Odontodysplasia (ghost teeth)**

Its a rare condition in which both enamel and dentin are hypoplastic and hypocalcified. Imaging feature described as “ghost-like”appearance. The pulp chambers are large and the root canals are wide with very thin enamel and dentin.

2- **Acquired defects:**

- **Turner hypoplasia**

It’s a frequent pattern of enamel defects seen in permanent teeth secondary to periapical inflammatory disease of the overlying deciduous tooth. The altered tooth is called (Turner’s tooth). Imaging features of the involved region of the crown may appear as an ill-defined radiolucent region.

- **Congenital syphilis**

It’s a dental hypoplasia that results from direct infection of the developing tooth by spirochete of syphilis, involves the permanent incisors that called (Hutchinson's teeth) and first molars that called (mulberry molars). Imaging features have a characteristic shapes of the affected incisor and molar crowns.

Hutchinson's teeth

Abnormalities in size:

- **<u>Macrodontia (large teeth)</u>**

It’s a condition in which the teeth are abnormally large, rarely affects the entire dentition. Often a single tooth or a group of teeth may be involved. Imaging features reveal the increased size of the teeth. The shape of the tooth is usually normal, but some cases may be distorted. It associated with crowding, malocclusion, or impaction.

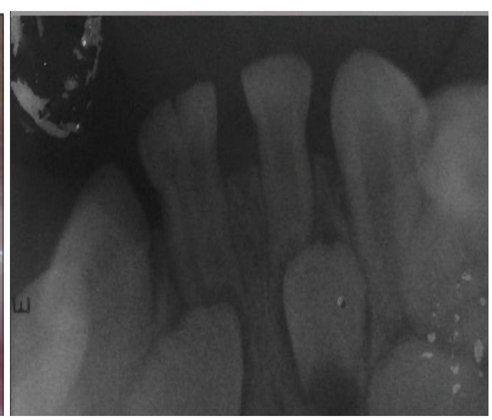
- **<u>Microdontia (small teeth)</u>**

It's a condition in which teeth appear smaller than normal. In the generalized form, all teeth are involved. In the localized form, only single or few teeth are involved. The most common teeth affected are the upper lateral incisors and third molars. Imaging features of the affected teeth are frequently small and malformed.


Abnormalities in shape (morphology):

- **<u>Fusion</u>**

Two teeth joined together into a single anatomic crown (union of two separated tooth germ). Fusion is more common in anterior teeth of both the deciduous and permanent dentitions. Imaging features of fused teeth show unusual shape, size, and pulp chamber or root canal

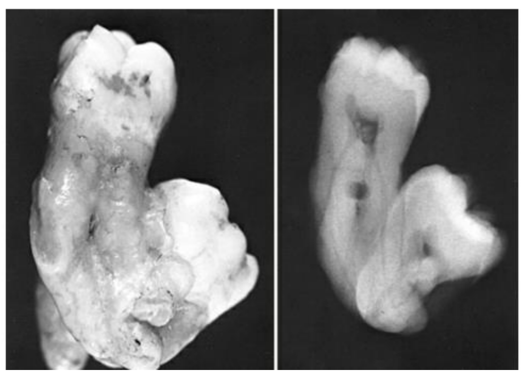



- **<u>Gemination</u>**

Single tooth germ divided into two teeth joined together (single root with two or enlarged crowns). Imaging features reveal the altered shape of the hard tissue and pulp chamber of the geminated tooth.

- **Concrescence**

  Is union of two adjacent teeth by cementum only. Maxillary third molar frequently involved. Imaging features reveal concrescence teeth may be in close contact or are simply superimposed.



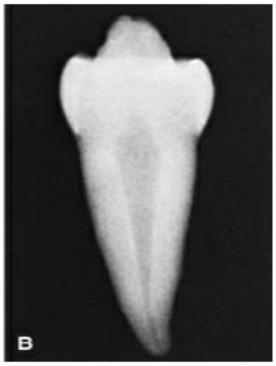
- **<u>Dilaceration</u>**

Is a deviation or sharp bend in the linear relationship of a tooth crown to its root; Imaging features is readily apparent on an intraoral radiograph when the roots are bending mesially or distally, buccally or lingually.

<u>Dens Invaginatus and Dens Evaginatus</u>

Dens invaginatus is <u>infolding of the enamel</u> surface into the interior of a tooth crown or the root . Imaging features show more radiopaque than the surrounding tooth structure, poorly defined root, while **Dens evaginatus** is the <u>outpouching of the enamel</u> on the occlusal surface. Imaging features shows an extension of a dentin tubercle on the occlusal surface covered with radiopaque enamel.

Dens Invaginatus



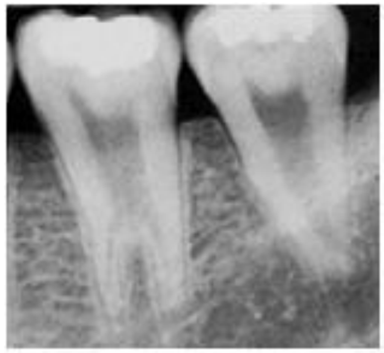
Dens Evaginatus

- **<u>Enamel pearl</u>**

It's small spherical enamel masses (enameloma) located at the root of the molars and are found in 3% of the population. Imaging features of the enamel pearl appears smooth, round radiopaque structure.

- **<u>Taurodontism</u>**

It's a condition found in the molar teeth whereby the body of the tooth and pulp chamber is enlarged vertically with short roots, the floor of the pulp and the furcation of the tooth is moved apically. Imaging features is the elongated pulp chamber and the more apically positioned furcation, shortened roots with long crown.

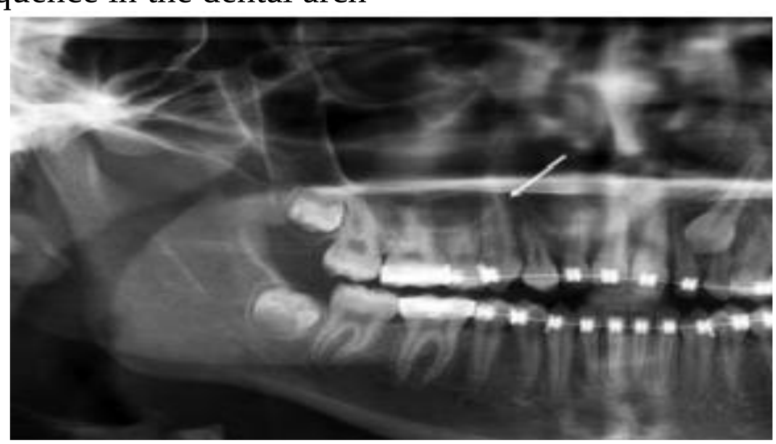


- **Talon cusp:**

It's an Accessory cusp like structure projecting from the cingulum area or cement-enamel junction of the maxillary or mandibular anterior teeth. Imaging features show a distinct radiopaque image of talon cusp on the crown of the involved tooth.

Abnormalities in Eruption of Teeth:

-Transposition is the condition in which two adjacent teeth have exchanged positions in the dental arch. Imaging features reveal transposition when the teeth are not in their usual sequence in the dental arch



-**Premature Eruption (natal and neonatal teeth)**

The teeth erupted in the oral cavity at the time of birth are called as 'natal teeth' and teeth erupting prematurely in first 30 days of life are called as 'neonatal teeth'. Imaging features the roots are not seen on the radiograph and the teeth are very small.

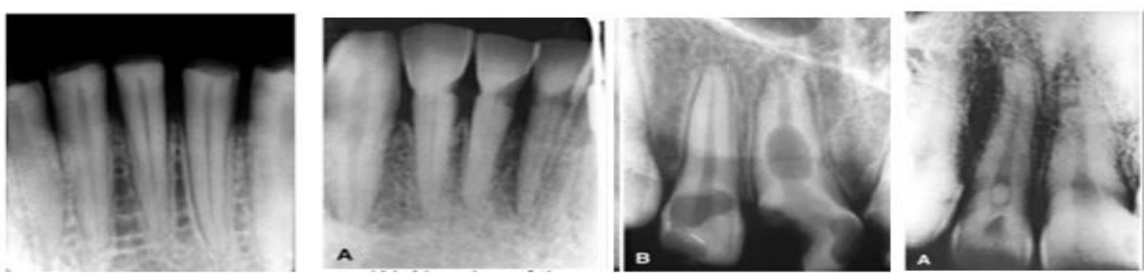
- **Delayed Eruption (Impacted Teeth)**

permanent teeth are observed to be delayed in eruption forming Partially or completely impacted teeth, is more commonly in mandibular third molar, followed by maxillary canine and maxillary third molar. Imaging features of impacted mandibular third molar show mesioangular , distoangular , vertical or horizontal impaction.

2-Acquired teeth Abnormalities

- **Attrition:** is physiologic wearing of teeth (occlusal contacts). The imaging appearance is flat incisal or occlusal surface.
- **Abrasion** is the nonphysiologic wearing of teeth (friction with a foreign toothbrush and dental floss , pipe ,…). Imaging appearance is defects at the cervical level of teeth
- **Erosion** (chemical action). Imaging features appear as radiolucent defects on the crown.

- **Resorption** is the removal of tooth structure (internal or external). Imaging features for external root resorption are smooth loss apical and cervical regions with blunt root apex, while internal resorption round, oval radiolucent within the root or crown
- **Secondary dentin** additional dentin deposited. Imaging features is a reduction in size of the normal pulp
- **Pulp stones** (foci of calcification in the dental pulp). The imaging appearance is radiopaque structures within pulp, **Pulpal sclerosis** is another form of pulp calcification, but it diffuse to larger area.
- **Hypercementosis** is excessive deposition of cementum on the tooth roots. Imaging is an excessive buildup of cementum around all or part of a root



Attrition abrasion internal resorption pulp stone

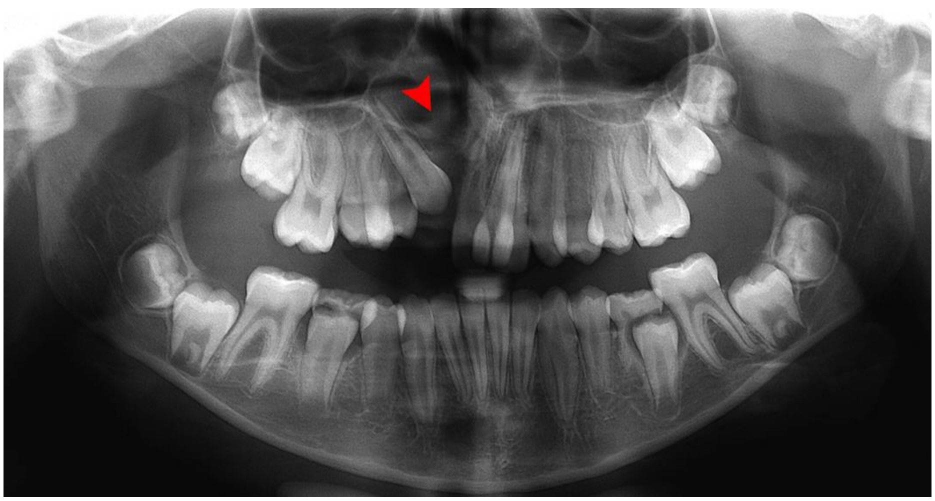
❖ Craniofacial anomalies

The craniofacial anomalies are usually first discovered in infancy or childhood. Some are caused by genetic mutations, others result from environmental factors, and a third group are multifactorial. Cleft lip and palate is one of these anomalies.

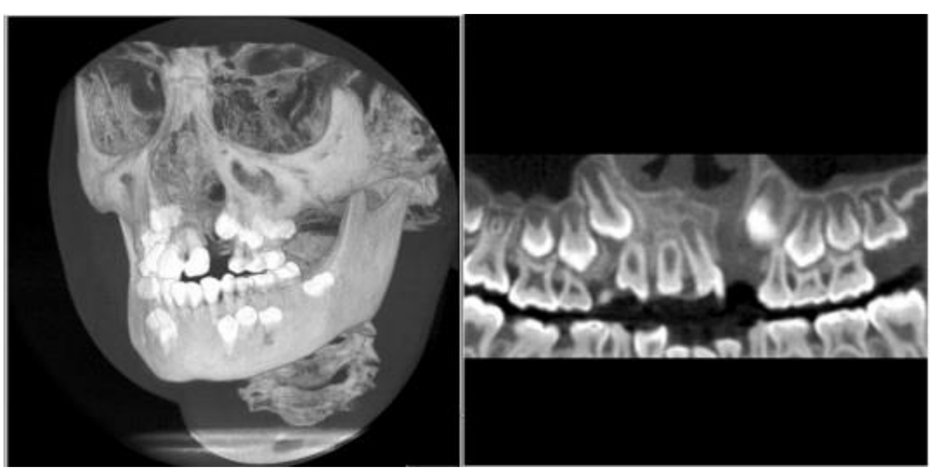
Cleft Lip and Palate

Cleft lip occurs due to failure of union of medial and lateral maxillary processes. While, cleft palate (CP) develops from a failure of fusion of the lateral palatal shelves Cleft lip and palate together (CL/P) is either unilateral or bilateral. In both CL/P and CP, the palatal defects interfere with speech and swallowing.

Multiple radiographic procedures are performed on patients with CL/P throughout childhood and adolescence. These may include panoramic, periapical, occlusal, and cephalometric radiographs, as well as multidetector computed tomography and, more recently, cone-beam imaging. Imaging Features appeare as well-defined vertical radiolucent defect in the alveolar process with numerous dental anomalies (absence of the maxillary lateral incisor, presence of supernumerary teeth, enamel hypoplasia, malformed teeth, delay eruption with hypodontia in both arches).



panoramic image



CBCT image

RADIOGRAPHIC APPEARANCE OF COMMON Inflammatory DENTAL & jaw DISEASES

Asst. Prof

Zainab H AL-Ghurabi

COMMON DENTAL DISEASES

1-Dental caries

2-Periodontal Diseases

3-pericoronitis

4-Inflammatory lesions of the jaws

5-Osteomylities.

1-Dental caries

Dental caries, the most common disease in the mouth, is also the most common disease of the entire body, is the common infectious disease strongly influenced by diet, affecting 95% of population.

Radiography is useful for detecting dental caries because the carious process causes tooth demineralization.

The carious lesion (the demineralized area of the tooth that allows greater infiltration of x-rays) is darker **(more radiolucent)** than the unaffected portion and may be detected on radiographs.

A thorough clinical examination that includes imaging is needed to diagnose carious lesions.

A clinical examination may be able to identify carious lesions on the occlusal and exposed smooth surfaces of the teeth.

However, it is nearly impossible to clinically identify caries occurring on the proximal surfaces of teeth (interproximal caries) unless there has been cavitation.

When this occurs, it usually means that the carious lesion has become large enough to be identified clinically.

An early carious lesion may not have yet caused sufficient demineralization to be detected radiographically.

Intraoral radiography can reveal carious lesions that otherwise might go undetected during a thorough clinical examination.

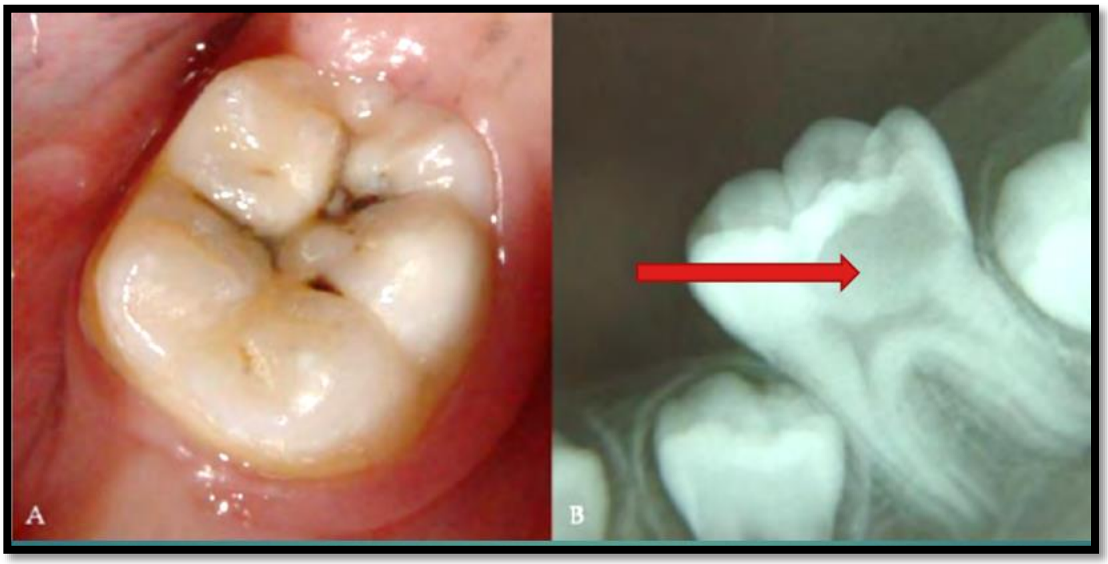
A number of studies have shown the value of dental radiographs by repeatedly demonstrating that approximately half of all proximal surface lesions cannot be seen clinically and may be detected only with radiographs

Interpretation of Dental Caries (DC) regarding to its location

Interpretation of Incipient Occlusal DC: Radiographs are usually not effective for the detection of an occlusal carious lesion until it reaches the dentin.

Interpretation of Moderate Occlusal DC: The moderate occlusal lesion is usually the first to induce specific radiographic changes.

The classic radiographic change is a broad-based, thin radiolucent zone in the dentin with little or no changes apparent in the enamel.



PROXIMAL CARIES

Interproximal carious lesions are most commonly found in a region that extends between the contact points of teeth apically to near the free gingival margin.

Radiographic detection of carious lesions on the proximal surfaces of teeth depends on loss of enough mineral to result in a detectable change in radiographic density.

Approximately 40% demineralization is required for radiographic detection of a lesion.

Bitwing intra oral film used to detect the proximal caries.

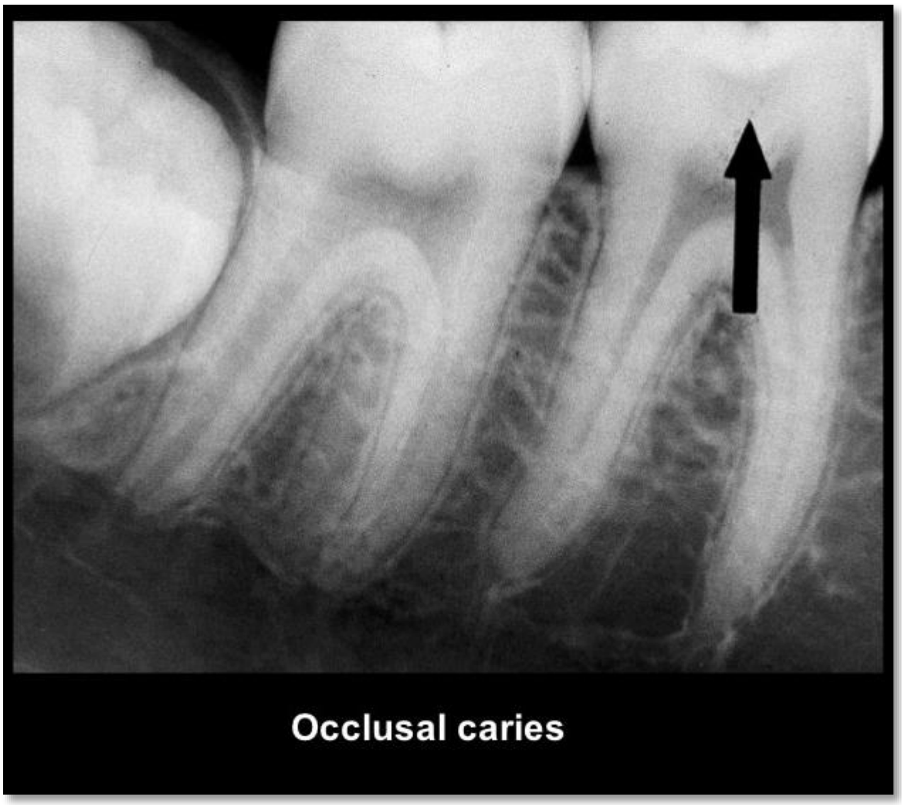
Facial, buccal, and lingual caries

Facial, buccal, and lingual carious lesions occur in enamel pits and fissures of teeth.

When small, these lesions are usually round, as they enlarge, they become elliptic or semilunar.

They demonstrate sharp, well-defined borders.

It is difficult to differentiate between buccal and lingual caries on a radiograph.

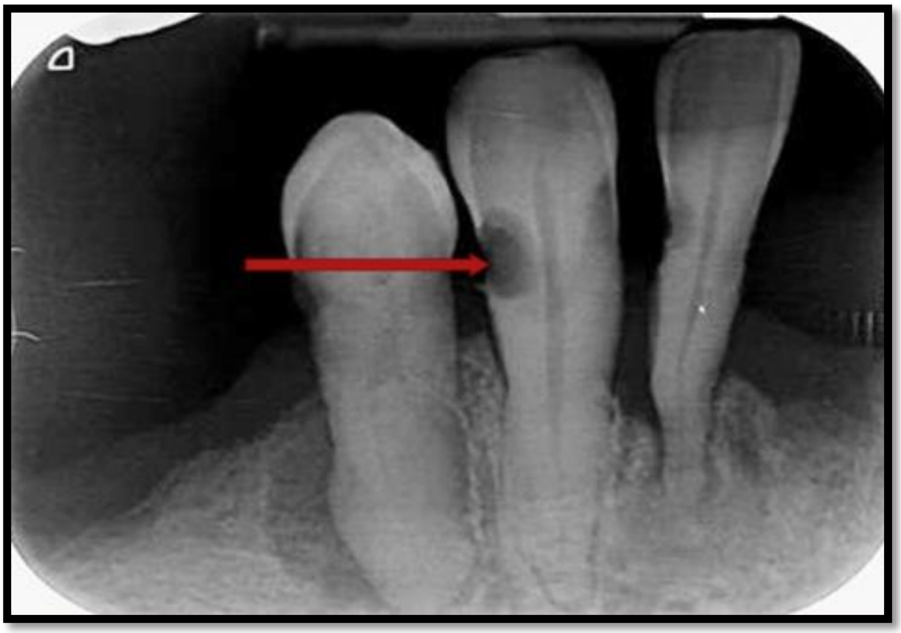


ROOT SURFACE CARIES Root surface

Caries (also called cemental caries) involves both cementum and dentin.

Its prevalence is approximately40% to 70% in an aged population.

The tooth surfaces most frequently affected are (in order) buccal, lingual, and proximal.



Recurrent caries

Recurrent caries is that occurring immediately next to a restoration.

It may result from poor adaptation of a restoration, which allows for marginal leakage, or from inadequate extension of a restoration.

In addition, caries may remain if the original lesion is not completely evacuated, which later may appear as residual or recurrent caries.

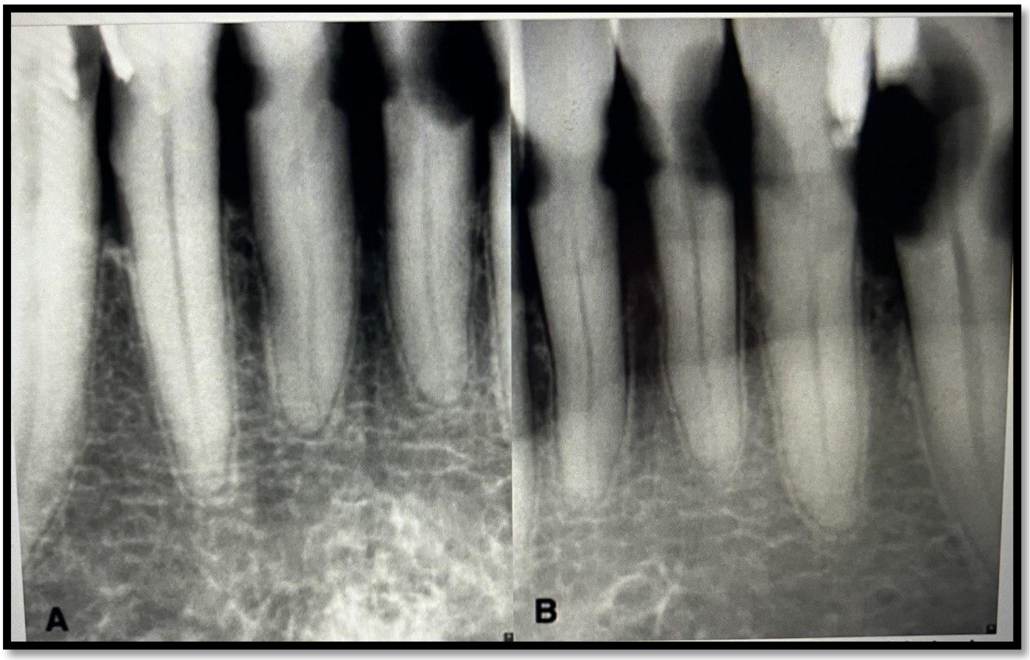
The radiographic appearance of recurrent caries depends on the amount of decalcification present and whether a restoration is obscuring the lesion

Rampant caries

is the term used to describe rapid progression with severe and widespread involvement.

This is most often seen in young children who have poor oral hygiene habits coupled with poor dietary habits (e.g., going to sleep with a bottle of milk or juice).

Imaging examinationsof these patients can demonstrate advanced, generalized caries, involvingsmooth surfaces and teeth that usually do not present carious lesions.



2-Periodontal Diseases

The most common of periodontal disease are **gingivitis and periodontitis.**

Assessment of Periodontal Disease, contributions of radiographs

Radiographs play an integral role in the assessment of periodontal disease. They provide unique information about the status of the periodontium and a permanent record of the condition of the bone throughout the course of the disease.

It is important to emphasize that the clinical and radiographic examinations are complementary.

The clinical examination should include periodontal probing, a gingival index, mobility charting, and an evaluation of the amount of attached gingiva.

Features that are not well delineated by the radiograph are most apparent clinically, and those that the radiograph best demonstrates are difficult to identify and evaluate clinically.

Radiographic features of healthy periodontium

A healthy periodontium can be regarded as periodontal tissue exhibiting no evidence of disease.

However, to be able to interpret radiographs successfully clinicians need to know the usual radiographic features of healthy tissues where there has been no bone loss.

The only reliable radiographic feature is the relationship between the crestal bone margin and the cemento-enamel junction (CEJ).

If this distance is within normal limits (2-3 mm) and there are no clinical signs of loss of attachment., then it can be said that there has been no periodontitis

Radiographic features of periodontal disease

Acute and chronic gingivitis

Radiographs provide no direct evidence of the soft tissue involvement in gingivitis.

Periodontitis

Periodontitis is the name given to periodontal disease when the superficial inflammation in the gingival tissues extends into the underlying alveolar bone and there has been loss of attachment.

The destruction of the bone can be **either localized affecting a few areas of the mouth, or generalized affecting all areas**.

The radiographic features of the different forms of periodontitis are similar; it is the distribution and the rate of bone destruction that varies.

The terms used to describe the various appearances of bone destruction include:

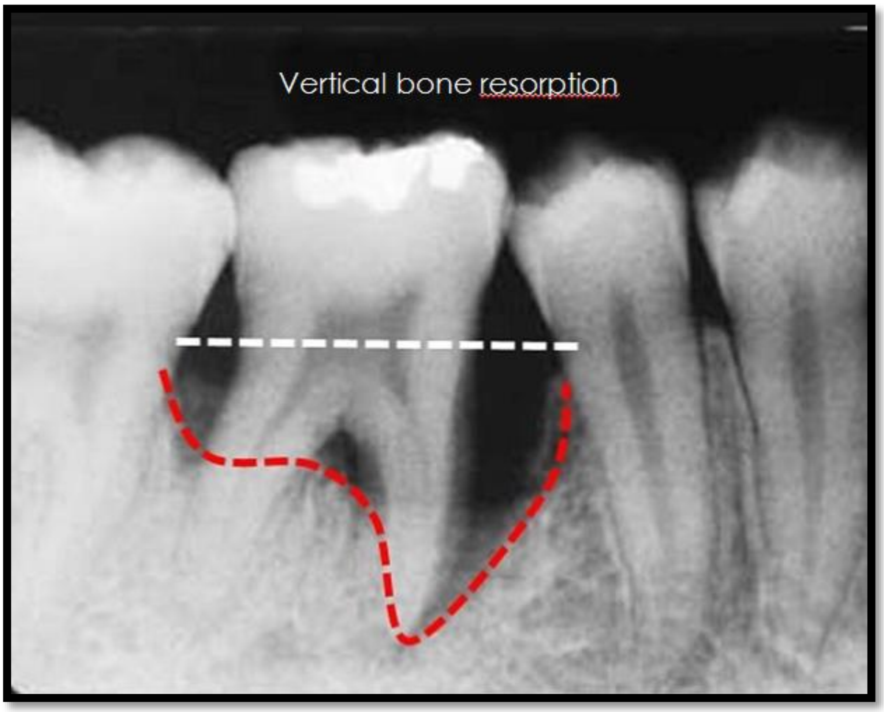
- **Horizontal bone loss**
- **Vertical bone loss**
- **Furcation involvements.**

The terms horizontal and vertical have been used traditionally to describe the direction or pattern of bone loss using the line joining two adjacent teeth at their cemento-enamel junctions as a line of reference.

The amount of bone loss is then assessed as mild, moderate or severe.

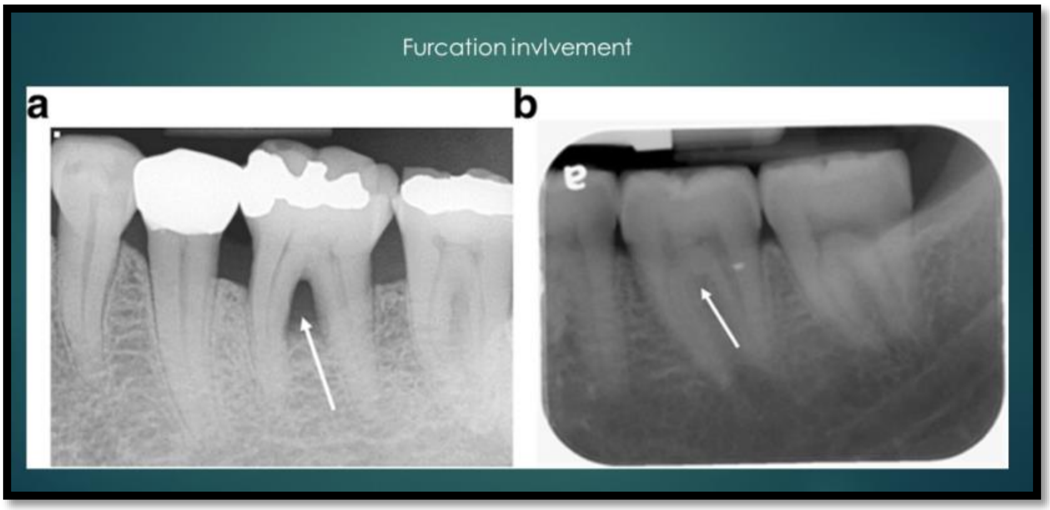
Horizontal bone loss

Severe vertical bone loss, extending from the alveolar crest and involving the tooth apex,



The term furcation involvement describes the radiographic appearance of bone loss in the furcation area of the roots which is evidence of advanced disease in this zone.

Although central furcation involvements are seen more readily in **mandibular molars**, they can also be seen in maxillary molars l



2-PERICORONITIS

Clinical Features

As mandibular third molar is the most commonly impacted tooth and its position is in such a way that its pericoronal flap gets frequently traumatised, it is the most commonly affected region.

Patient usually presents with swelling in affected area and inability to open the mouth completely. Patient may be having severe pain.

Radiographic Features

The most common radiographic feature of pericoronitis of mandibular third molar is that there is presence of distal bone loss.

This distal bone loss is semilunar or circumferential in shape.

In the case of mesially tilted impaction, bone loss is present on the mesial side.

Inflammatory lesions of the jaws

Inflammation is the most common disease process that the dentist encounters in practice. Whether acute or chronic, localized or generalized, dentists are responsible for identifying the important radiologic features of inflammation and for determining the extensiveness of bone involvement. Imaging plays a key role in this process, and is an important first step in patient diagnosis and management.

1-Periapical lesions

Inflammatory lesions are by far the most common pathologic condition of the jaws.

When the initial source of inflammation is a necrotic pulp and the bony lesion is restricted to **the region of the tooth**, the condition is called **a periapical inflammatory lesion.**

When the infection spreads in the **bone** marrow and is no longer contained, it is called **osteomyelitis.**

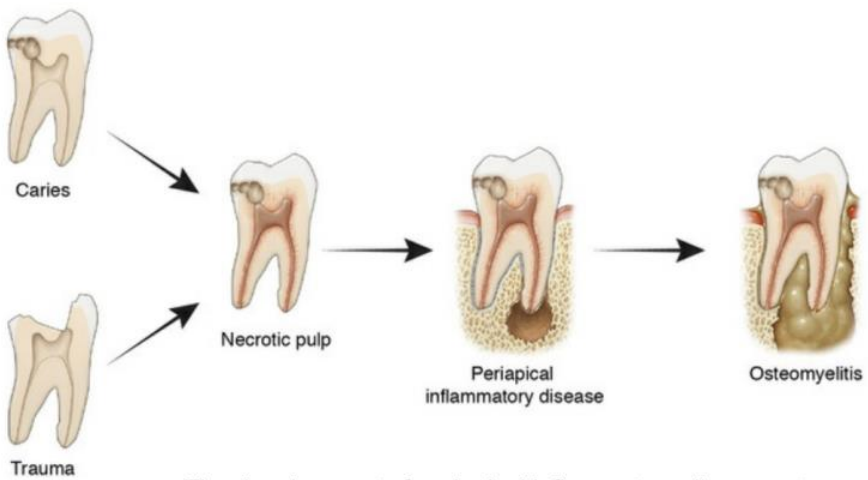


FIG. 22.1 The development of periapical inflammatory disease at the tooth root apex and dissemination into the adjacent bone.

It must be emphasized that the names of the various inflammatory lesions tend to describe their clinical and radiologic presentations and behavior.

Terminology

Apical periodontitis (acute and chronic).

(periapical, radicular, or periradicular) abscess.

(periapical, radicular, or periradicular) granuloma.

(periapical, radicular, or periradicular) cyst.

Normal radiographic appearances

The appearances of normal, healthy, periapical tissues vary from one patient to another, from one area of the mouth to another and at different stages in the development of the dentition.

Radiographic Features of periapical lesion

The radiographic features of periapical inflammatory lesions vary depending on the time course of the lesion

A-Early lesion Early periapical inflammatory lesions

may show no radiographic change in the normal bone pattern.

The earliest detectable change is loss of bone density, which usually results in widening of the periodontal ligament space at the apex of the tooth and later involves a larger diameter of surrounding bone.

At this early stage no evidence may be seen of a sclerotic bone reaction.

B-Periapical granuloma Periapical granuloma

Clinical Features

Patient is usually asymptomatic. In some cases, pain occurs which is mild in intensity. Vitality test of the tooth

is negative. Due to periapical lesion, tooth may feel elongated in the socket.

Swelling is usually not presen

Radiographicly are the most common **periapical rdiolucencies encountered in dental practice the lesion is not fully dark but it has greyish appearance with well defined borders , there is a loss of lamina dura in relation with the affected tooth** , the size of radiolucency is less than 1.5 cm in diameter if the size larger so it consider periapical cyst.

1. Granuloma Periapical Radiograph Image

Differential Diagnosis

Differences between cyst and granuloma: It is not easy to differentiate periapical granuloma from periapical cyst on the basis of radiographs.

It is accepted that lesions having a diameter smaller than 1.5 cm are apical granulomas and lesions bigger than this are periapical cysts

Difference between granuloma and apical abscess: Apical abscesses form large radiolucencies with diffuse irregular borders.

Periapical scar: Periapical scar is associated with endodontically treated tooth

C-Chronic periapical abscess

Clinical Features

This creates minimal discomfort for the patients.

Clinically, there will be a moderate-to-large carious lesion.

The tooth may be slightly loose or tender to percussion.

Radiographic appearance of the lesion the periapical tissue may appear normal radiographically, as it requires 10 days or more for an infection to erode cortical bone,,may be quite variable, the lesion may **have radiolucent appearance with ill-defined borders** and in this time it impossible to differentiate from granuloma or cyst.

Differential Diagnosis

There are many normal radiographic landmarks as well as pathological conditions which can be included in differential diagnosis.

The normal radiographic anatomical landmarks include normal foramina, inferior dental canal and a large marrow space.

All these conditions can be diagnosed by looking at the lamina dura.

Lamina dura in all three conditions is intact.

The pathological condition which can be confused with periapical abscess is periapical osteofibrosis, but in this condition tooth is vital.

Differential Diagnosis

Condensing osteitis should be differentiated from:

Idiopathic osteosclerosis (radio-opacity is separated from the apex).

Other conditions that should be differentiated are hypercementosis (lamina dura is inside the lesion).

OSTEOMYELITIS

Osteomyelitis is an inflammation of bone.

The inflammatory process may spread through the bone to involve the marrow, cortex, cancellous portion and periosteum.

Clinical Features

Osteomyelitis of the maxilla is much less frequent than that of the mandible because the maxillary blood supply is far more extensive.

Clinically, patients present with facial swelling, localised pain and tenderness, low-grade fever, draining sinus tracts, suppuration, dental loss and sequestrum (i.e. necrotic bone fragment) formation Radiographic Features.

Acute osteomyelitis: Very early in the disease no radiographic changes are identified.

The first radiographic evidence of the acute form of osteomyelitis is slight decreased density of the involved bone.

There is loss of sharpness of the existing trabeculae.

In time bone destruction becomes more profound, resulting in an area of radiolucency in one focal area or in scattered regions throughout the involved bone.

Sequestra may be present but usually more clearly seen in chronic form of the disease.

FIGURE 44.14 **Osteomyelitis seen in mandible – sequestra surrounded by radiolucency.**

Differential Diagnosis

Osteomyelitis should be differentiated from malignancy, Paget disease and eosinophilic granuloma. In the case of malignancy, there is no formation of sequestration which is very typical feature of osteomyelitis. Usually patient is aged below 40 years in case of osteomyelitis and in case of malignancy patient is above 40 years.

In Paget disease, bone involvement is multiple and in case of osteomyelitis bone involvement is single. Margins of eosinophilic granuloma are better defined if we compare it with osteomyelitis.

Cysts of the jaw

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Cyst is defined as a pathologic cavity filled with fluid, and is lined by epithelium. It can also be defined as fluid- or semi-fluid-filled pathologic cavity lined by epithelium more often occurring in the jawbones than in any other bone.It is thought to arise from the rests of odontogenic epithelium remaining after tooth formation.

Odontogenic cysts(ODC)

Inflammatory ODC

Radicular (dental) cyst

Residual radicular cyst

Developmental ODC

Dentigerous cyst

Odontogenic Keratocyst (OKCs

Lateral periodontal cyst

Glandular odontogenic cyst

Adenomatoid odontogenic cyst

Non odontogenic cyst

Nasopalatine duct/Incisive canal cyst

Traumatic bone cyst

Inflamatory ODC

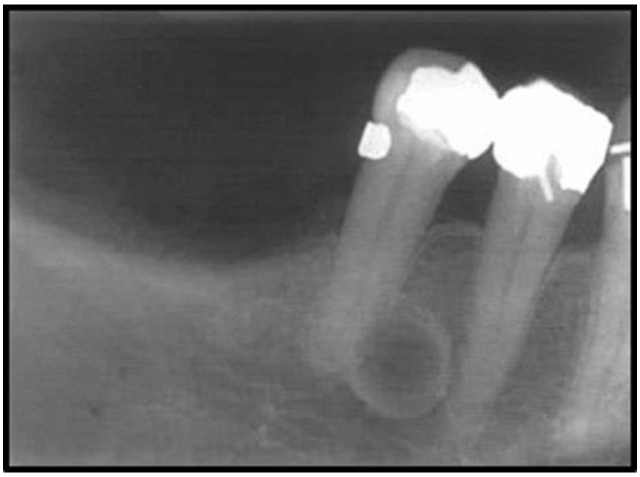
RADICULAR CYST

Clinical Features Radicular cyst is commonly seen in second to fifth decades of life . Maxillary anterior region is most commonly affected as it is prone to more frequent trauma. It is seen at apex of **non-vital teeth.**

It is asymptomatic unless it is secondarily infected. Large cyst results in the swelling of the jaw and mobility of adjacent teeth.

Radiographic Features Radicular cyst appears as radiolucent area at the apex of tooth with well-demarcated sclerotic margins unless secondarily infected.

The size of radiolucency is vary from small to large in diameterIn case of secondary infection margin of cyst can be destroyed. Anatomical structures, such as maxillary antrum, nasal fossa and mandibular canal are frequently involved by teeth.



Differential Diagnosis It includes periapical granuloma (size of granuloma is less than 1.5 cm), periapical scar (history), traumatic bone cyst (not associated with teeth) and periapical cemental dysplasia (tooth is vital

RESIDUAL CYST

Residual cysts most commonly are the retained periapical cysts from teeth that have been removed. They could also develop in a periapical granuloma that is possibly left after an extraction.

Clinical Features Residual cyst can be found in any of the tooth-bearing area of the maxilla or mandible. Size may range from a few millimetres to several centimetres. Clinically, these cysts are usually found on routine radiographic examination of patients. Usually they are painless unless secondarily infected. They do not show expansion of cortical plates.

Radiographic Feature: There is well-defined unilocular radiolucency in the periapical area of extracted tooth. If the cyst is secondarily infected, the hyperostotic border may be absent. Cyst may displace mandibular canal and adjacent teeth.

Differential Diagnosis Differential diagnosis includes
keratocyst (mandibular posterior area),
traumatic cyst (not associated with teeth) .

Developmental odontogenic cysts

DENTIGEROUS CYST

Clinical Features Dentigerous cysts develop around the crown of an impacted or embedded unerupted or supernumerary tooth or in association with odontomas. They are frequently associated with mandibular third molar followed by maxillary canines, maxillary third molar and mandibular second molar.

Radiographic Features

Dentigerous cyst appears as well-defined radiolucency with sclerotic borders seen at the cementoenamel (CE) junction of unerupted tooth.

The sclerotic border is absent in case of infected cyst. The teeth are usually greatly displaced from their original position and are found lying on floor of cavity. Radiographically, dentigerous cyst can be central (cyst enclosing the crown of tooth symmetrically), lateral (cyst arising laterally from one side of crown) and circumferential (when whole tooth lies within the cystic cavity).

Differential Diagnosis Differential diagnosis includes:

adenomatoid odontogenic cyst (AOT; maxillary anterior region)

Calcifying epithelial odontogenic tumour (evidence of calcification)

Radicular cyst (carious teeth).

<u>Odontogenic Keratocyst (OKCs)</u>

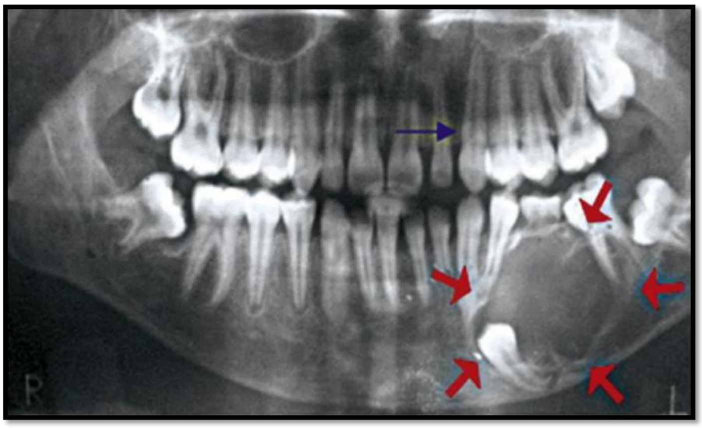
Clinical Features

OKCs can develop in association with an unerupted tooth or as solitaryentities in bone.OKCs usually cause no symptoms, although mild swelling may occur

It is most commonly located in molar ramus area of the mandible

Radiographic Features

It has radiolucency radiographic appearance. Radiographically, it appears as round or oval unilocular or multilocular radiolucency; however, as compared to other cysts, it is less radiolucent due to the presence of keratin in it. The well-defined and sclerotic borders may be visible around the radiolucency if the lesion is not infected



Differential diagnosis includes:

radicular cyst (nonvital teeth)

dentigerous cyst (does not expand anteroposteriorly)

residual cyst (history)

traumatic bone cyst (no expansion)

<u>LATERAL PERIODONTAL CYSt</u>

Clinical Features It is usually asymptomatic and often discovered during normal radiographic examination. It is usually seen in fifth or sixth decade of life with slight male predilection. Eighty percent of the cases are reported in mandibular premolar–canine and lateral incisor areas.

Radiographic Features As the name suggests this cyst appears as a radiolucent area situated laterally at middle third of the affected tooth between the apex and the alveolar crest of tooth. It is oval or round in shape with the size as small as less than 1 cm in diameter. The associated **tooth is vital.** The borders are sclerotic, well-defined surrounding the radiolucency, which is often missing in case of infected cyst.

Differential Diagnosis Differential diagnosis includes dentigerous cyst (associated with unerupted tooth), and radicular cyst (teeth are non-vital).

<u>GLANDULAR ODONTOGENIC CYST</u>

Clinical Features It is relatively rare cystic lesion that occurs over a wide age range from the second to ninth decades, with a peak frequency in the sixth decade, more frequently in males than in females with a predilection for anterior mandible. The lesion shows slow, progressive, locally destructive, painless growth.

Radiological Features The lesion appears as well-defined multilocular, occasionally unilocular radiolucency with sclerotic or scalloped borders. Root resorption of associated teeth and tooth displacement is noted.

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Differential Diagnosis All the lesions which are considered in the differential diagnosis of lateral periodontal cyst should be considered

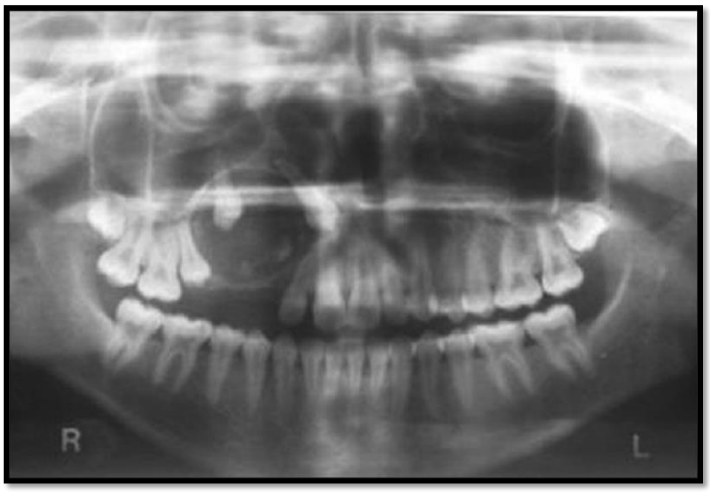
ADENOMATOID ODONTOGENIC CYST

Clinical Features Adenomatoid odontogenic cyst is most commonly seen in individuals between 10 and 40 years of age with female predilection.

The most common site of occurrence in the jaw is the anterior portion of maxilla than in the mandibular region. It may produce obvious swelling clinically, which is usually asymptomatic. It is painless.

Radiographic Features It appears commonly as a unilocular radiolucency with smooth corticated border. Sometimes, it may be having sclerotic border.

Generally, it presents as radiolucency adjacent to or involving crown of associated tooth.Occasionally, area of multilocular radiolucency with scalloped border may be seen. Sometimes, radio-opaque foci may be identified within the radiolucent region. Adjacent tooth displacement and divergence of associated root may be reported with slight erosion of underlying alveolar bone



Differential Diagnosis It includes

odontogenic keratocyst tumour (more in posterior region)

calcifying odontogenic cyst (common in old age)

dentigerous cyst (posterior region).

No odontogenic cyst

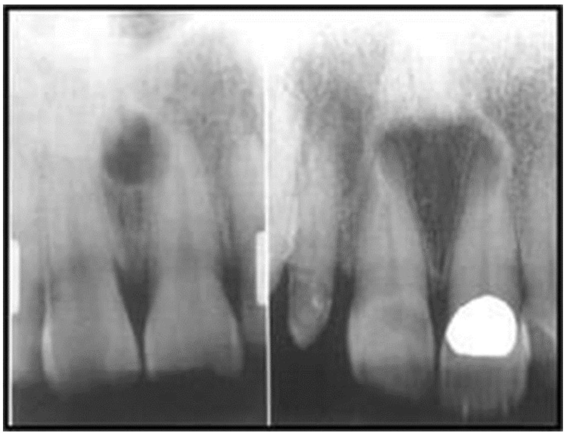
NASOPALATINE DUCT CYST

Nasopalatine cyst is also called incisive canal cyst.

Clinical Features Nasopalatine cyst is seen in fourth and fifth decades with male predilection. There is swelling in the anterior palate.

Many lesions are asymptomatic and discovered only on routine radiographic examination.

Radiographic Features It appears as an area of midline radiolucency situated between roots of upper central incisor in nasopalatine canal. It can be round, oval or irregular in shape with curved margin. If the superimposition of anterior nasal spine occurs, cyst appears **as heart shaped**. It can cause resorption of root and displacement of teeth.



Differential Diagnosis It includes incisive fossa (radiolucency less than 6 mm), radicular cyst (pulp is non-vital) and median palatine cyst (radiolucent lesion is behind the incisive canal).

TRAUMATIC BONE CYST

Clinical Features It is most frequently reported in older age group with male predominance.Mandible is affected more than maxilla in the jaws. It is seen in premolar–molar area. It presents as painless swelling. . Teeth in the affected area are vital.

Radiographic Features Area of radiolucency is situated in canine, bicuspid and molar regions of mandible. The radiolucent lesion is well demarcated from the adjacent bone. Margin is well defined or ill defined with thin radio-opaque border. In some cases, as lesion extends between roots, the border becomes irregular and scalloped.

Differential Diagnosis It includes: radicular cyst, keratocyst (it expands along the bone).

Panoramic Radiography

Panoramic imaging (also called pantomography) is a technique for producing a single tomographic image of the facial structures that includes both the maxillary and mandibular dental arches and their supporting structures.

Principles of panoramic radiography

Paatero and Numata were the first to describe the principles of panoramic radiography. x-ray source rotates around the patient's head and in opposite direction to the rotation of image receptor and collimator. Lead collimators in the shape of a slit, located at the x-ray source and at the image receptor, limit the central ray to a narrow vertical beam. Another collimator between the objects and the receptor reduces scattered radiation.

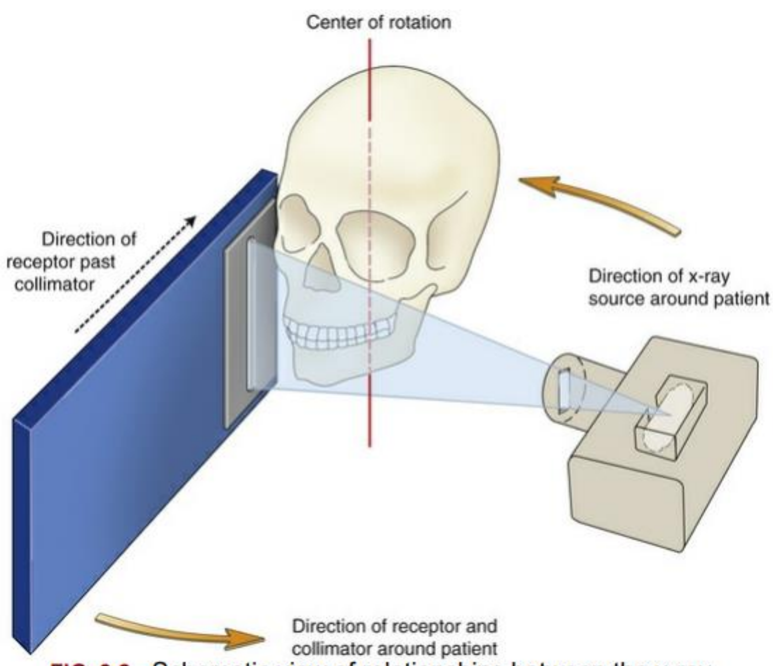


FIG. 9.2 Schematic view of relationships between the x-ray source, the patient, the secondary collimator, and image receptor.

Indications

1. Overall evaluation of dentition

2. Evaluation of intraosseous pathology such as cysts, tumors and infections.

3. Gross evaluation of of tempromandiular joints

4. Evaluation of impacted teeth, dental implant, and orthodontic treatment

5. Evaluation of permanent teeth eruption and mixed dentition.

6. Dentomaxillofacial trauma such as fracture.

7. Developmental disturbances of maxillofacial skeleton.

Advantages of Panoramic radiograph

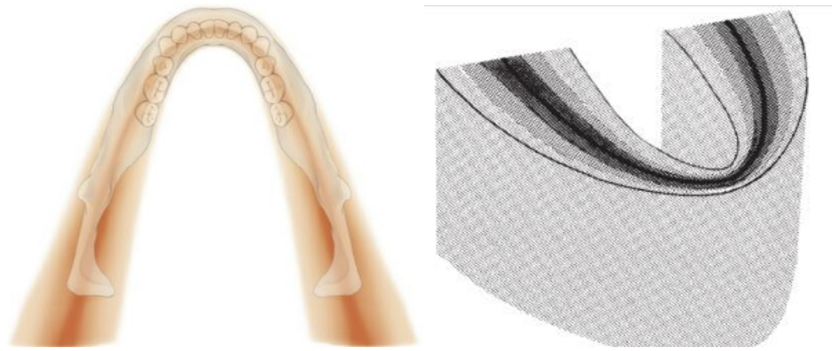
1. Broad coverage of facial bones and teeth
2. Low radiation dose
3. Ease of panoramic radiographic technique
4. Can be used in patients with trismus or in patients who cannot tolerate intraoral radiography
5. Quick and convenient radiographic technique
6. Useful visual aid in patient education and case presentation

Disdvantages

1. Lower-resolution images that do not provide the fine details provided by intraoral radiographs
2. Magnification across image is unequal, making linear measurements unreliable
3. Image is superimposition of real, double, and ghost images and requires careful visualization to decipher anatomic and pathologic details
4. Requires accurate patient positioning to avoid positioning errors and artifacts, so it is not suitable for children under 5 years or on some disabled patients.
5. Difficult to image both jaws when patient has severe maxillomandibular discrepancy

Focal Trough (Image Layer)

is a wide, three-dimensional curved zone, where the structures lying within this layer are reasonably well defined on panoramic image. The structures seen on a panoramic image are primarily those located within the image layer. Objects outside the image layer are blurred, magnified, or reduced in size and are sometimes distorted to the extent of not being recognizable.



Focal trough

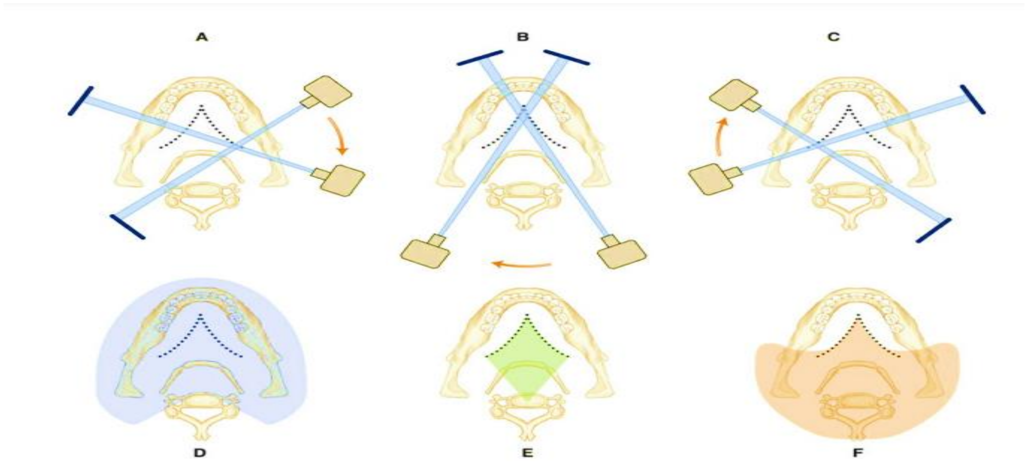
Real, Double, and Ghost images

Because of the rotational nature of x-ray source and receptor, the x-ray beam intercepts some anatomic structures twice. Depending on their location, objects may cast three different types of images:

1. **Real images**: object that lie between the center of rotation and the receptor form a real image (all the objects within focal trough cast relatively sharp images). (figure D)

2. **Double images**: objects that lie posterior to the center of rotation and that intercepted twice by the x-ray beam form double images (figure E).

3. **Ghost images**: objects that located between the x-ray source and center of rotation, can cast ghost images. The ghost image appear on the opposite side of it's true anatomic location and at higher level. (figure F)



Technique, Patient Positioning and Head Alignment

This technique utilises a narrow vertical negatively angled beam. The angle can be (−4 to −7°), so the beam exposes the patient just below the occipital bone. The beam is shaped by a lead collimator which is long, narrow slit located at the X-ray source and the image receptor (film or digital plate).

Proper patient preparation and positioning within the focal trough are essential to obtaining diagnostic panoramic radiographs.

1. Dental appliances, earrings, necklaces, hairpins, and any other metallic objects in the head and neck region should be removed.

2. Demonstrate the machine to the patient by cycling it while explaining the need to remain still during the procedure. This is particularly true for children, who may be anxious. Children should be instructed to look forward and to not follow the tube head with their eyes

3. The anteroposterior position of the patient head is achieved typically by place the incisal edges of their maxillary and mandibular incisors into a notched positioning device (the biteblock).

4. The midsagittal plane must be centered within the focal trough without any lateral shift in the mandible

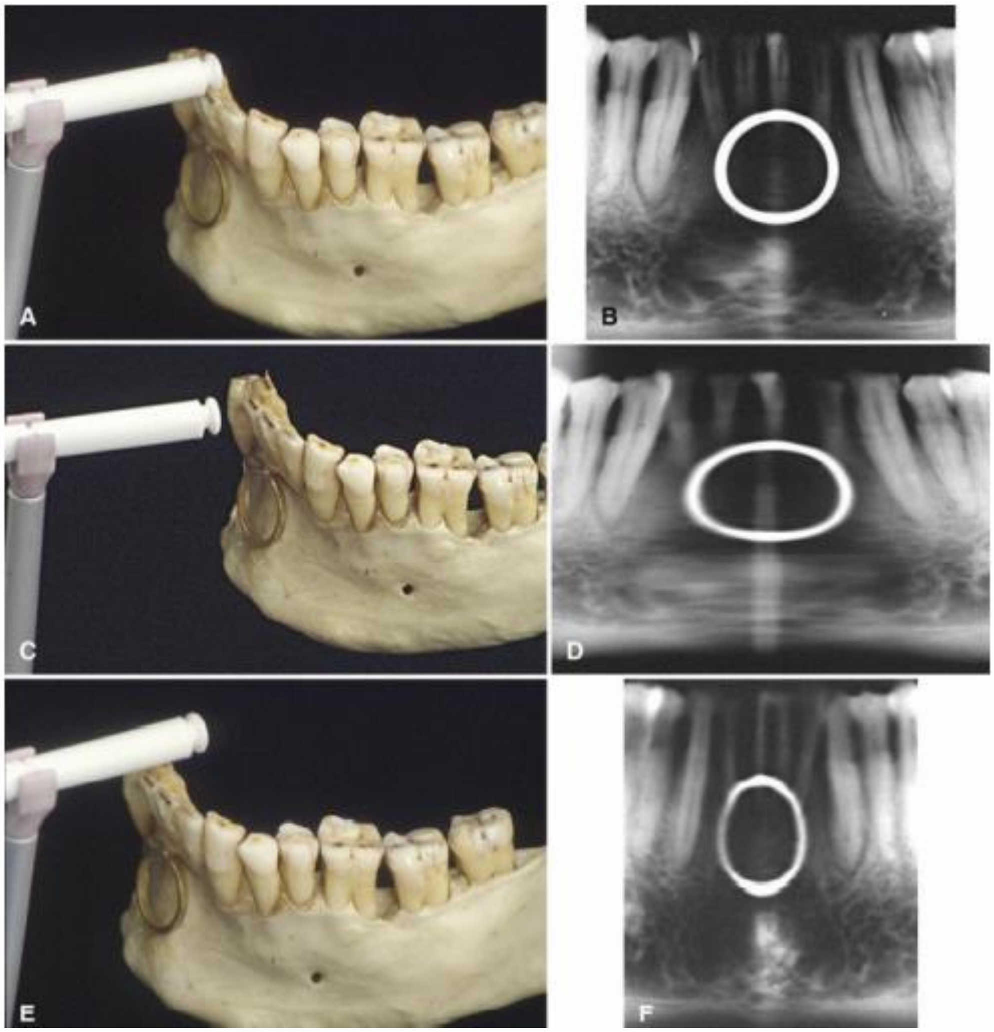
5. The patient's chin and occlusal plane must be properly positioned to avoid distortion. The occlusal plane is aligned so that it is lower anteriorly.

6. Patients are positioned with their backs and spines as erect as possible and their necks extended.

7. Ask the patient to swallow and hold the tongue on the roof of the mouth. This raises the dorsum of the tongue to the hard palate, eliminating the air space and providing optimal visualization of the apices of the maxillary teeth

Placement of the patient either too far anterior or too far posterior relative to the focal trough results in significant dimensional **errors** in the images for example:

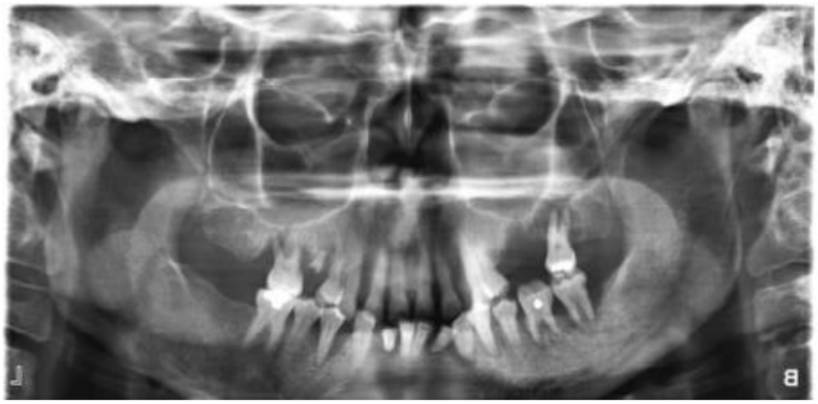
- Too far posterior results in magnified mesiodistal dimensions through the anterior sextants and resulting "fat" teeth (D). Too far anterior results in reduced mesiodistal dimensions through the anterior sextants and resulting " thin " teeth (F).



- Failure to position the midsagittal plane lead to rotational midline results in a radiograph showing right and left sides that are unequally magnified in the horizontal dimension . Poor midline positioning is a common error, causing horizontal distortion in the posterior regions, excessive tooth overlap in the premolar regions and, on occasion, nondiagnostic, clinically unacceptable images.

- If the chin is tipped too high, the occlusal plane on the radiograph appears flat or inverted, and the image of the mandible is distorted (A). In addition, a radiopaque shadow of the hard palate is superimposed on the roots of the maxillary teeth. While If the chin is tipped too low, the teeth become severely overlapped, the symphyseal region of the mandible may be cut off the film, and both mandibular condyles may be projected off the superior edge of the film (B).

A



B

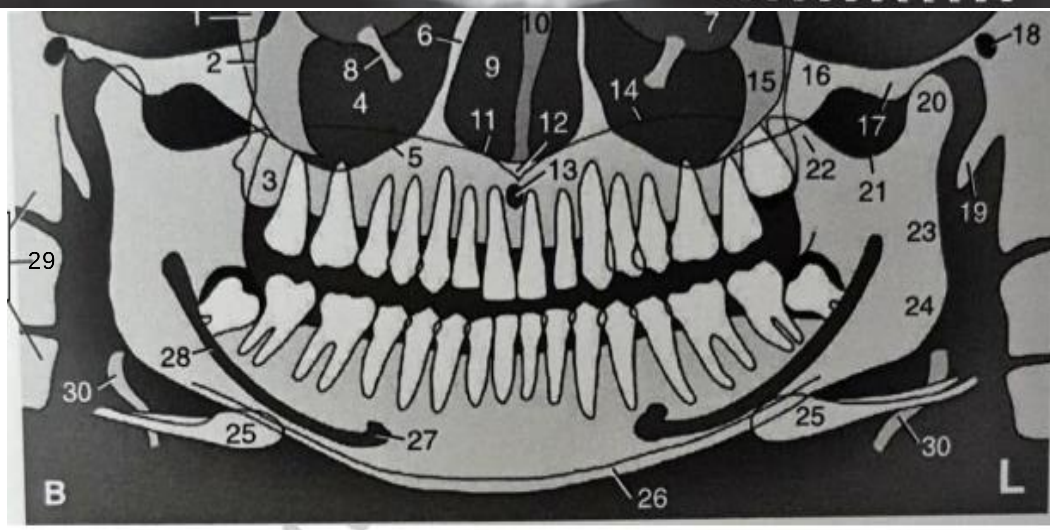
- improperly positioned patient. Patients don't sit straight and align or don't stretch their back leading to large radiopaque region in the middle (vertebral shadow)

Interpretation of Panoramic Images

Interpretation of normal anatomical structures, ghost image and pathological conditions on a panoramic image can be complex. As a general rule, images should be viewed in dim light room using a viewer box or a computer monitor. An operator should always analyses a panoramic image for any possible technique or processing errors.

It is important to know a good panoramic radiograph the mandible is "U" shaped, the condyles are positioned about an inch inside the edge of the film and 1\3 of the way down from the top edge of the film. The occlusal plane exhibits a slight curve or "smile line", upwards. The roots of the maxillary & mandibular anterior teeth are readily visible.

interpretation of Normal Anatomical landmarks in the panoramic radiograph



Anatomical landmarks in the panoramic radiograph

1. Pterygomaxillary fissure
2. Posterior border of maxilla
3. Maxillary tuberosity
4. Maxillary sinus
5. Floor of the maxillary sinus
6. Medial border of maxillary sinus/ lateral border of the nasal cavity
7. Floor of the orbit
8. Infraorbital canal
9. Nasal cavity
10. Nasal septum
11. Floor of the nasal cavity
12. Anterior nasal spine
13. Incisive foramen
14. Hard palate/floor of the nasal cavity
15. Zygomatic process of the maxilla
16. Zygomatic arch
17. Articular eminence
18. External auditory meatus
19. Styloid process
20. Mandibular condyle
21. Sigmoid notch
22. Coronoid process
23. Posterior border of ramus
24. Angle of mandible
25. Hyoid bone
26. Inferior border of mandible
27. Mental foramen
28. Mandibular canal
29. Cervical vertebrae
30. Epiglottis

Extraoral radiography

(Craniofacial projections, Cephalometric projections, TMJ projections)

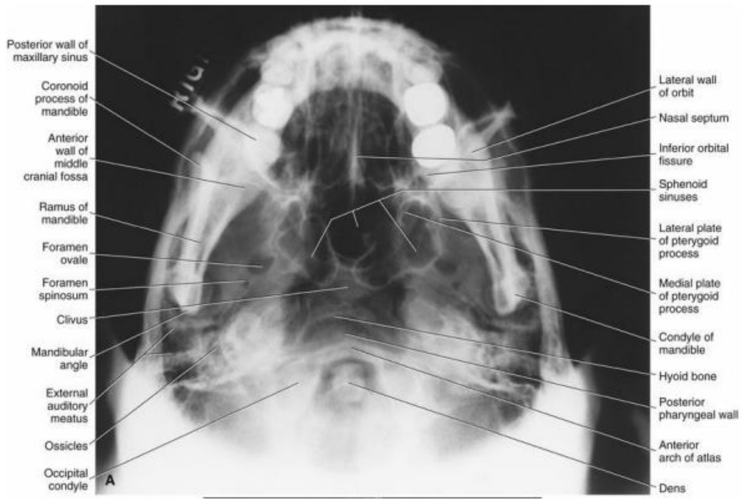
This lecture describes the most common projections for extraoral radiographic examinations in which both the x-ray source and the image receptor (film or digital sensor) are placed outside the patient's mouth.

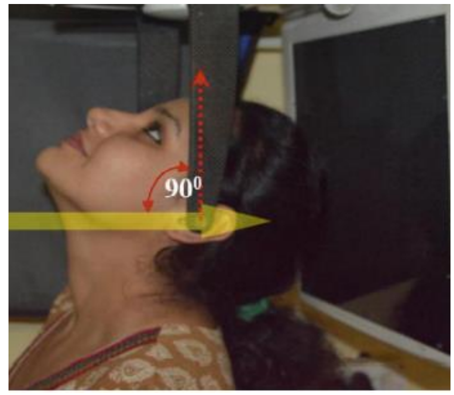
Extraoral radiographs are used to examine areas not fully covered by intraoral radiographs or to evaluate (the cranium, face including the maxilla and mandible, or cervical spine) for diseases, trauma, abnormalities, relationship between various orofacial and dental structures, growth and development of the face, or treatment progression.

For evaluation of extraoral images, it should first be evaluated for overall quality, proper exposure and processing, when film-based, result in an image with good contrast and density. Proper patient positioning prevents unwanted superimpositions and distortions and facilitates identification of anatomic landmarks. Interpreting poor-quality images can lead to diagnostic errors and subsequent treatment errors.

Craniofacial and skull projections

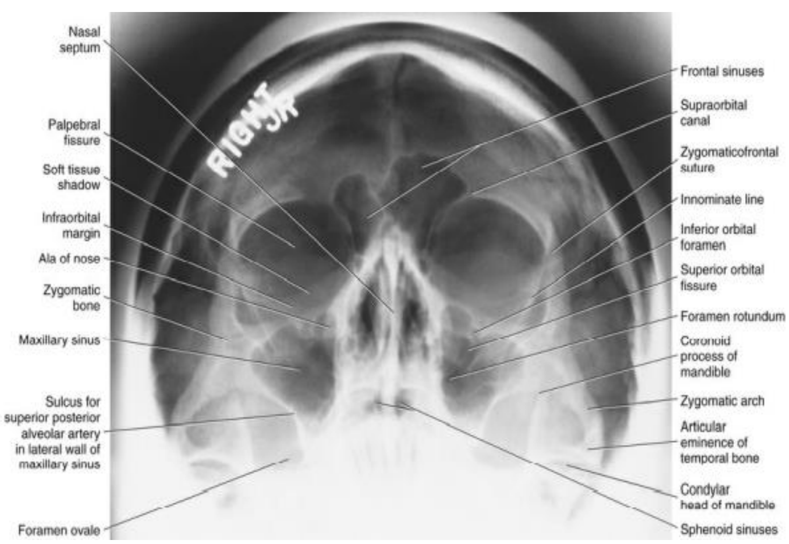
Submentovertex (SMV) or Base Projection: In this projection the patient's neck is extended as far backward as possible and the central beam is perpendicular to the image receptor, directed from below the mandible toward the vertex of the skull (so named SMV), it displays the base of the skull, the zygomatic arches fracture, and the sphenoid sinuses, hard palate, and mandible.

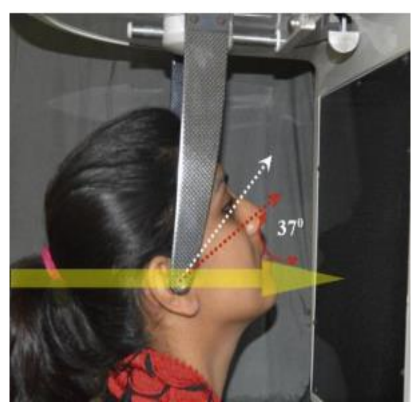




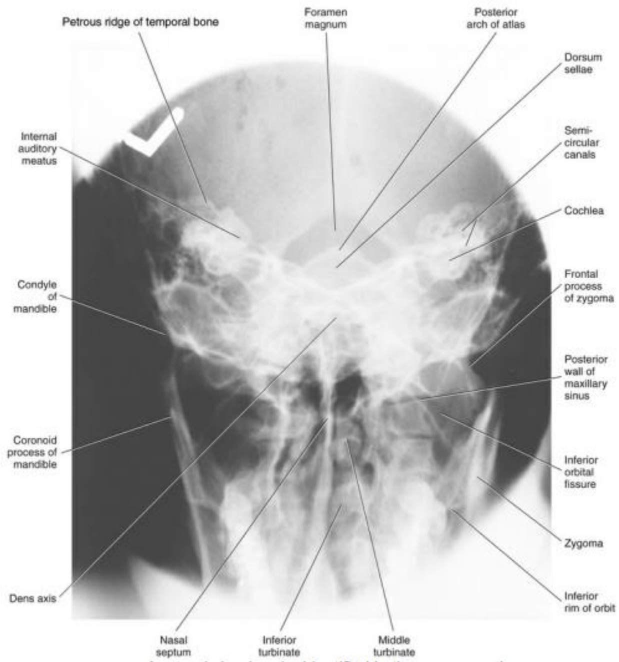
Waters (Occipitomental) Projection

It is the best projection to view ‘sinuses’. The image receptor is placed in front of the patient and the central beam is perpendicular to the image receptor and centered in the area of the maxillary sinuses. It displays predominantly the maxillary sinuses. It also images the orbital ridges and floor, frontal and ethmoid sinuses as well as the nasal cavity and midfacial fractures.



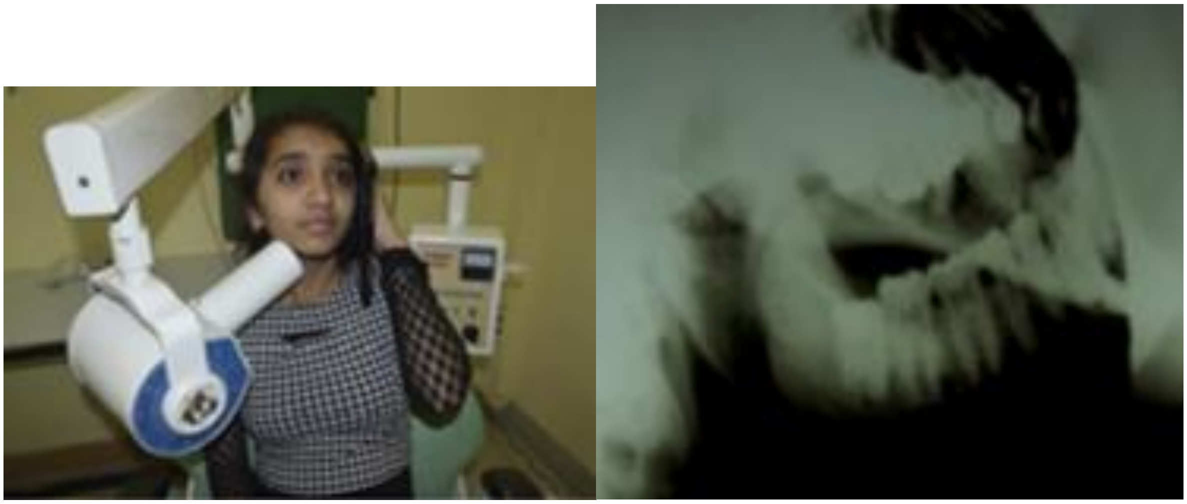


Reverse Towne Projection: It is an open mouth technique, the image receptor is placed in front of the patient, The central beam is perpendicular to the image receptor and parallel to the patient's midsagittal plane centered at the level of the condyles, used to evaluate patients with suspected fractures of the condyle and condylar neck also show the posterolateral wall of the maxillary antrum.



Lateral Oblique Projection: An extraoral view of the jaw used to assess presence of unerupted teeth, fractures of the mandible, and evaluation of jaw lesions, it is of 3 types:

- **Mandibular ramus projection** it gives a view of the ramus from the angle of the mandible to the condyl. It often is very useful for examining the third molar regions of the maxilla and mandible
- **Mandibular body projection** it demonstrates the premolar-molar region and the inferior border of the mandible. It provides much broader coverage than is possible with periapical projections
- **Bimolar view**: In this view, both the right and left sides of mandible are taken in one film.



lateral oblique view of mandibular ramus

Lateral oblique view of mandibular body

Bimolar view

Cephalometric projections

They are standardized projections made with a Cephalostat, which helps to maintain a constant relationship between the skull, the receptor, and the x-ray beam. A cephalometric projection used a long source-to-object distance of 5 ft; to minimizes image magnification. The object-to-receptor distance is typically 10 to 15 cm. These projections using film or digital receptors. There are 2 main types of cephalometric projections:

- **Lateral Cephalometric Projection** **(Lateral Skull Projection)**

Indications:

1. A pretreatment record prior to the placement of appliances
2. Evaluate the relationships between the maxilla, mandible, and cranial base, in addition to soft-tissue relationships.
3. Monitor progress of orthodontic treatment and treatment outcomes.
4. Proceed with orthognathic surgical treatment planning.

Technique and positioning:

The image receptor is positioned parallel to the patient's midsagittal plane, the patient is placed with the left side toward the image receptor and asked to occlude in his normal intercuspation position. The central beam is perpendicular to the midsagittal plane and the image receptor centered over the external auditory meatus. Exact superimposition of right and left sides is impossible because the structures on the side near to the image receptor are magnified less than the same structures on the side far from the image receptor.

- **Postero-anterior cephalometric projection**

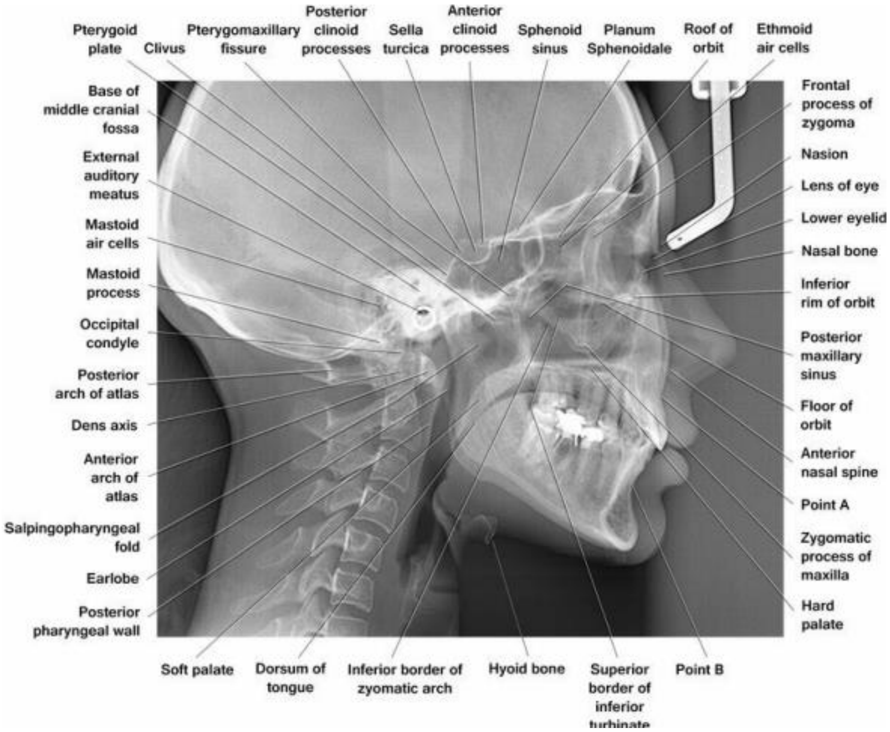
Indications

1. Evaluate craniofacial asymmetry.
2. Assess jaw skeletal relationships.
3. Monitor progress of treatment and treatment outcomes.
4. Proceed with orthognathic surgical treatment planning.

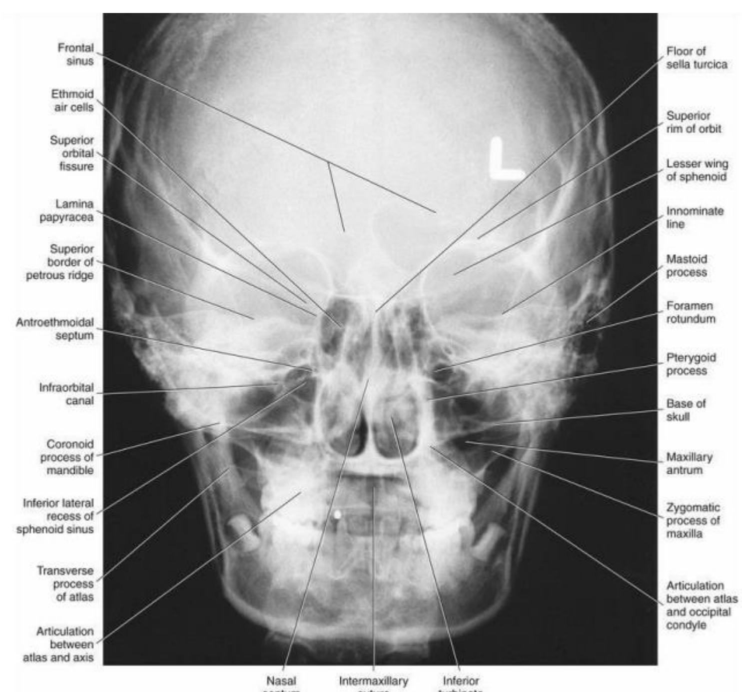
Technique and positioning:

The image receptor is placed in front of the patient, perpendicular to the midsagittal plane and parallel to the coronal plane. The central beam is perpendicular to the image receptor, directed from posterior to anterior (hence the name PA) at the level of the bridge of the nose.

Another lateral skull and PA projection are made without cephalostate or standardization; used when a single lateral view of the skull is required like middle third facial fractures but not in orthodontics or growth studies.



Anatomic landmarks identified in the lateral cephalometric projection.



Anatomic landmarks identified in the PA cephalometric projection

Most common Cephalometric Landmarks

Skeletal Landmarks	Soft Tissue Landmarks
1. Porion (P): Most superior point of the external auditory canal 2. Sella (S): Center of the hypophyseal fossa 3. Nasion (N): Frontonasal suture 4. Orbitale (O): Most inferior point of the infraorbital rim 5. PNS: Tip of the posterior nasal spine 6. ANS: Tip of the anterior nasal spine 7. A point (A): Deepest point of the anterior border of the maxillary alveolar ridge concavity 8. B point (B): Deepest point in the concavity of anterior border of the mandible 9. Pogonion (Po): Most anterior point of the symphysis 10. Gnathion: Midpoint of the symphysis outline between pogonion and menton 11. Menton (M): Most inferior point of the symphysis 12. Gonion: Most convex point along the inferior border of the mandibular ramus	1. Soft tissue glabella: Most anterior point of the soft tissue covering the frontal bone 2. Soft tissue nasion: Most concave point of soft tissue outline at the bridge of the nose 3. Tip of nose: Most anterior point of the nose 4. Subnasale: Soft tissue point where the curvature of the upper lip connects to the floor of the nose 5. Soft tissue A point: Most concave point of the upper lip between the subnasale and the upper lip point 6. Upper lip: Most anterior point of the upper lip 7. Lower lip: Most anterior point of the lower lip 8. Soft tissue B point: Most concave point of the lower lip between the chin and lower lip point 9. Soft tissue pogonion: Most anterior point of the soft tissue of the chin 10. Soft tissue gnathion: Midpoint of the chin soft tissue outline between the soft tissue pogonion and soft tissue menton 11. Soft tissue menton: Most inferior point of the soft tissue of the chin

Tempromandibular Joint (TMJ) projections

TMJ is the area where the mandible articulates with cranium. **TMJ is consists of :** Bones (mandibular condyle and temporal bone), Articular disc, Capsular ligament, and Joint cavity (synovial membrane)

1- **Bony components:** The condyle is the mandibular component of the TMJ extends superiorly from the ramus by a narrow neck Various shapes noticed; may be flat, round, or convex. The articular component of the temporal bone is formed by the inferior surface of the squamous process, and is composed of the glenoid fossa posteriorly and the articular eminence and tubercle anteriorly.

2- **Articular disc (meniscus):** is composed of avascular fibrous connective tissue, and is positioned between the condylar and temporal components of the joint divides the joint cavity into inferior and superior joint spaces, which are located below and above the disc, respectively.

3- **Retrodiscal tissues (Posterior Disc Attachment):** is consist of superior and inferior lamellae enclosing a region of loose vascular tissue, and this is often referred to as the bilaminar zone.

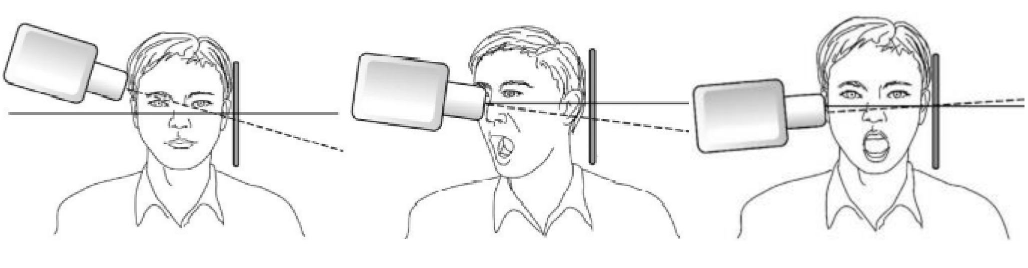
Types of imaging techniques

1. Plain radiographs (transcranial projection, transorbital projection, transpharyngeal projection

2. Panoramic radiography (OPG)
3. Cone beam computed tomography (CBCT) and Multidetector computed tomography (MDCT)
4. MRI and ultrasonography (for soft tissue imaging)

Plain radiography:

1. **Transcranial-view**: it is one of the most popular plain imaging techniques to study the TMJ. The film cassette is positioned against the facial skin surface on the side of interest and the central beam projected across the cranium passing through the TMJ from other side either with Closed-mouth or Open-mouth position It used in visualization of changes in lateral aspect of the articulating surface, position and shape of condyle and fossa.
2. **Transorbital view**: is a frontal projection of the TMJ. the film cassette Position behind the patient's head so that the central ray is projected infront of the patient through the orbit to the TMJ asking the patient to open the mouth. It demonstrate the entire latero-medial articulating surface of the condyle and articulator eminence and the condylar neck.
3. **Transpharyngeal view**: It also called infracranial view, the film cassette is positioned against the side of patient's head, parallel to the sagittal plane next to TMJ of interest. the central X-ray directs below the base of the skull through the oropharynx to TMJ, before film exposure the patient opens the mouth wide. it demonstrate the angular process, diagnosis of fracture in the condyle and condylar neck, detection the alteration in condyle morphology.



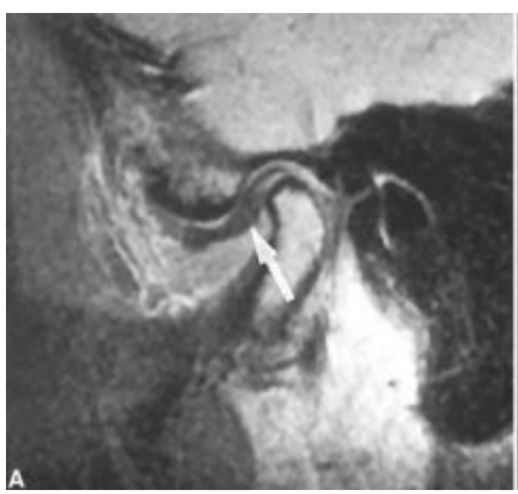
Transcranial view **Transorbital view** **Transpharyngeal view**

Abnormalities of the TMJ

1- Developmental abnormalities such as (condylar hypoplasia, condylar hyperplasia and coronoid hyperplasia, bifid condyle)
2- Soft tissue abnormalities such as disc displacement (with or without reduction)
3- Remodeling and arthritic conditions
4- Trauma such as fracture, dislocation and effusion
5- Ankylosis such as bony and soft tissue ankylosis
6- Tumors (benign and malignant)

PA view of right condylar hyperplasia

CBCT of Bifid condyle



MRI of anterior disc displacement with reduction.

Radiology

Lec 14. **Patient's Management** **Dr. Areej Ahmed**

Not all dental radiographic techniques can be successfully performed on all patients. Radiographic examination techniques must often be modified to accommodate patients with special needs.
The dental radiographer must be competent in altering radiographic techniques to meet the specific diagnostic needs of individual patients.
We discuss how to manage patients with a Gag reflex, patients with physical or developmental disabilities, pediatric, and edentulous patients.

1. Gagging Reflex

Intra oral films are placed in oral areas specifically related to the initiation of this reflex. Some patients may unconsciously activate this reflex as a defense against anticipated unpleasantness.
Gagging (retching): Refer to strong involuntary effort to vomit.
Gag reflex (pharyngeal reflex): reaction that is elicited by stimulation of the sensitive tissues of the soft palate region.
A gag reflex is a protective mechanism of the body that serves to clear the airway of obstruction. In the dental radiography a hypersensitive gag reflex is a common problem.
The areas that are most likely to elicit the gag reflex are the soft palate and the lateral posterior third of the tongue.

Prior to gag reflex, two reactions occur:

1.Cessation of respiration.
2.Contraction of the muscles of the throat and abdomen.

The precipitating factors that are responsible for initiating the gag reflex include (psychogenic stimuli) and (tactile stimuli)

Patient management:

a. Operator attitude:

Most gagging can be controlled through the creation of the patient confidence or by-diverting the patient's concentration away from gagging reflex like asking the patient to breathe deeply through the nose or moving his/her arm.

b. Patient and equipment preparations :

In a patient with hypersensitive gag reflex, every effort should be made to limit the amount of time that a film remains in the mouth. The longer a film stays in the mouth, the more likely the patient to gag.

c. Exposure sequencing:

It play an important role in preventing gag reflex. The dental radiographer should always start with anterior exposure; with posterior exposure the dental radiographer should always expose the premolar before molar.

d. Film placement and technique:

Each film must be placed and exposed as quickly as possible. Placement and technique modification include the following:

- Avoid the palate: position the film lingual to the teeth and then firmly bring the film in to palatal tissue using one decisive motion.
- Demonstrate film placement: in the areas that are most likely to elicit the gag reflex, rub a finger along the tissues near the intended area of film placement, while telling the patient, "This is where the film will be positioned." Then quickly place the film.

e. Use of extraoral radiograph:

occasionally the dental radiographer encounters a patient with a gag reflex that is uncontrollable. In such a patient, intra oral radiograph is impossible to obtain, so the dental radiographer must use extra oral films such as panoramic or lateral jaw radiographs.

f. Using topical anesthetic agent :

When the cause of gag reflex is tactile , in such cases with gag reflex we can use local anesthesia.Salt application on the palate said to be useful.

2<u>. Neuromuscular problems</u>

Refer to patient inability to remain immobile

a. Speed is essential in radiographic procedure.

b. Minimization of the exposure interval through:

*The use of fast films.

*Decrease the source-object distance.

*Maximally high kilo voltage.

*Highest milli amperage

c. Using of films holders that can be stabilized by another person but not by dental office staff.

d. Extraoral films may be useful supplemented by intraoral films.

e. Sedation sometimes is essential.
f. Radiograph can be performed under anesthesia.

3. Physical Disabilities

Patients with disabilities physical impairment that substantially limits one or more of an individual's life activities.

a. **Vision impairment:** if a patient is blind or visually impaired, the dental radiographer must communicate using clear verbal explanations. The dental radiographer must keep the patient informed of what is being done and explain each procedure before performing it.
b. **Hearing impairment:** if a person is deaf or hearing impaired, the dental radiographer may ask the caretaker to act as interpreter, or use written instructions. When the patient can read lips, the dental radiographer must face the patient and speak clearly and slowly.
c. **Mobility impairment**: if a person is in a wheelchair and does not have use of the lower limbs, the dental radiographer may offer to assist the patient in transferring to the dental chair. If a transfer is not possible, the dental radiographer may attempt to perform the procedure with the patient seated in the wheelchair. If a person does not have use the upper limbs and a holder cannot to stabilize the film placement, the dental radiographer may ask the caretaker to assist with film holding, the caretaker must wear a lead apron and thyroid collar. The dental radiographer must never hold a film during exposure.

4. Developmental Disabilities

Is a substantial impairment of mental functioning that occurs before the age of 22 and is of indefinite duration. (Autism, cerebral palsy, epilepsy and other neuropathies and mental retardation).
A person with a developmental disability may have problems with coordination or comprehension of instruction. As a result the dental radiographer may experience difficulties in obtaining intraoral films. If coordination is a problem, mild sedation may be useful. If comprehension is a problem and the patient cannot hold a film, the caretaker may be asked to assist with film holding.
It's important that the dental radiographer recognize situations in which the patient cannot tolerate intraoral exposure. In such cases no intraoral films must be used and change to extraoral films.

5. Child patient

a. Use conveniently small intraoral films

b. Lead apron, the growing organs of the child are particularly susceptible to the effects of ionizing radiation and must be protected, so lead apron and thyroid collar must be placed on the child prior to the x-ray exposure.

c. Exposure factors (mA, kVp , time) must be reduced.

d. Extraoral films can be used instead of intraoral.

e. Radiographic procedures should not be hurried nor should the child be apprised of any negative possibility like you might hurt a bit or you may gag.

f. Do not expose the young child to two or more circumstances simultaneously.

g. Show him a radiograph of another child's teeth and let him see the radiographic procedure on another member of the family.

h. A mirror enabling the child to observe the procedure, maybe helpful.

6. Edentulous patient

Edentulous patient require dental radiograph for the following reasons:

- Detect the presence of root tips, impacted teeth and lesions.
- To establish the position of normal anatomic land marks relative to the crest of alveolar ridge
- To observe the quantity and quality of bone that is present.

The radiographic examination of edentulous patient may include;

a. Panoramic radiograph: is the most common way, its quick and easy. If the panoramic technique reveals any root tips, impacted teeth, foreign bodies or lesions in the jaw, a periapical film of that specific area must be used.

b. Periapical radiograph: it has more definition and permits the area in question to be examined in greater detail. When using parallel technique, cotton roles must be placed on both sides of biting block to take the place of missing teeth. If the alveolar ridge is severely absorbed, bisecting angle technique is used.

c. Occlusal radiograph: to examine the tooth bearing area and detection of bone lesions not recognized by OPG.

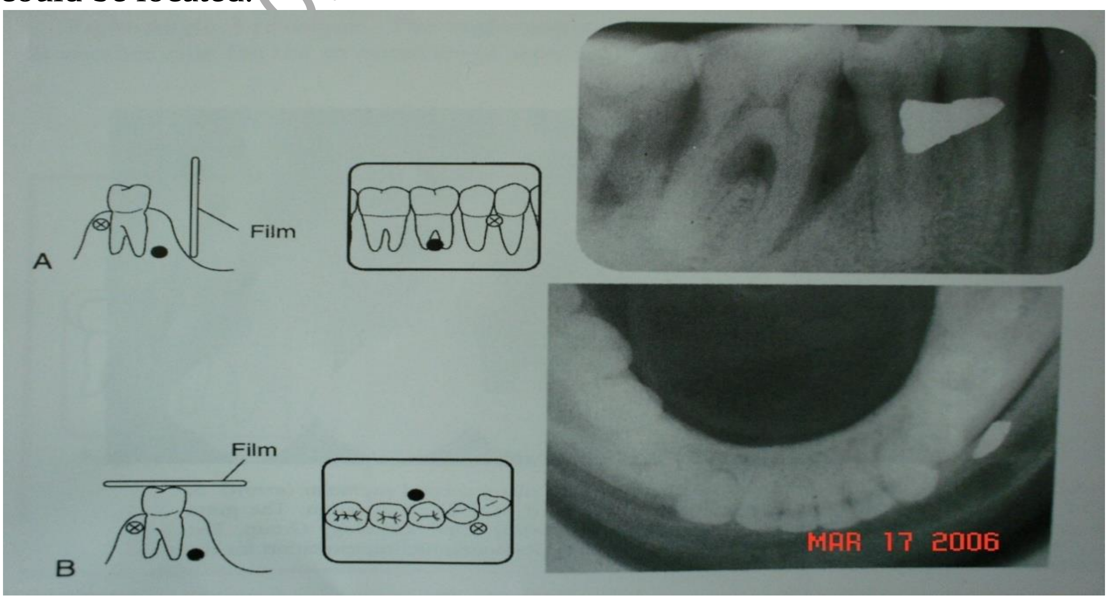
Localization techniques
Is a method used to locate the position of a tooth or object in the jaws.

Localization technique may be used to locate the followings:
1) foreign bodies
2) impacted teeth
3) unerrupted teeth
4) retained roots
5) salivary stones
6) root positions
7) jaw fractures
8) broken needles & instruments
9) filling materials

The radiograph presents as two dimensional image of a three-dimensional object. There is often a need for determining special relationship. So techniques for doing this are discussed as follows:

A. Right angle technique.
B. Tube shift technique.
C. Stereo radiography (It is not widely used because it is time consuming and need a special viewing device).
D. Use of radio-opaque media

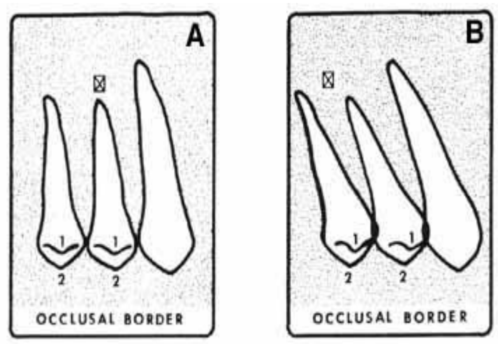
Right angle procedure
It involves the use of at least 2 films taken at right angles to each others. For example: lateral skull projection demonstrates the anteroposterior areas and posteroanterior projection demonstrates the mediolateral areas so an object could be located.



Tube shift technique:

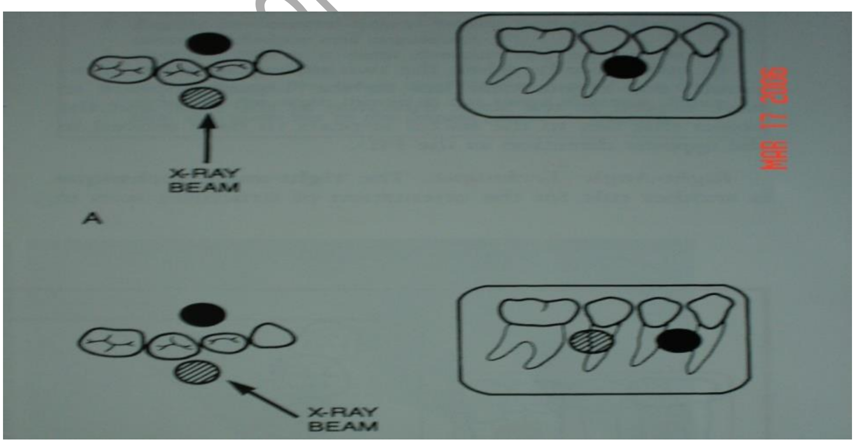
It employs the concepts called Clark's rule. The area in question is anesthetized, a small hypodermic needle is inserted in vertical position in mucobuccal fold near the object in question, a radiograph is taken, then insert another film and second radiograph is taken with mesial shifted tube. The 2 films are processed and compared.

If the object in the second radiograph appears more mesialy, that means the object is located far lingualy or palately, while if it is more distally (in relation to the needle) it means it is buccaly positioned, and if it is not move it means that it is close to the needle.



When the object in question is close to a tooth or surface of a crown so that there is no need for insertion of a needle

*note: to remember the tube shift technique. Keep in your mind the word (SLOB) Same = Lingual , Opposite = Buccal



Use of radio-opaque media*:*

Barium sulfate, lipiodol and dionosil can be used to demonstrate cavernous areas with hard and soft structures. After the injection of the radio-opaque media (mostly lipiodol) in cyst for example, film exposed, processed and viewed to see the extension of the cyst. Radio-opaque media also used in sialogram to demonstrate the salivary glands and their duct.

Radiographic survey

An examination of a part or an area designed to determine whether any abnormal changes exist within the part or area. It is either routine scanning procedure, or specific purpose survey for example cephalometric films designed to study growth pattern

A new complete survey is not necessary for a period of at least 5 years, but new bite-wing films are often necessary every 6 months. Any single film in the complete mouth survey should have the following criteria of excellence:.

1.Should show no film fog other than that inherent in the film base itself.
2.Should have no stain or discoloration resulting from inadequate darkroom procedure.
3.Film density varies with personal performance but excessively dark or light films are unacceptable.
4.The position of the identifying dot must be toward the occlusal plane, such positioning will avoid superimposing important structures on the dot.
5.The film should be placed so that the incisal edges or cups of the teeth are approximately 1/8 inch (2mm) from film margin.
6.Each single film should show a suitable reproduction of the area being examined.
7.Each tooth's image should be neither elongated nor foreshortened.
8.Inter proximal surfaces of teeth should not overlapped.
9.Each film should show the inter proximal bone crest without superimposition of the adjacent teeth. It is necessary that approximately 1/8 of an inch of alveolar be observable beyond the apex of the tooth (for periapical view).
10.In the excessively long tooth we use 2 films to cover the whole area.
** Criteria of excellence for extraoral films are largely similar to those for intra oral films.

Radiographic survey methods

Routine: for children, adult and edentulous 14-17 periapical films with 2-4 posterior bite-wing films are necessary for adequate interpretation of oral conditions.
Alternate: lateral jaw projections, anterior periapical mandibular and maxillary views with bitewing for posterior teeth. For edentulous patients topographic occlusal films could be used instead of periapical films as alternative survey method .

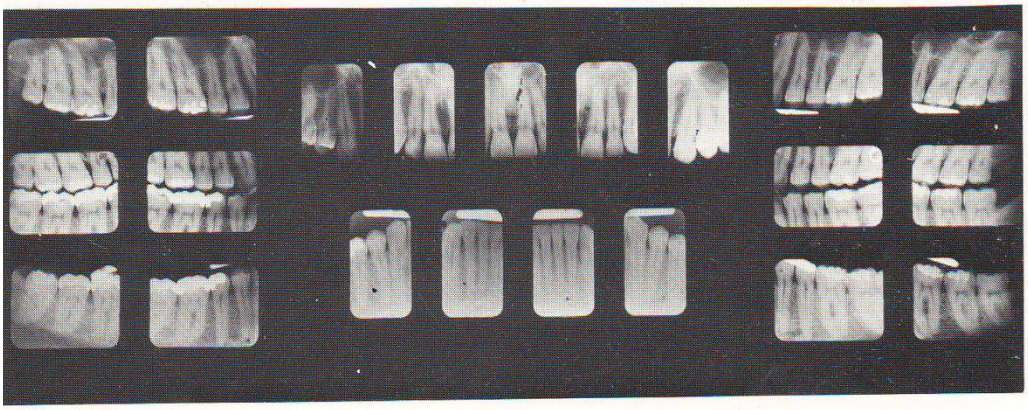


Fig. 10-1. Adult complete mouth periapical survey.

Ref. of lecture: White and Pharaoh's. Oral radiology principles and interpretation. 8th edition 2019.

Radiology

د. زينب البحراني

Digital Imaging

The term digital imaging refers to the numeric format of the image Content. unlike conventional dental radiographic techniques; there is no film or processing solutions used instead.

Components of a Digital Radiographic System

- **Source of radiation** most of the systems use a conventional X-ray unit
- **Image receptor** it measures the photon intensity of the x-ray beam and convert it into electrical signal (analog signal) using Analog-digital converter (ADC) or digitizer that based on the binary number system recognizable by the computer.
- **Data processing unit** is consisting of computer and output device as computer monitor, laptop or flat panel, printer.

Methods of Acquiring a Digital Image

Digital images are acquired either **Directly** or **Indirectly** using :

- **Solid-state technology:**

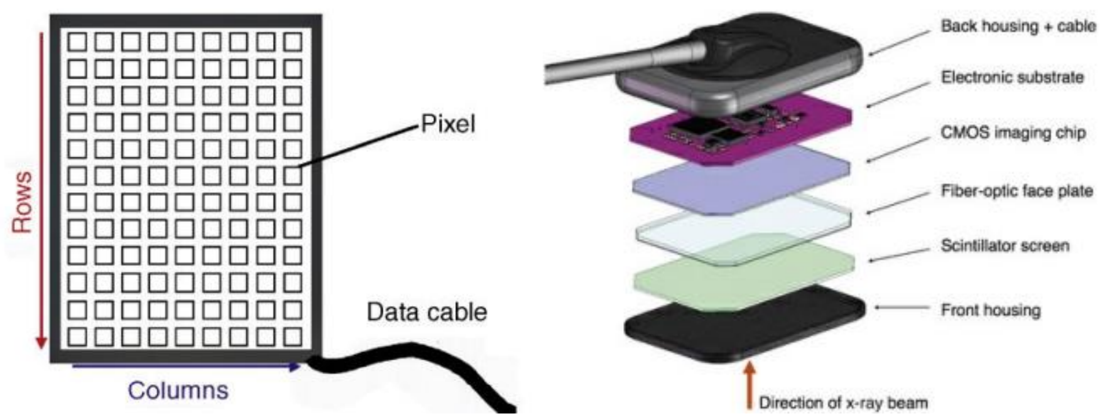
This technology have the ability to generate a digital image directly in the computer without any other external device uses conventional x-ray machine but conventional film is replaced by solid-state detector which is of two types either a **CCD (charge coupled device)** or **CMOS (complementary metal oxide semiconductor)**

The X-ray photons that reach the sensor are converted to light, since it consists of silicon crystals arranged in a network pattern forming a pixel matrix and picked by the CCD/CMOS and converted into an electrical charge which, once produces a digital image on the monitor of the computer sensors which connected to it via a cable or cord (so called real time and corded).

Specially designed intraoral sensor holders similar to those used for conventional film, have been developed, when used clinically, the sensors need to be covered with a protective plastic barrier housing for infection control purposes. Different sized intraoral receptor (adult size and small size sensor for children) and larger extraoral receptors for both panoramic and cephalometric radiographs are required.

Advantages of CCD and COMS:

- The image appears on the monitor instantaneously.
- Infection control is easier and quicker.



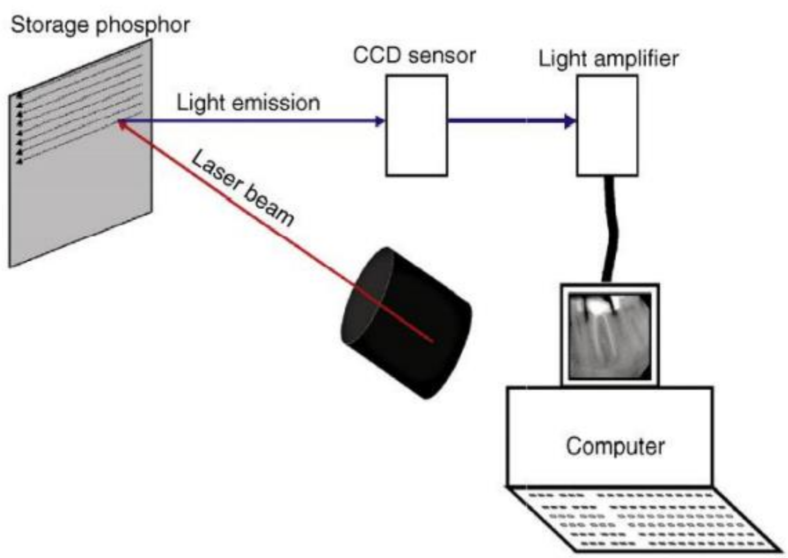
- Photostimulable phosphor technology:

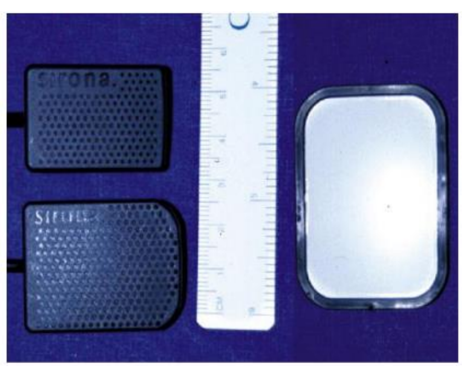
This technology consists of a phosphor-coated plate in which a latent image is formed after x-ray exposure. The latent image is converted indirectly to a digital image by a scanning device through stimulation by laser light. the conventional film is replaced by **photostimulable phosphor storage plate (PSPP)** which is flexible re-usable.

The phosphor layer plates contain a layer of barium fluorohalide phosphor it absorbs and stores the X-ray energy. The image plate is then placed in a reader where it is scanned by a laser beam. The stored X-ray energy in the phosphor layer is released as light (phosphorescence) which is detected by a photomultiplier, the information is indirectly scanning and digitizing a film-captured image then displayed on the monitor. The time taken to read the plate depends on the system being used, and the size of the plate, but usually varies (1 – 5) minutes. A range of intraoral plate sizes are available identical in size to the conventional periapical and occlusal film packet. The intraoral plates are inserted into protective barrier envelopes and can then be used in conventional film holders. The essential components of the indirect system are a CCD camera so the signal amplified and transferred to the computer.

Advantages of PSPP:

• Detectors are thin and flexible, more comfortable for the patient, and easier for operator to use.
• Cheaper and reusable.





Two solid-state CCD receptors on the left, a storage phosphor plate PSPP on the right

Digital Image theory

Digital images are numeric (because computers deal with numbers and not pictures). A digital image consists of a large collection of individual pixels organized in a (matrix of rows and columns), at each pixel of an electronic detector, the absorption of x-rays generates a small voltage.

As a radiographic image within a computer is represented as a sequence of numbers. Each pixel has an x and y axis. Each number, and hence each pixel has an appropriate shade of grey. Most current dental system operates with 8-bit images 2^8 shades of grey ranging (0 - 256), 0 representing black, 256 representing white and all others are shades of grey.

The pictures can be changed by giving the pixels different numbers. The coordinates of pixels may be changed also, and the shades of grey may be altered or using different colures. These variables are the basis for what is called (image processing or image manipulation). Despite being able to alter the final image, the computer cannot provide any additional real information to the original image. It should be remembered that although enhancement may make images look aesthetically more pleasing, it may also cause clinical information to be lost and diagnoses compromised.

pixel	350	351	352	353	354	355	356	357
261	228	222	184	107	76	92	90	98
262	227	218	186	110	90	104	103	98
263	222	219	181	107	97	107	102	104
264	225	217	176	107	98	100	100	107
265	221	204	159	107	105	101	107	102
266	217	196	157	114	105	104	106	100
267	209	190	154	114	107	103	97	100
268	202	195	166	118	102	102	92	94
269	197	196	168	122	98	102	90	94
270	195	190	166	130	104	105	92	97
271	199	190	172	144	111	107	100	106
272	201	193	177	160	120	103	112	106
273	203	195	181	166	129	102	111	106
274	201	200	186	172	133	110	112	102

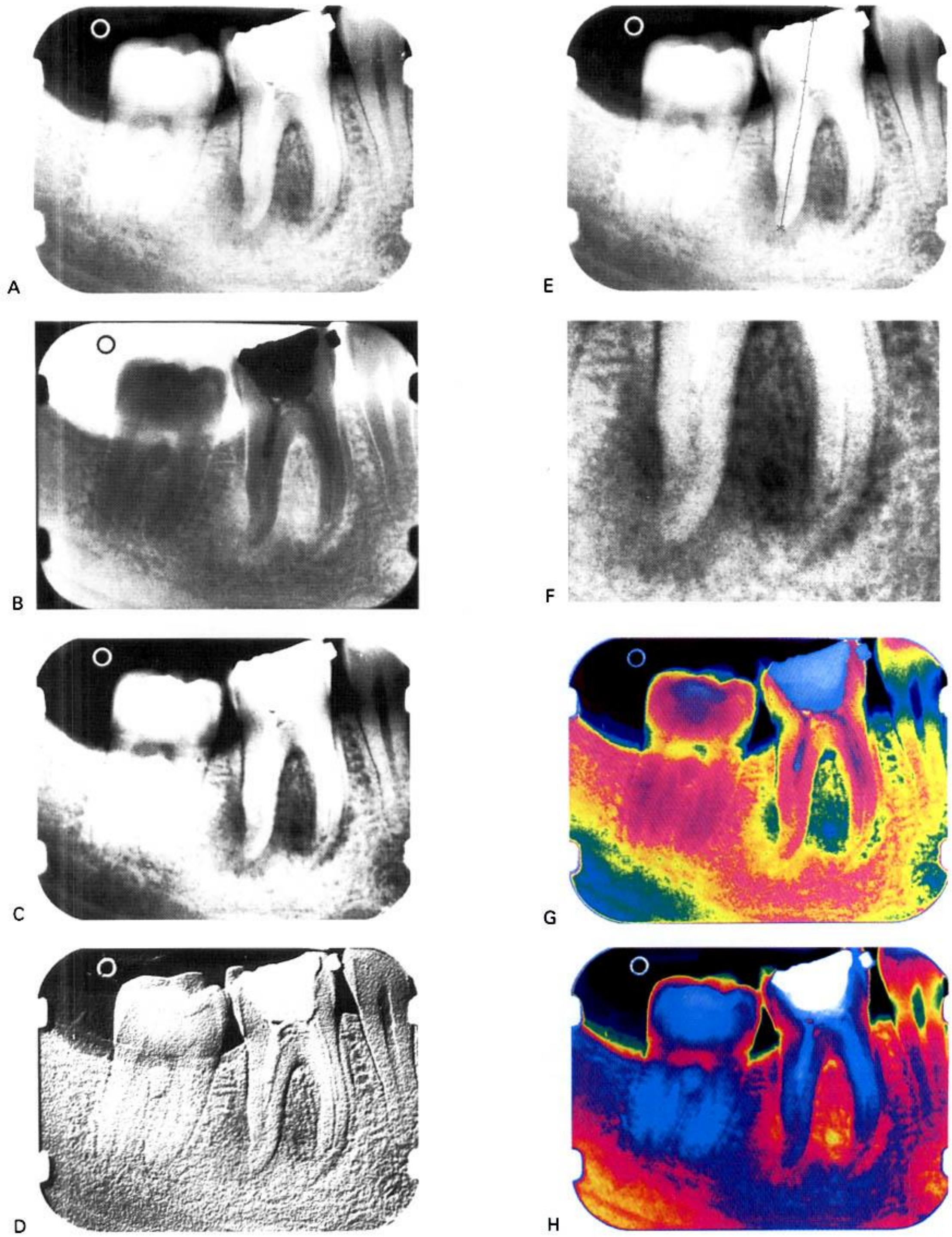
Advantages of Digital Imaging Over Conventional Film-Based Radiography:

1- Lower dose of radiation required as both types of digital image receptors are much more efficient at recording photon energy than conventional films.
2- No need for conventional processing, thus avoiding all processing film faults and the hazards associated with handling the chemical solutions.
3- Easy storage and archiving of patient information
4- Easy transfer of images electronically (teleradiology) and time reduction
5- Image enhancement and processing which include:
    - Inversion (reversal),
    - Alteration in contrast, brightness, sharpness, and colors (Pseudo-color)
    - embossing or pseudo 3-D,
    - Magnification,
    - Automated measurement,
    - image subtraction.

Digital image subtraction

When two images of the same object are registered and the image intensities of corresponding pixels are subtracted, a new difference image is produced. This technique requires two identical images exposed at different times then subtract one image from another, leaving only the changes that occur over time between the two intact.

It is useful in the diagnosis of (periodontal diseases, carious lesions, evaluation of small changes in the condylar position and assessment of dental implant).



A Original image. **B** Inverted/reversed. **C** Altered contrast. **D** Embossed or pseudo 3-D. **E** Automated measurement. **F** Magnified **G** and **H** Pseudo-colored.

Disadvantages of Digital Imaging:

1- Expensive, especially panoramic systems
2- Long-term storage of the large images required more storage space although this should be solved by saving them on CD-ROM
3- Digital image security and the need to back up data
4- The connecting cable (or cord) can make intraoral placement of these system's sensor difficult.
5- Loss of image quality and resolution on the hard copy-out when using thermal, laser or ink-jet printers
6- Image manipulation can be time-consuming and misleading to the inexperienced
7- Although manufacturers provide safeguards to the original images within their own software, but it is relatively easy to access these images using cheap software and to change them.

Indications:

1- Carious lesion detection: it measures lesion depth more accurately
2- Detection of structural changes: detection of morphological changes (periapical lesions, carious lesions) in the tissues
3- Growth and development: useful in cephalometric analysis and growth prediction of the facial structures
4- Research purpose and documentation: useful for a variety of scientific research approaches giving pure mathematical information applied for scientific purposes.

Radiology

Lec. 16 **Infection Control** **Dr. Areej**

Dental personnel and patients are at increased risk for acquiring tuberculosis, HIV, herpes viruses, upper respiratory infections, and hepatitis strains A through E.

The primary goal of infection control procedures is to prevent cross-contamination and disease transmission from patient to staff, from staff to patient, and from patient to patient.

The potential for cross-contamination in dental radiography is great. Cross-contamination can be happened in different way:

1. An operator's hands become contaminated by contact with a patient's mouth and saliva-contaminated films and film holders. Then the operator also must adjust the x-ray tube head and x-ray machine control panel settings to make the exposure.
2. An operator handles digital sensors or opens film packets to process the films in the darkroom.

The dentist is responsible for minimizing or eliminating cross-contamination procedures. And responsible also to educates other members of the practice.

Key Steps in Radiographic Infection Control

• Apply standard precautions

• Wear personal protective equipment during all radiographic procedures

• Disinfect and cover x-ray machine, working surfaces, chair, and apron

• Sterilize nondisposable instruments

• Use barrier-protected film (sensor)

• Prevent contamination of processing equipment

1. **<u>Standard Precautions</u>**

Standard precautions (also called universal precautions) are infection control practices designed to protect workers from exposure to diseases spread by blood and certain body fluids, including saliva. Under standard precautions, all human blood and saliva are treated as infectious for human immunodeficiency virus (HIV) and hepatitis B virus.

2. **<u>Wear Personal Protective Equipment During All Radiographic Procedures</u>**

Personal protective equipment is an effective means to shield the operator from exposure to potentially infectious material, including blood and saliva.

- Hand hygiene is most important to prevent spread of infections. After the patient is seated, the hand should be washed using plain or antimicrobial soap. Alcohol-based hand rubs are also effective.
- Disposable gloves should be worn in sight of the patient. The operator should always wear gloves when making radiographs or handling contaminated film or when removing barrier protections from surfaces and radiographic equipment.
- Operators should wear protective clothing (e.g., disposable gown or laboratory coat) that covers clothes and skin to protect against potential contamination.

3. **<u>Disinfect and Cover Clinical Contact Surfaces</u>**

Clinical contact surfaces are surfaces that might be touched by gloved hands or instruments that go into the mouth. These include the x-ray machine and control panel, chair-side computer, beam alignment device, dental chair and headrest, protective apron, thyroid collar, and surfaces on which the receptor is placed. These are noncritical items. The goal of preventing cross-contamination is by disinfecting all such surfaces and by using barriers to isolate equipment from direct contact.

Barriers made of clear plastic wrap should cover working surfaces that were previously cleaned and disinfected, and should be changed when damaged and routinely after each patient.

Intermediate- and low level activity disinfectants recommended for use on clinical contact surfaces.

FIG. 16.6 The exposure control console should be covered with a clean barrier and changed after every patient.

FIG. 16.7 A new plastic bag is placed over the chair and headrest for each patient.

FIG. 16.8 A plastic bag is slipped over the x-ray tube head with a large rubber band just proximal to the swivel or tie ends, as shown here. The plastic is pulled tight over the position-indicating device (PID) and secured with a light rubber band slipped over the PID and placed next to the head.

FIG. 16.9 Hanging apron is sprayed with disinfectant and then dried and covered with a garment bag.

Panoramic chin rest and patient handgrips should be cleaned with a low-level disinfectant. Disposable biteblocks may be used. The head-positioning guides, control panel, and exposure switch should be carefully wiped with a paper towel that is well moistened with disinfectant.

Cephalostat ear posts, ear post brackets, and forehead support or nasion pointer should be cleaned and disinfected. These may then also be covered with a plastic barrier.

After patient exposures are completed, the barriers should be removed, and contaminated working surfaces (including surfaces in the darkroom) and the apron should be sprayed with disinfectant and wiped as described previously. The barriers should be replaced in preparation for the next patient.

4. **<u>Sterilize Non disposable Instruments</u>**

Film -holding instruments are classified as semicritical items —instruments that are not used to penetrate soft tissue or bone but do come in contact with the oral mucous membrane. It can be sterilized by steam under pressure (autoclave).

5. **<u>Use Barriers With Digital Sensors</u>**

Digital Sensors cannot be sterilized by heat, so a plastic barrier used to protect them from contamination when placed in the patient's mouth.

6. **<u>Prevent Contamination of Processing Equipment</u>**

After all film exposures are made, the operator should remove his or her gloves and take the container of contaminated films to the darkroom.

The goal in the darkroom is to break the infection chain so that only clean films are placed into processing solutions. Two towels should be placed on the darkroom working surface. The container of contaminated films should be placed on one of these towels. After the exposed film is removed from its packet, it should be placed on the second towel. The film packaging is discarded on the first towel with the container.

FIG. 16.10 Film-holding instrument with barrier wrapping to protect sensor and cord from saliva. (Image courtesy Dentsply Rinn:

FIG. 16.11 Dental film with a plastic barrier to protect film from contact with saliva. During opening, the plastic is removed and the clean film is allowed to drop into a container.

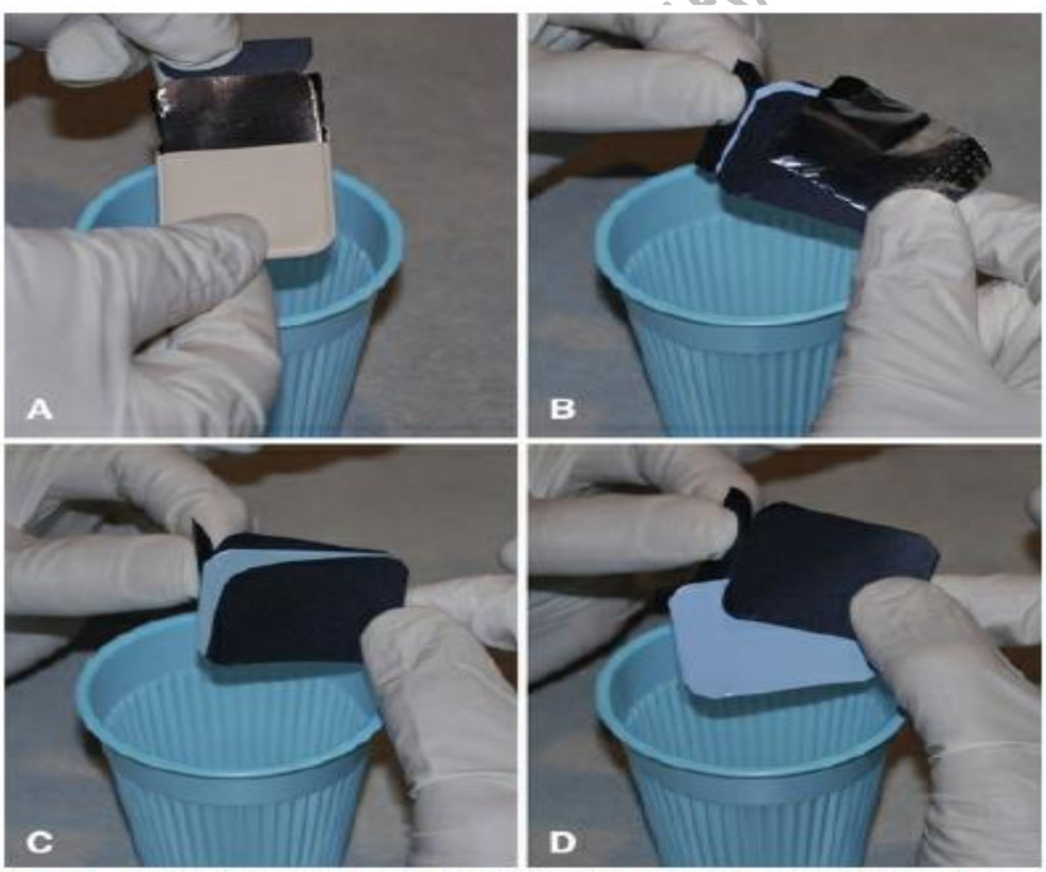


FIG. 16.12 Method for removing films from packet without touching them with contaminated gloves. (A) Packet tab is opened, and lead foil and black interleaf paper are slid from wrapping. (B) Foil is rotated away from black paper and discarded. (C) Paper wrapping

Zainab al-bahrani

Radiology

Advanced Imaging Modalities

The advanced imaging modalities employ equipment and principles that are beyond the routine needs of most general dental practitioners which include:

- Magnetic resonance imaging MRI
- Ultrasonography US
- Computed tomography CT (will discuss in another lecture with CBCT).

Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is an imaging technique with a revolutionary impact in diagnostic imaging. it is noninvasive and uses nonionizing radiation. **Instead, it depends** on the magnet and radio frequency waves (RF)

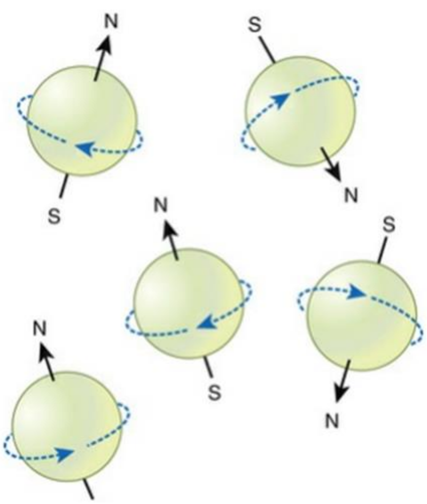
MRI principle and technique:

The essential **principle** of MRI involves the behavior of protons (positively charged nuclear particles) in the simplest atom which is hydrogen that consisting of one proton in the nucleus so it used to create the MRI image

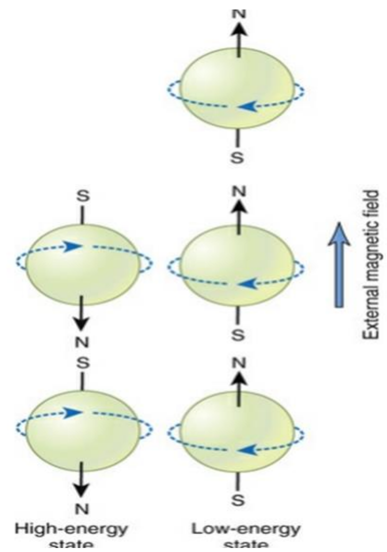
To **make an MR image**, the patient is first placed inside a large magnet. This magnetic field causes the nuclei of many atoms in the body, particularly hydrogen, to align with the magnetic field. The scanner directs a radiofrequency (RF) pulse into the patient, causing some hydrogen nuclei to absorb energy (resonate). When the RF pulse is turned off, the hydrogen nuclei release the stored energy, which is detected as a signal in the scanner. The magnetic field in MRI scanner is provided by external powerful permanent magnet with strength range from (0.1 to 7 Tesla), 1.5 Tesla is the most commonly used (which is about 30,000 times the strength of the earth's magnetic field).

The **strength of the MRI signal** depends on the degree to which hydrogen is bound within a molecule. Tightly bound hydrogen atoms (in bone) produce weak signal. While loosely bound or mobile hydrogen atoms (in soft tissues and liquids) produce strong signal. It makes images with excellent soft-tissue resolution.

Relaxation at the end of the RF pulse results in recovery of the longitudinal magnetization (T1 relaxation time required for 63% of the longitudinal magnetization return to equilibrium, while T2 relaxation time is time constant required to loss transverse magnetization). **The MRI images** either T1-weighted images are more commonly used to demonstrate anatomy or T2 weighting are used to depict pathologic changes, such as inflammation and neoplasia. In MRI the most common **Contrast agents** used is Gadolinium (a paramagnetic substance) that shortens the T1 relaxation times of tissues and making them appear brighter.



randomly oriented Hydrogen nuclei



Hydrogen nuclei parallel with the magnetic field

Advantages of MRI

1. It offers **best contrast** resolution of soft tissues

2. **No ionizing** radiation is involved, with **no adverse effects** have yet been demonstrated

3. Direct **multi planar** imaging is possible without patient re-orientation, **image manipulation** can be done.

Disadvantages of MRI

1. Relatively long imaging times
2. Patients with claustrophobia may not be able to tolerate the narrow space within the MRI scanner this can be managed by using open MRI, chemical sedation, general anesthesia, or listening to music on headphones.
3. Hazard associated with the presence of ferromagnetic(metal) substances in the patient's body, the strong magnetic fields can move these objects, cause excessive heating, or induce strong electrical currents, which may harm the patient, so MRI is contraindicated in patients with cardiac pacemakers, some cerebral aneurysm clips, vagus nerve stimulators, insulin pumps, cochlear implants, and in patients with embedded ferrous foreign bodies, such as shrapnel or bullets.
4. Metals dental restorations do not move but distort the image, Removable dental appliances must be removed prior to MRI scanning. • Special considerations to patients with Steel orthodontic archwires treatment
5. There is medical evidence that a tattoo can cause a reaction (burning sensation) during MR imaging because some tattoo inks containing **iron oxide**
6. Contraindicated In first trimester of pregnancy (especially with using Gadolinium contrast agent)

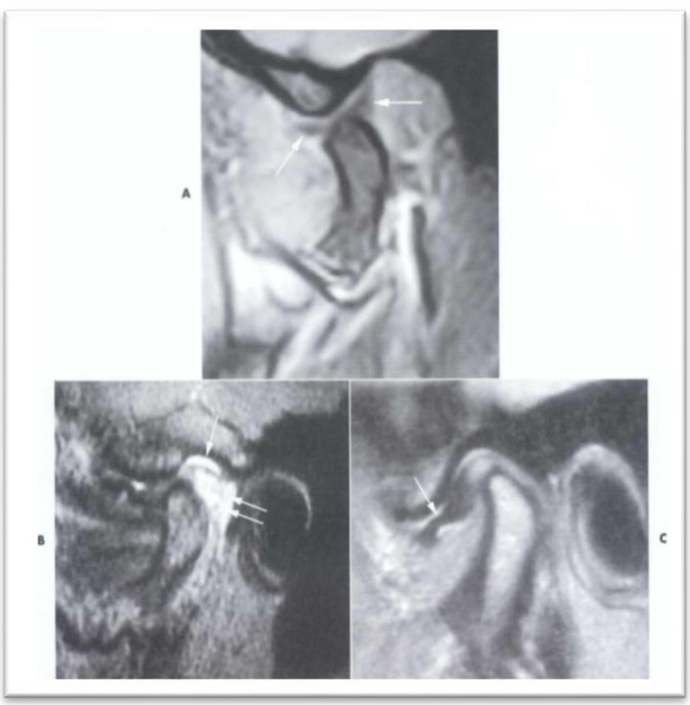
Applications of MRI in Maxillofacial Diagnosis

Because of its excellent soft-tissue contrast resolution, MR imaging is useful in evaluating soft tissue conditions (Bone does not give an MR signal, a signal is only obtainable from bone marrow). Applications of MRI in dentistry include:

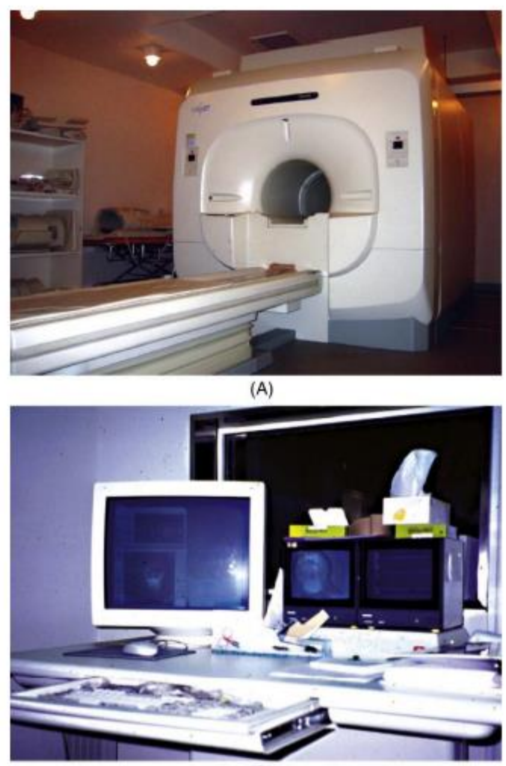
1. Evaluation of TMJ
2. Evaluation of neoplasms
3. Evaluation of salivary gland diseases
4. Evaluation of vascular lesions in the orofacial region
5. Evaluation of early jaws osteomyelitis
6. Evaluation of maxillary sinus, nasal cavities, the tongue, and floor of mouth
7. Functional MRI (fMRI) which is identification of motor and sensory areas of the brain in relation to pain, occlusion, fear, love, smell,….

CT versus MRI

	CT	MRI
1	uses X-rays (ionizing radiation) it a good tool for examining hard tissue such as bone	uses non-ionizing radio frequency (RF) signals is best suited for soft tissue
2	contrast in CT images is generated from X-ray attenuation	variety of properties may be used to generate contrast in MR images.
3	Contrast agents is iodine or barium	Contrast agents is gadolinium
4	limited to axial plane images from which images reconstructed in any plane	generate cross-sectional images in any plane
5	best for solid tumors of the abdomen and chest	Best For brain tumor detection
6	more widely available, faster, and less expensive	Long time, expensive



MRI image of TMJ



MRI device

Ultrasonography (US)

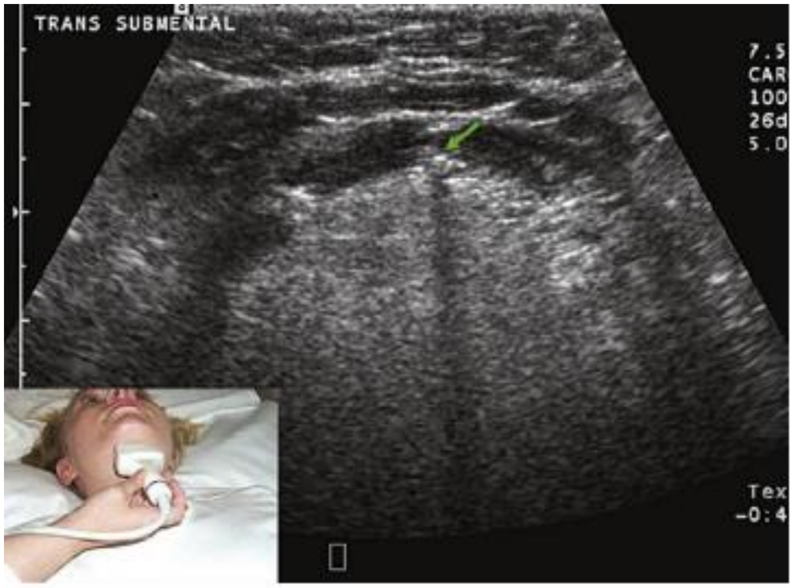
Is an advanced modality in oral and maxillofacial imaging, this technique **based on** sound waves that acquires images in real time without the use of ionizing radiation.

US principle and technique:

The US unit **consists of** a transducer and the monitor on which sonogram can be seen. A **transducer** is a device that can convert electrical energy into sonic energy with frequencies range (1 to 20 MHz). The transducer emitting ultrasound is held against the body part being examined. The ultrasonic beam passes through or interacts with tissues of different acoustic impedance. some Sonic waves are reflected and the rest are absorbed. The sound waves travel fast through the first tissue layer until they meet a different tissue, that reflect (echo) toward the transducer are detected by the transducer, amplified, processed, and displayed on monitor as a digital image. **Interpretation** of sonograms relies on the tissues signals. Tissues that do not produce signals, such as fluid-filled cysts, are said to be anechoic and appear black. Tissues that produce a weak signal are hypoechoic, whereas tissues that produce intense signals, such as ligaments, skin, or needles or catheters, are hyperechoic and appear bright

Applications of ultrasonography in oral and maxillofacial imaging

1- Evaluation of benign and malignant masses of neoplasms in head and neck region (the thyroid, parathyroid, lymph nodes, sinuses)
2- Salivary glands pathologies (neoplasm, stones, inflammation, and Sjögren's syndrome)
3- Evaluation of vessels of the neck, including the carotid artery for atherosclerotic plaques
4- Ultrasonography is also used to guide fine-needle aspiration.
5- More recent advances include 3D imaging of a fetal face
6- Color Doppler sonography for evaluation of blood flow
7- Detection of Orofacial Fracture
8- Detection of facial muscles thickness



Transverse section of the submental region shows a small hyperechoic structure, a sialolith(stone), green arrow.

US device

Radiology

Lec. 15 Guidelines for Prescribing Radiographs Dr. Areej

Radiographs can only be prescribed by a dentist and only after a clinical examination has been performed to determined which projections are required to give the maximum diagnostic information. Patient imaging needs are determined by findings from the dental history and clinical examination and modified by patient age and general health.

It's very important to avoid taking radiographs that will not contribute diagnostic information (according to ALARA). If a patient is complaining of sensitivity to cold, taking a radiograph to examine the periapical area for pathosis is not required because no pathological periapical lucency will be seen in a vital tooth.

As a general principle, radiographs are indicated when a high probability of providing information about a disease that cannot be seen clinically is exist; i.e. the probable benefit to the patient outweighs any possible disadvantage.

The cost of the examination and the radiation dose should be considered when selecting views. Conventional tomography, CBCT, CT or MRI will often be required to best see the lesions. However, do not request a CT where you feel a panoramic radiograph will be adequate. If one wishes to visualize the disc [or position of the disc] in the TMJ or soft tissue then MRI is required.

Radiographic examination

After concluding that a patient requires a radiograph, the dentist should consider which radiographic examination is most appropriate to meet the patient's diagnostic and treatment planning needs. Some patients need simple periapical or panoramic imaging only while other more complicated cases require CBCT or CT or MRI.

The design of the type and scope of the imaging examination should be guided by:

1. The perceived nature or severity of an abnormality (including its size and accessibility)
2. The ability of the imaging technique to accurately reveal the characteristic diagnostic features of the abnormality (sensitivity and specificity)
3. The amount of image detail required (resolution)
4. The radiation dose to the patient

Guidelines for Ordering Radiographs

• Make radiographs only after a clinical examination.

• Order only those radiographs that directly benefit the patient's diagnosis or treatment plan.

• Use the least amount of radiation exposure necessary to generate an acceptable view of the imaged area - ALARA Principle

CARIES

Buccal, lingual and occlusal caries can be seen clinically. Early interproximal caries can only be seen radiographically. The rate of caries varies from person to person. The rate of caries progression is more rapid in deciduous teeth. In carious prone patients radiograph should be taken every 6 - 12 months; in non-caries prone patients every 18 - 24 months is adequate.

The best radiographic view for visualizing both interproximal caries and periodontal bone height is **bite-wing** radiographs.

PERIAPICAL INFLAMMATORY DISEASE

When patient presents with a toothache, deep caries, or large or deep restoration, the likelihood of an inflammatory lesion of pulpal origin occurring at the tooth apex increased. Clinical examination combined with **periapical radiograph** is sufficient to make diagnosis and treatment planning.in some cases with complex root canal anatomy, failed endodontic treatment, intra or postoperative complications, or when periapical radiograph doesn’t provide adequate information; therefore high resolution, limited volume **CBCT** may be required.

PERIODONTAL DISEASES

The radiograph is important in determining the amount of periodontal involvement. The radiographic examination shows the amount and type of bone loss and also whether it is localized or generalized. After treatment, follow-up radiographs are important to monitor the progression of the condition. A combination of **periapical and bitewing** images is required

DENTAL ANOMALIES

Abnormalities occur less frequently in deciduous teeth. The impact of anomalies on the permanent dentition is more serious. The most common finding is additional or missing teeth. Mesiodens is the most common additional tooth. The most common tooth missing is the last one in the series; incisors – the maxillary lateral; premolars - mandibular second; molars - all third molars. The same teeth are also most commonly peg shaped.

A **panoramic radiograph** is the best view for anatomic anomalies but there is no need for this before the age of about 10 years. Should there be a missing tooth, a periapical or an occlusal view of that area may be required.

GROWTH, DEVELOMENT AND MALOCCLUSION

A radiographic examination for growth, development and dental malocclusion can involve several different views, depending on what is being examined. These can vary from **periapicals**, an **occlusal**, **CBCT**, a **panoramic** view to a **cephalometric** and a **lateral skull** for orthodontics. Sinus involvement could require an **Occipito-mental**; non symmetrical growth of the mandible could require a **PA** [postero-anterior]. For impacted teeth, a panoramic radiograph is required at the age of about 17 - 20 years of age for general examination, while CBCT required for evaluation of roots relation with inferior alveolar nerve.

OCCULT DISEASE

Occult disease refers to a disease process presenting NO signs or symptoms; they can be dental or osseous. Dental findings vary from interproximal caries to root resorption, dilaceration, concrescence or hypercementosis. Intra-osseous findings can be impacted teeth, sclerosing / condensing osteitis, idiopathic osteosclerosis , tumors [benign or malignant] and cysts.
In edentulous patients who require dentures, there are often dental or general problems and this requires a radiographic examination to exclude occult disease. A clinical exam will determine whether a **periapical, an occlusal or a panoramic radiograph** is required.

JAW PATHOLOGY

Imaging of known jaw lesions, such as fibro-osseous diseases or neoplastic diseases, before biopsy and definitive treatment is also important for appropriate management of the patient. For small lesions of the jaws, **periapical** or **panoramic** radiographs may be enough as long as the lesion can be seen in its entirety. If clinical evidence exists of swelling, some type of radiograph at **90 degrees to the original plane (often occlusal image)** should be made to detect evidence of expansion of the jaw and **perforation** of the buccal or lingual cortical bone. If lesions are too large to fit on standard dental films, extend into the maxillary sinus or other portions of the head outside the jaws, or are suspected of malignancy, additional imaging such as **CBCT or computed tomography (CT)** is appropriate. These types of imaging can define the extent of the lesion, provide excellent bone details and provide information about the nature of the lesion.

TEMPOROMANDIBULAR JOINT

A wide variety of diseases affect the TMJ, including congenital and developmental malformations of the mandible and cranial bones; acquired disorders such as disc displacement, neoplasms, fractures, and dislocations; inflammatory diseases including rheumatoid and osteoarthritis. The goal of TMJ imaging should be to obtain new information that will influence patient care. Radiologic examination may not be needed for all patients with signs and symptoms referable to the TMJ regions, particularly if no treatment is contemplated.

The decision of whether and how to image the joints should depend on the results of the history and clinical findings, the clinical diagnosis, and results of prior examinations, as well as the tentative treatment plan and expected outcome. The cost of the examination and the radiation dose should also influence the decision if more than one type of examination can provide the desired information. For example, information about the status of the osseous tissues can be obtained from **panoramic radiographs, CBCT, CT**. while investigation of soft tissue component (disc), magnetic resonance imaging (**MRI**) is used.

IMPLANTS

Preoperative planning is crucial to ensure success of the implants. The dentist must evaluate the adequacy of the height and thickness of bone for the desired implant; the quality of the bone, the location of anatomic structures such as the mandibular canal or maxillary sinus; and the presence of structural abnormalities such as undercuts that may affect placement or angulation of the implant.

Standard **periapical and panoramic** radiographs can supply information regarding the vertical dimensions of the bone. However, some type of cross-sectional imaging, like **CBCT** is recommended before implant placement for visualization of important anatomic landmarks, determination of size and path of insertion of implant, and evaluation of the adequacy of the bone for anchorage of the implant. Also evaluation of implants may be needed at later times to judge healing, complete seating of fixtures, and continued health of the surrounding bone.

PARANASAL SINUSES

Because sinus disease can present as pain in the maxillary teeth and because periapical inflammation of maxillary molars and premolars can also lead to changes in the mucosa of the maxillary sinus, the dentist needs to obtain an image of the maxillary sinus. Sometimes sinus imaging is required to assess the need for bone augmentation or sinus lift before implant placement in posterior maxilla. **Periapical and panoramic** radiographs demonstrate the floor of the maxillary sinus well, but visualization of other walls requires additional imaging techniques such as **occipitomental (Waters') view, CBT or CT.**

TRAUMA

For patients who experience trauma to the oral region **periapical and/or panoramic** radiographs are helpful for evaluation of fractures of the teeth. If a suspected root fracture is not visible on a periapical radiograph, a second radiograph made with a **different angulation** may be helpful. A fracture that is not perpendicular to the beam may not be detectable. **CBCT** may be useful (if taken without artifact). Otherwise a tooth with a history of trauma but no associated clinical finding should be monitored and evaluated radiographically on a periodic basis.

Fractures of the mandible can frequently be detected with **panoramic radiographs**, **supplemented** by images **at 90 degrees** such as a **posteroanterior or reverse Towne's** view. Trauma to the maxilla and midface may require **CBCT or CT** for a thorough evaluation.

Summary of the more common types of radiographic examinations for general dental patients and factors to consider in choosing the most appropriate one (note: the table is required)

TABLE **15-1**
Dental Radiographic Examinations and Their Properties

TYPE OF EXAMINATION	COVERAGE	RESOLUTION	RELATIVE EXPOSURE*	DETECTABLE DISEASE
Intraoral Radiographs				
Periapical	Limited	High	1	Caries, periodontal disease, occult disease
Bitewings	Limited	High	10	Caries, periodontal bone level
Full-mouth periapical	Limited	High	14-17	Caries, periodontal disease, dental anomalies, occult disease
Occlusal	Moderate	High	2.5	Dental anomalies, occult disease, salivary stones, expansion of jaw
Extraoral Radiographs				
Panoramic	Broad	Moderate	1-2	Dental anomalies, occult disease, extensive caries, periodontal disease, periapical disease, TMJ
Conventional tomography/slice	Moderate	Moderate	0.2-0.6	TMJ, implant site assessment
CBCT	Broad	Moderate to high	4-42	Implant, TMJ, craniofacial relationships, dental anomalies, extent of disease, fracture
CT/head	Broad	High	25-800	Extent of craniofacial disease, fracture, implants
MRI	Broad	Moderate	—	Soft tissue disease, TMJ
Skull	Broad	Moderate	30	Fracture, anatomic relation, jaw disease

Traumatic Injuries

Ass.prof

Zainab H. AL-Ghurabi

Oral and maxillofacial injuries refer to injuries of the orofacial soft tissues, facial skeleton, teeth and associated specialised soft tissues within the head and neck region as a result of wounding or external violence. These injuries can lead to orofacial deformity and malfunction, greatly diminishing quality of life and worker productivity.

Traumatic Injury to Teeth

Traumatic dental injuries of teeth occur frequently in children and young adults.

•Enamel infraction: An incomplete fracture (crack) of the enamel without loss of tooth substance.

•Enamel fracture (uncomplicated crown fracture): A fracture with loss of enamel only.

•Enamel–dentine fracture (uncomplicated crown fracture): A fracture with loss of enamel and dentine, but not involving the pulp.

•Complicated crown fracture: A fracture involving enamel and dentine, and exposing the pulp.

•Crown–root fracture: A fracture involving enamel, coronal and radicular dentine, and cementum.

•Root fracture: A fracture involving radicular dentine, cementum and the pulp.

Radiographic Evaluation

Radiographic evaluation of dentoalveolar injuries should include a panoramic radiograph and periapical radiograph of involved teeth.

The radiographic examination reveals the stage of root formation and discloses injuries affecting root portion of the tooth and periodontal structures.

Multiple periapical radiographs taken at different angles are useful to demonstrate the root fractures that are minimally displaced.

Ideally three different radiographs from different angles should be obtained for each traumatised tooth.

Fractures of the Alveolar Process

Fractures of the alveolar process are found predominantly in the anterior teeth and the premolar region. These injuries may be isolated or may be seen in conjunction with traumatic injuries to teeth .

Radiographic Features

The fracture is readily identified in the intraoral periapical radiograph .

Lateral extraoral radiographs best demonstrate the location of the fracture if some bone displacement has occurred . More close the fracture to the alveolar crest, greater is the possibility of presence of root fractures. Usually two radiographs produced with different projecting angles are required for the accurate diagnosis.

Fracture of the Mandible

Despite the fact that the mandible is the largest and strongest facial bone, by virtue of its position on the face and its prominence, it is commonly fractured when maxillofacial trauma has been sustained

According to the anatomical site

The fractures can be classified according to the site of fracture and its incidence as follows:

• Symphyseal fractures and parasymphyseal fractures .

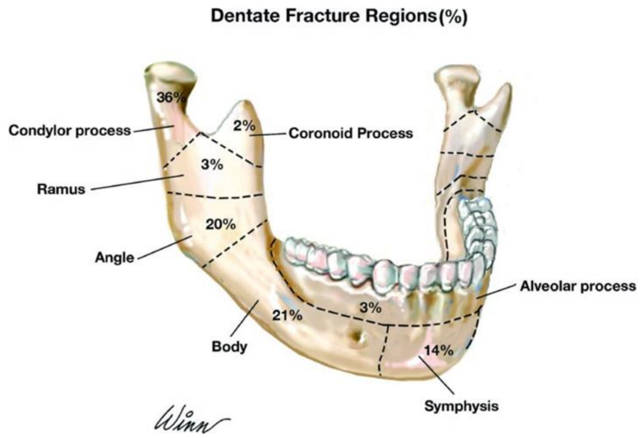
• Body fractures .

• Gonial area or angle fractures .

• Condylar fractures (intracapsular) and subcondylar fractures

• Coronoid process fracture

• Dentoalveolar fractures

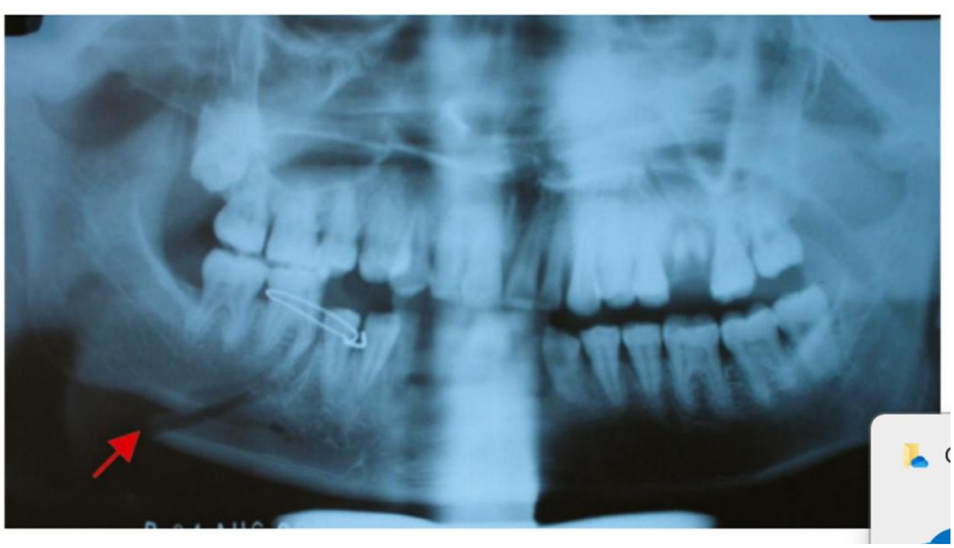


Radiographic Features

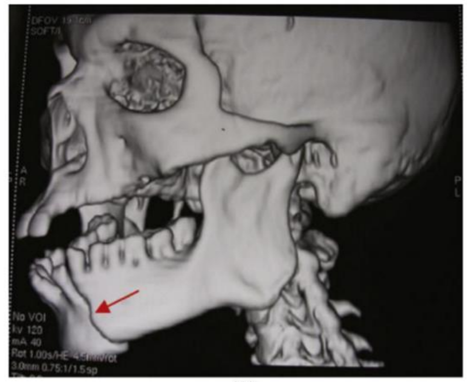
The radiographic examination of a suspected mandibular fracture may include intraoral or occlusal views, intraoral periapical radiograph, panoramic view, posteroinferior or submentovertex plain radiograph, reverse Towne view, lateral oblique radiograph and CT.

The margins of the fractures usually appear as sharply defined radiolucent lines of separation that are confined to the structure of the mandible.The lateral oblique view of the mandible can be of help in the diagnosis of ramus, angle and posterior body fractures.

The posteroanterior (PA) view demonstrates any medial or lateral displacement of the fractures of ramus, angle, body or symphysis.The mandibular occlusal view demonstrates displacement in the lateral or medial direction of the body fractures and also shows the anterior or posterior displacement of the symphyseal fracture



IGURE 54.12 **Comminuted fracture of body of mandible.**



(A)

<u>Trauma to temporomandibular joint region</u>

The complexity of the TMJ, as well as its anatomical proximity to other craniofacial structures, makes diagnosis and treatment specifically challenging.

<u>Classification of TMJ Region Fracture</u>

Relationship of condylar fragment with mandibular fragment:

- Non-displaced
- Deviated
- Displacement with medial or lateral overlap
- Displacement with anterior or posterior overlaps
- No contact between the fractured segments

Relationship between condylar head and glenoid fossa:

- Non-displaced
- Displacement
- Dislocation

<u>Radiographic Features</u>

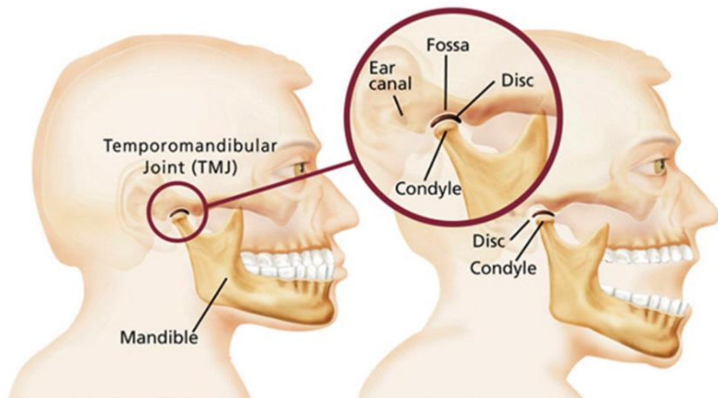
At least two radiographs must be obtained at right angle to each other to adequately evaluate the TMJ region. **Orthopantomography (OPG) and lateral oblique view of mandible**

Panoramic radiograph contains higher accuracy in detecting all the mandibular fractures. If OPG facilities are not available, lateral oblique view is more informative

Reverse Towne view and PA mandible: It shows condylar head much better than more conventional PA or AP view of mandible in which these structures tend to be superimposed by base of the skull.

Transcranial and transorbital view of TMJ: This view may occasionally be helpful in defining the relationship of the condylar proximal fragment to the glenoid fossa.

CT scan: In difficult cases, CT scan has been demonstrated to show changes in the relationship of the condyle to the mandibular fossa more precisely than the conventional radiographic examination.



<u>Middle third fracture of face</u>

Fructure of Maxilla

Middle third consists of maxilla, zygomatic bones and zygomatic process of temporal bones, palatine bone, nasal bone, lacrimal bone, inferior conchae, pterygoid plates, sphenoid, vomer and ethmoid. Fractures of the midface , often classification owing to the severity of the force

and the multidirectional source of the trauma.

Classification:According to Rene Le Fort

Le Fort I

It is also known as low-level fracture/horizontal fracture of maxilla/Guerin fracture/floating fracture/horizontal fracture above the level of nasal floor.

Radiographic Features

Le Fort I this type of fracture is identified on PA, lateral skull and Water projections. Both maxillary sinuses are cloudy and may show air-filled level.

Lateral view shows slight posterior displased fragments.

Le Fort I

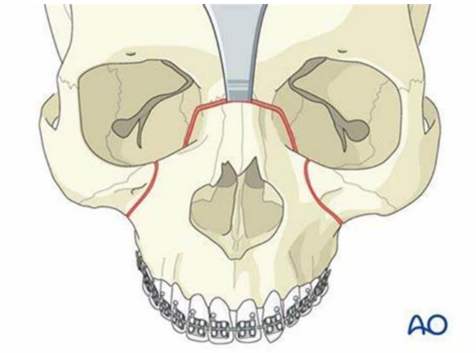
Le Fort II

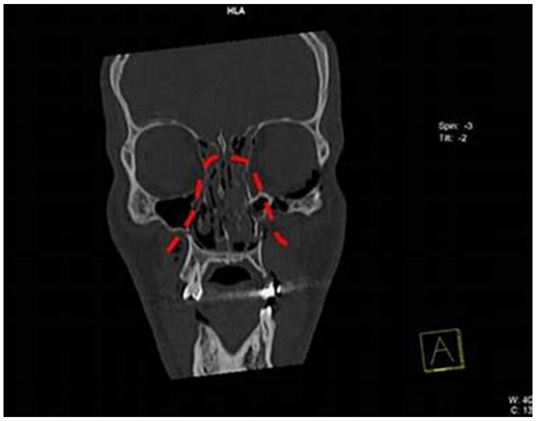
Le Fort II fracture is also known aspyramidal/subzygomaticfracture.

This fracture runs from the thin middle area of the nasal bones down to either side crossing the frontal processes of maxilla into the medial wall of each orbit.

<u>Radiographic Features</u>

Le Fort II It will reveal fracture of the nasal bone and both frontal processes of maxilla and infraorbital rims on both sides or separation of zygomatic sutures on both sides.





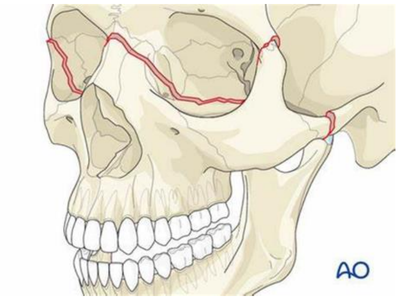
Le Fort III

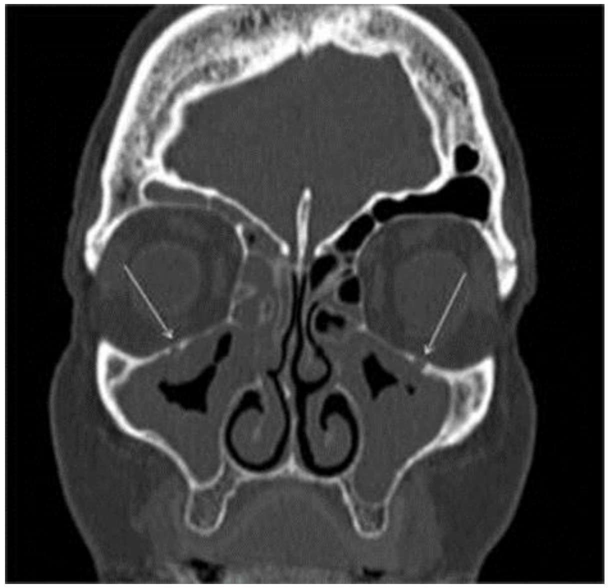
Le Fort III fracture is also called high transverse/suprazygomatic fracture.

The fracture runs from near the frontonasal suture transversely, parallel with the base of the skull and involves the full depth of the ethmoid bone, including the cribriform plate

Radiographic Features

CT coronal and sagittal scans are the most useful imaging aids in determining the extent of the injuries.





COMPUTED TOMOGRAPHY (CT) & CONE BEAM COMPUTED TOMOGRAPHY (CBCT)

ASS. PROF

ZAINAB H. AL-GHURABI

Computed Tomography (CT): is a well-accepted imaging modality for evaluation of the entire body.

Computed Tomography (CT) Scan Machines Uses X- rays, a powerful form of Electromagnetic Radiation.

CT has undergone several evolutions and nowadays multi- detectors CT scanners have been evolved which have better application in clinical field.

Applications of CT

MDCT imaging has several applications in the diagnosis and treatment of dento-maxillofacial diseases:

Infections, including osteomyelitis and space infections

• Midfacial and mandibular trauma

• Developmental anomalies of the craniofacial skeleton

• Benign intraosseous cysts and neoplasms of the jaws

• Benign and malignant neoplasms that originate in, or extend into, the

orofacial soft tissues

• Soft-tissue cysts

Advantages of CT

It provides axial, coronal and sagittalviews of the tissue.

- It shows anatomically precise location ofthe lesion and extent.
- The structures of the soft tissues both normal and pathological are clearly displayed .
- Because the image that is produced is formulated by the computer, areas of interest may be selectively viewed and enlarged by using computer programmers.
- As the information is stored in the computer it can be viewed any time in the absence of patient.
- Image can be manipulated.

Disadvantages of CT

Is sophisticated, costly and expensive to maintain.

- Very high-density materials such as metal bullets and dental restorations produce severe artefacts on CT scan, which makes the interpretation difficult.
- There is an inherentrisk associated with the contrast medium.

Cone-beam computed tomography (CBCT)

Is a new medical imaging technique that generates 3D images.

This imaging technique is based on a cone shaped X-ray beam centered on a 2D detector that performs one rotation around the object, producing a series of 2D images.

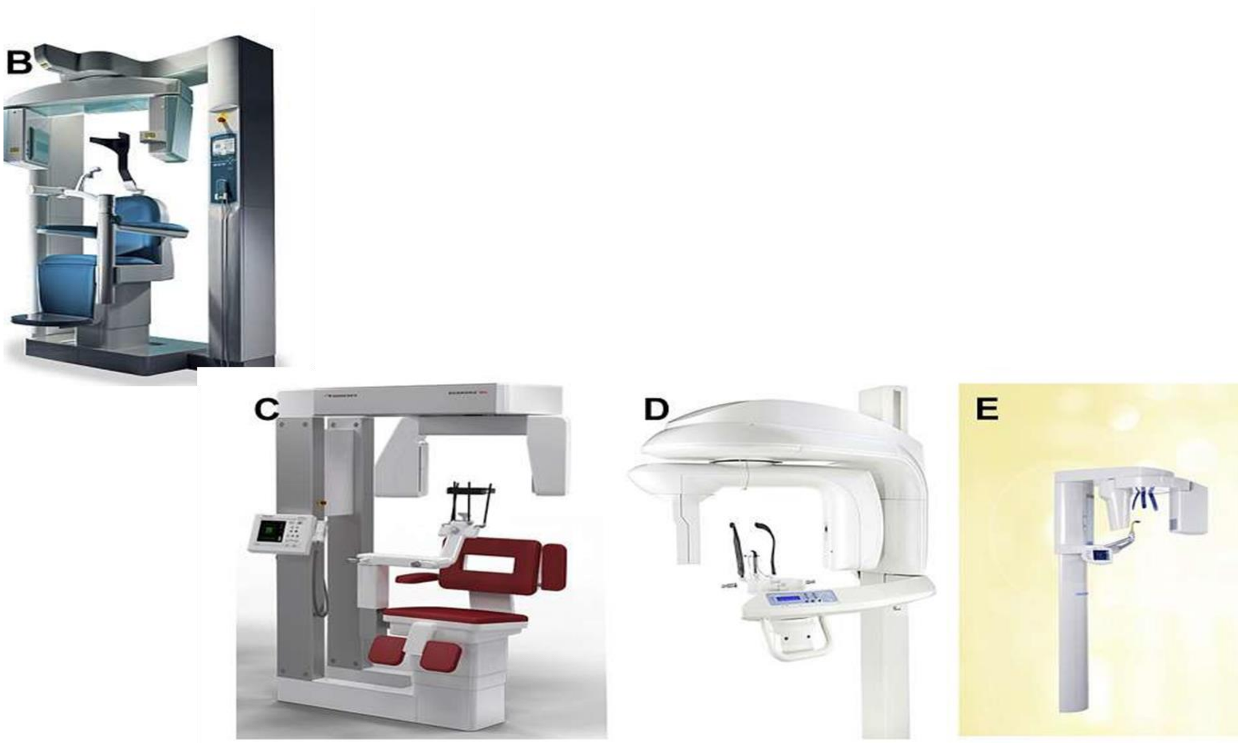
Components of CBCT

CBCT is composed of **X-ray source** with a **rotating gantry**.

A divergent pyramidal or cone-shaped source of ionizing radiation is directed through the middle of the region of interest .

CBCT scanner utilizes a **2D X-ray detector** on the opposite side, which allows for a single rotation of the gantry to generate a scan.

Computer to display the images



<u>Advantages Disadvantages</u>

- Rapid scan time
- Beam limitation
- Image accuracy

- Reduced patient radiation dose
- Interactive display modesapplicable to maxillofacial imaging

Disadvantages

- Extinction artefacts
- Beam hardening artefacts
- Ring artefacts
- Motion artefacts (misalignment artefacts)

Application of CBCT

Implant imaging

orthodontic and orthognathic surgeries

endodontics

Periodontics

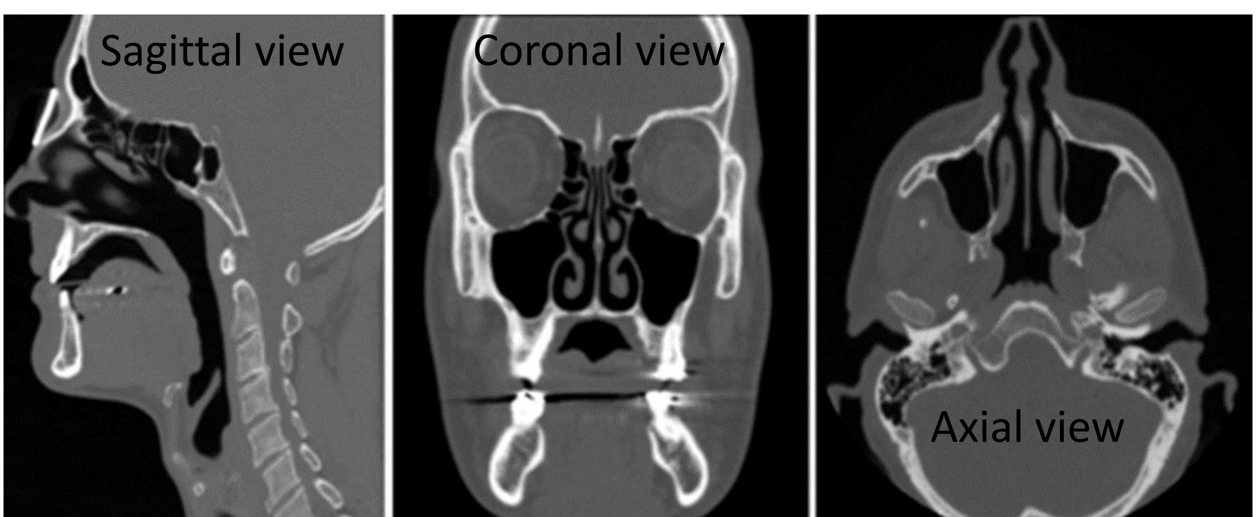
TMG diagnosis

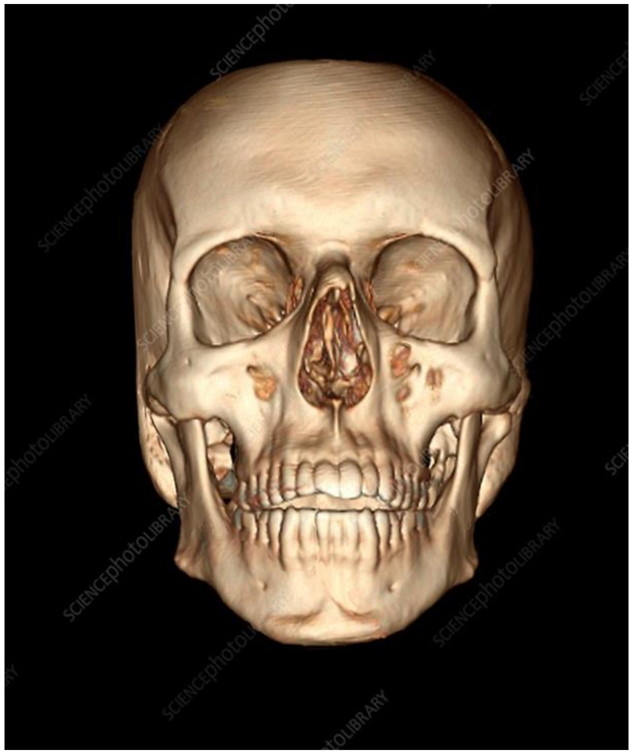
Maxillary sinus assessment

Impacted teeth (Third molar and canine)

Views interpretations and Anatomy

There are three 2D views sagittal, coronal and axial , all these 2D views will reconstructed to form 3D view





Salivary gland imaging

Dr. zainab H Al-Ghurabi

ANATOMY AND OUTLINE OF IMAGING

The parotid, submandibular and sublingual glands are regarded as major salivary glands and have bilaterally symmetric lobes.

The parotid gland (the largest salivary gland) is situated at the parotid space.

The gland is divided into deep and superficial lobes by branches of the facial nerve.

The duct of salivary secretion is known as Stensen duct that runs anteriorly on the superficial portion of the masseter muscle and pierces the buccinator muscle.

The submandibular gland is located mainly in the so-called mandibular triangle.

The secretory duct is known as Wharton duct that runs on the surface of the mylohyoid muscle and opens at the anterior portion of the floor of the mouth.

The sublingual gland is located under the mucosal surface of the oral cavity and lies on the mylohyoid muscle.

The gland has many small ducts known as 'ductsBartholin' that open directly on the mucosal surface of the floor of the mouth.

Types of Salivary Gland Imaging

Conventional imaging (CR): This includes occlusal, panoramic or posteroanterior (PA) views.

Sialography: It is defined as a method of radiographic study of the salivary gland and alveoli of the parotid and submandibular salivary glands.

Computed tomography (CT): It demonstrates small differences in soft-tissue radiographic examination and distinction between gland and the adjacent soft tissues is greatly improved.

Magnetic resonance (MRI): It is useful in discrete swelling of salivary glands and provides excellent soft-tissue details.

It readily enables differentiation between the normal and the abnormal.

Ultrasonography (USG): It involves the transmission of energy into the salivary tissues, receiving of the energy after the tissues have reflected it and recording it so that it can be presented for interpretation. Doppler Sonography

Doppler Sonography

CONVENTIONAL RADIOGRAPHY

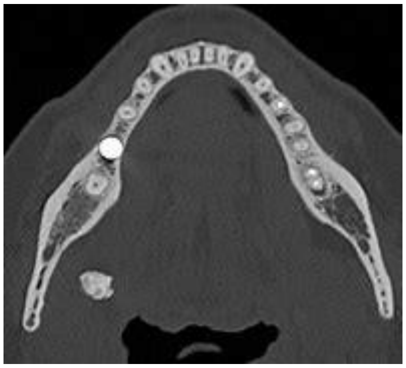
Mainly views taken in CR are **occlusal, panoramic, and lateral oblique view and PA views.**

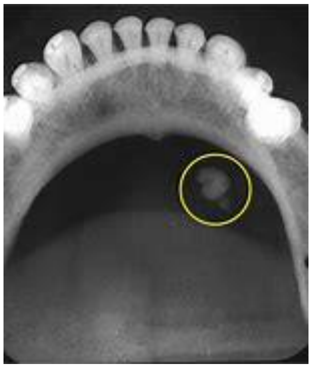
It is generally limited to detection of **sialoliths,** primarily in submandibular gland, Stensen duct and Wharton duct.

Sialoliths occur more frequently in **submandibular gland than in parotid gland**.

They can rarely be seen in sublingual or minor salivary gland.

A sialolith of the submandibular gland usually appears **as a round, isolated radio-opaque mass beneath the inferior border of the mandible**.





SIALOGRAPHY

Sialography is a radiographic procedure for detection and monitoring salivary gland disease.

It is used to examine the ductal acinar system of major salivary gland by injecting radio-opaque contrast medium into the gland to make it visible on radiographs.

After injection of contrast agent radiographs are taken on plane film.

The lateral oblique is best to delineate submandibular gland because it projects image below the ramus of jaw.

For parotid gland**, anteroposterior (AP) and panoramic view can be taken.**

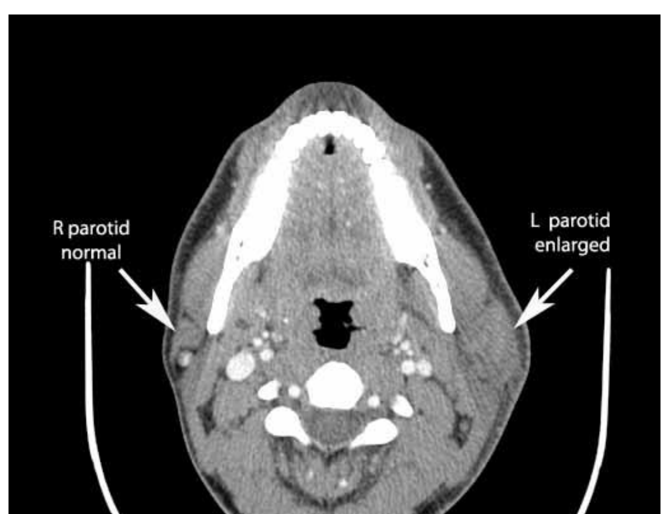
After sialographic view is taken the catheter should be removed from duct orifice.

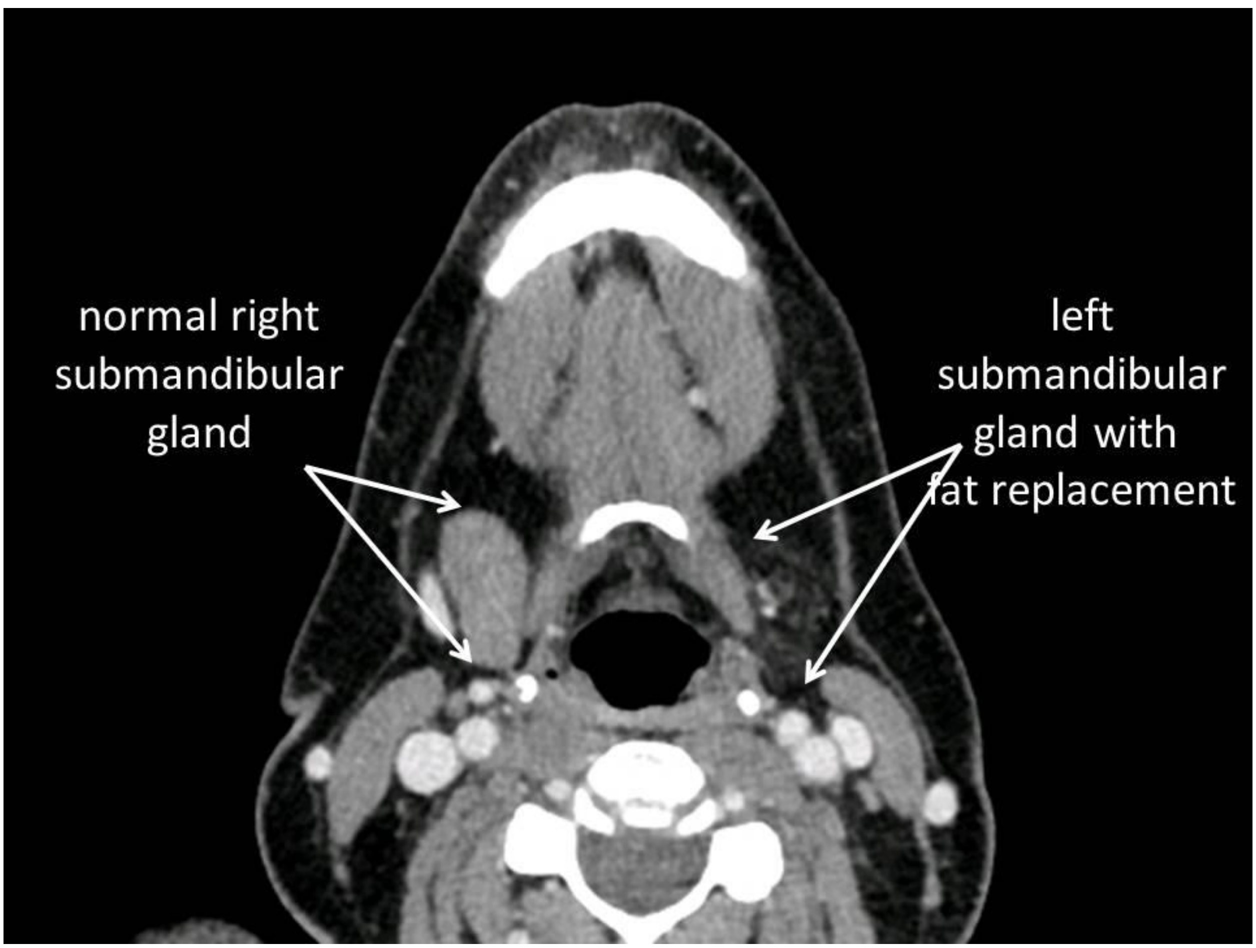
Patient is instructed to chew gum or suck on lemon.

COMPUTED TOMOGRAPHY

It is valuable in examining salivary gland, particularly after injection of contrast media, i.e. **CT sialography.**

CT enables the lesions and changes in surrounding structures to be visualised.





MAGNETIC RESONANCE IMAGING

MRI, like CT, has several advantages over CR for disease localisation.

The difference between MRI and CT is **in tissue differentiation**.

Because MRI is superior to CT for the tissue differentiation, it is more effective for qualitative diagnosis, such as determining whether a tumour is benign or malignant.

ULTRASONOGRAPHY

Normal Appearance of Parotid Gland :parotid gland appears as a homogeneous hyperechoic area.=(radiopaque)

Submandibular Gland: The normal submandibular gland also appears as a homogeneous hyperechoic area relative to the surrounding muscle.

Doppler Sonography

Intraglandular blood flow can be demonstrated with Doppler sonography.

<u>Dental Implantology</u>

Ass.Prof

Zainab H Al-Ghurabi

Dental implant: is a device made of alloplastic (foreign) material implanted into the jaw bone beneath the mucosal layer to support a fixed or removable dental prosthesis.

Dental implants are gaining immense popularity and wide acceptance because they not only replace lost teeth but also provide permanent restorations that do not interfere with oral function or speech or compromise the self-esteem of a patient.

Imaging plays an important part in dental implant procedures.

The imaging modalities vary from standard projections to more complex radiographic techniques.

Implant imaging provides accurate and reliable diagnostic information of the patient's anatomy at the proposed implant site.

Standard projections include intra-oral (periapical, occlusal) and extra-oral (panoramic, lateral cephalometric) radiographs.

More complex imaging techniques includes computed tomography (CT), and cone beam computed tomography (CBCT).

Multiple factors influence the selection of radiographic techniques for a particular case including cost, availability, radiation exposure, and patient's anatomy

The goals of imaging are:

To measure bone height and width (bone dimensions)

To assess bone quality

To determine the long axis of alveolar bone

To identify and localize internal anatomy

To establish jaw boundaries

To detect any underlying pathology.

INTRAORAL RADIOGRAPHY

Intraoral radiography used is either periapical or occlusal radiography.

It is usually done to determine the vertical height of bone, bone architecture and bone quality.

Intraoral radiography is recommended for the use of **single-tooth implants.**

(A) (B) (C) (D)

The disadvantages of intraoral periapical radiography

There is limited area of exposure; it can be used only in case of single-tooth implant.

• There is foreshortening and elongation of the image which results due to anatomical variation.

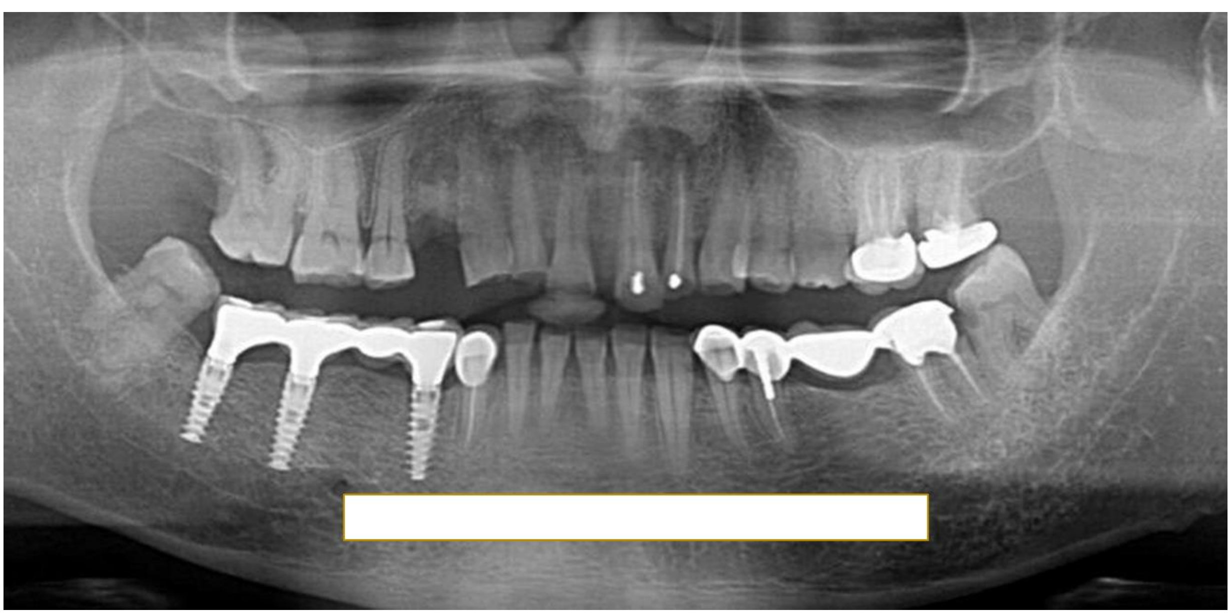
It is very difficult to reproduce the same image as the technique is not standardized.

PANORAMIC RADIOGRAPH

In comparison with the intraoral radiography, panoramic radiography has got advantage of broader visualization of the image.

But in case of panoramic radiography, sharpness and resolution is less.

Panoramic radiography is also helpful in preliminary estimation of bone height and position of inferior nerve canal. It is usually indicated when implant is planned for more than one teeth



Disadvantages with the panoramic radiography

It has got image size distortion, foreshortening and elongation.

Dimensional accuracy in the case of panoramic radiography is also limited due to superimposition of various structures.

Horizontal image magnification with panoramic radiographs can be twice the actual size.

CBCT imaging in dental implant

CBCT is the most accurate radiographic means for dental implant planning.

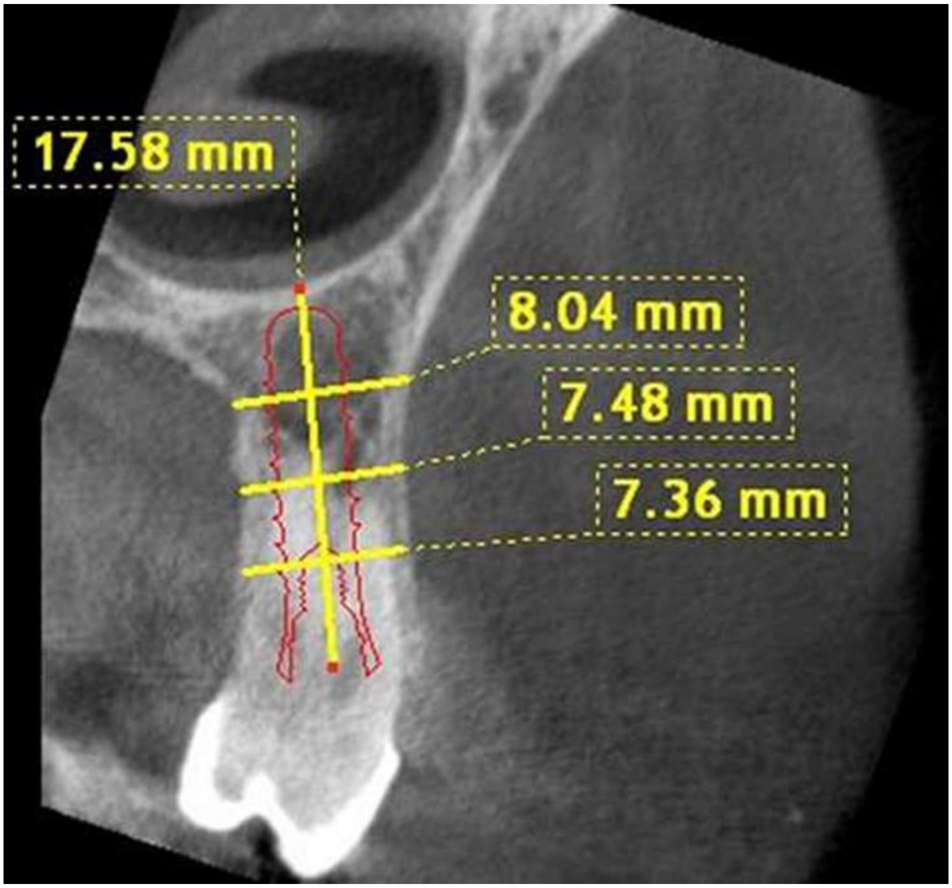
It allows for complete 3D evaluation of bone architecture with high accuracy and can be used for standardized estimation of bone quality.

According to the available literature, CBCT imaging is not required in cases

1-in which the clinical examination reveals sufficient bone width

2- Where standard radiographic examination reveals adequate bone height and space for implant placement.

However, many clinical situations demand additional CBCT examination for optimal preoperative implant planning.



Imaging modality is useful in three phases

Phase 1

Pre-prosthetic implant imaging Imaging in this phase determines the quantity, quality, and angulation of bone; relationship of critical structures to prospective implant sites; and the presence or absence of disease at the proposed surgical sites.

Phase 2

Surgical and interventional implant imaging Imaging in this phase evaluates the surgical sites during and immediately after surgery, assists in the optimal positioning and orientation of dental implants, and ascertains the healing and integration phase of implant surgery.

It also ensures appropriate abutment positioning and prosthesis fabrication.

Phase3

Post-prosthetic implant imaging This phase commences just after placement of the prosthesis and continues as long as the implant remains in the jaw.

Imaging in this phase evaluates the long-term change, if any defect in the implant's fixed position and function, including the crestal bone levels around each implant, and evaluates the status and prognosis of the dental implant.

It also helps to routinely assess the bone adjacent to the dental implant to note any changes in mineralization or bone volume.