Radiological Imaging Techniques

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Learning outcomes

- Understand the range and uses of the different radiographic views used in orthodontic practice

- Describe the radiation protection and ALARP guidelines

- Explain likely causes of faulty images

- Understand the basic principles of cephalometry including radiological landmarks
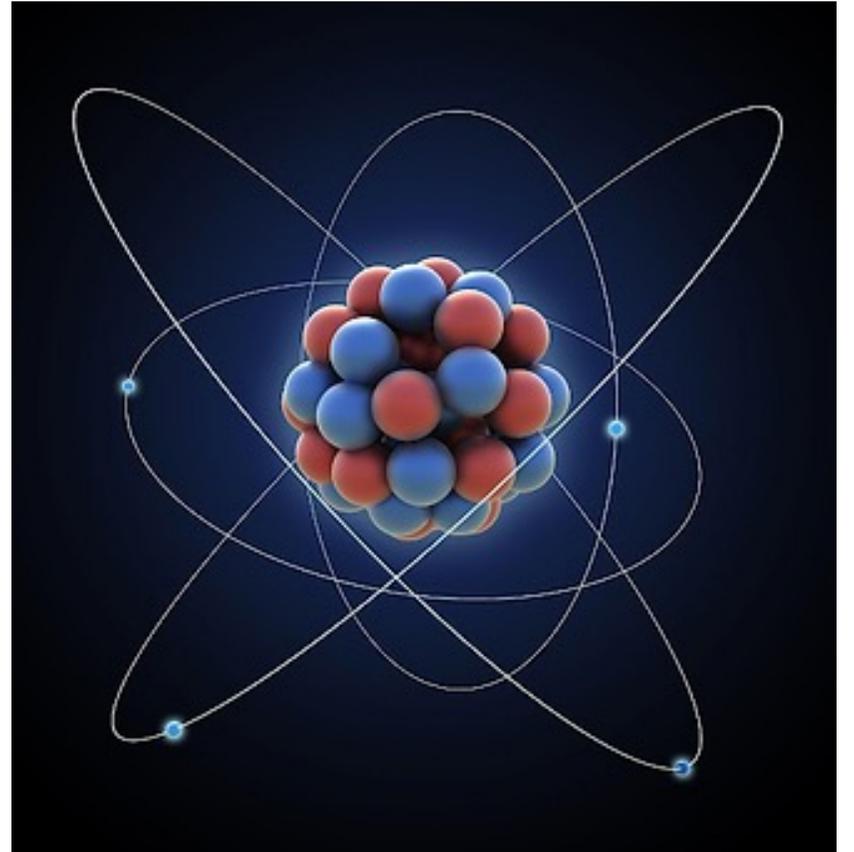
Risks associated with dental x-rays

- X-rays are a type of electromagnetic radiation

- Types of electromagnetic radiation that make up electromagnetic spectrum

Risks associated with dental x-rays

- Higher frequency, shorter-wavelength radiation: X-rays, gamma rays are types of ionizing radiation

- They ionize the atoms they interact with and have the potential to cause harm

- The lower part of the ultraviolet spectrum, visible light, radio waves are types of electromagnetic radiation, but do not have the ability to ionize the atoms.

Risks associated with dental x-rays

- Damaged DNA=cell death or cell mutation

- Radiotherapy results in cell death

- Cell mutations result in stochastic effect

- Development of malignancy in damaged tissue

Doses from dental x-rays

- Xray's deposit energy in tissue which it passes

- Greater energy=greater biological damage

- Absorbed dose is the mean energy imparted per unit mass of tissue

- Different tissues in the body have varying susceptibilities to ionizing radiation

Doses from dental x-rays

- Effective dose allows a direct comparison between different types of tissue

- This can be directly correlated to the risk of cancer

- Effective dose is measured in Sieverts

- Risk of cancer from dental radiography is 1 in 15000/mSv for men and 1 in 18000/mSv for women

Radiation

- Background radiation: 7 µSv per person/per day

- Chest X-ray: 14 µSv   2 days background radiation

- Transatlantic flight: 80 µSv 10 days background radiation

Effective does from dental radiographs

- Bitewings: 2μSv

- Lateral cephalogram: 6μSv

- Panoramic Radiograph: 20μSv

Effective does for CBCT

- Higher doses than intra-orals and panoramic radiographs

- Lower does than medical CT

- Lower field of view

- CBCT 5 X 5 cm=40μSv

- CBCT < 10 cm=80μSv

Principals of radiation protection

- Justification: benefit outweighs risk of exposure

- Optimization: every reasonable attempt is made to reduce unnecessary dose to patients
- 'ALARP'

- Limitation: Doses should not exceed the limits that are set in UK law

- Effective dose of 20 mSv per year for adults

Key points in IRR 17 and IRMER 17

- Ionising Radiation Regulations (IRR)
- Concerned with safety of workers and general public
- Enforced by Health and Safety Executive

- Ionising Radiation Medical Exposure Regulations (IRMER)
- Concerned with patient safety
- Enforced by RQIA in NI

IRR 17

- The IRR 17 legislation sets out the role of the employer as the person who takes legal responsibility for implementing the regulations.

- It is the responsibility of the employer (practice owner, or CEO of a corporate body or NHS Trust) to provide a safe working environment for staff and the public.

IRR 17

- Register with the HSE before undertaking practices involving ionizing radiation

- Appoint a radiation protection advisor (RPA) to act as a safety consultant

- Perform a risk assessment prior to starting any new procedure involving ionizing radiation, and have contingency plans for adverse accidents

- Designate certain areas as being 'controlled areas'

- Provide 'local rules' for all controlled areas, and appoint radiation protection supervisors (RPS) to ensure compliance with them.

IRMER 17

- The objective of the IRMER 17 legislation is to protect patients exposed to ionizing radiation

- There are no dose limits for patients, but all exposures must be justified and the ALARP principle should be observed.

- The IRMER legislation defines five separate individuals:

- The employer;

- The referrer;

- The practitioner;

- The operator;

- The medical physics expert (MPE).

IRMER 17

- The employer is responsible for setting up a framework for the protection of patients. They must ensure staff are adequately trained, and they must appoint an MPE.

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IRMER 17

- The employer should identify who is entitled to act as a referrer, practitioner and operator, and must ensure they have adequate training.

- The referrer provides sufficient clinical information to allow the exposure to be justified.

- The practitioner justifies the exposure, and the operator is responsible for all practical aspects associated with performing the exposure.

- Reporting of the radiographs is also defined as an operator role under IRMER

IRMER 17

- There is now updated guidance regarding the rating of clinical image quality.

- Previously, a three-tier system was used, rating images as excellent, diagnostically acceptable or unacceptable.

- It is now advised that a simplified two-tier system is used rating both dental radiographs and CBCT examinations as diagnostically acceptable or not acceptable.

IRMER 17

- Requirement of both sets of legislation that the employer ensures staff involved in dental radiography have adequate training.

- All IRMER practitioners and operators must undergo continuing professional development (CPD), and it is recommended by the General Dental Council (GDC) that any dentist or dental care profession involved in radiography.

- At least 5 hours of CPD in radiography and radiation protection in each CPD cycle.

Radiograph errors

- Ghost Image

- A ghost image consists of a radiopaque artifact that is visible in a panoramic image and is caused by the double penetration of the X-ray beam into an object.

- Looks similar to the real image, but appears on the opposite side of the film, is larger and taller than the real image.

Radiolucent shade on anterior teeth

- This error can occur for two reasons, the first is when the patient's lips are not closed on the bite-tab during the panoramic X-ray , this can cause a shadow to be seen dark radiolucent that blocks the view of the front teeth.

- The second reason is that the tongue is not resting against the palate during the orthopantomography, this can cause a dark radiolucent shadow to be seen on the apices of the upper teeth, making diagnosis difficult.

Flat or upward curved smile line

- The cause of these error is attributed to the incorrect placement of the Frankfurt plane, with the head tilted backwards.

- This occurs when the patient's chin is too high or tilted upward, causing the Frankfurt plane to tilt.

One side of the x-ray is magnified and the other side is reduced

- This occurs because the sagittal plane is not correctly centered.

- The magnification of the ramus and of the posterior teeth will be asymmetric in the orthopantomography.

Radiographs

- Used to assess:
- Presence or absence of permanent teeth
- Root morphology
- Presence of dental disease
- Presence of supernumerary teeth
- Position of ectopic tooth
- Relationship of dentition to skeletal base

Orthopantomogram

Periapical radiographs

Bitewing radiographs
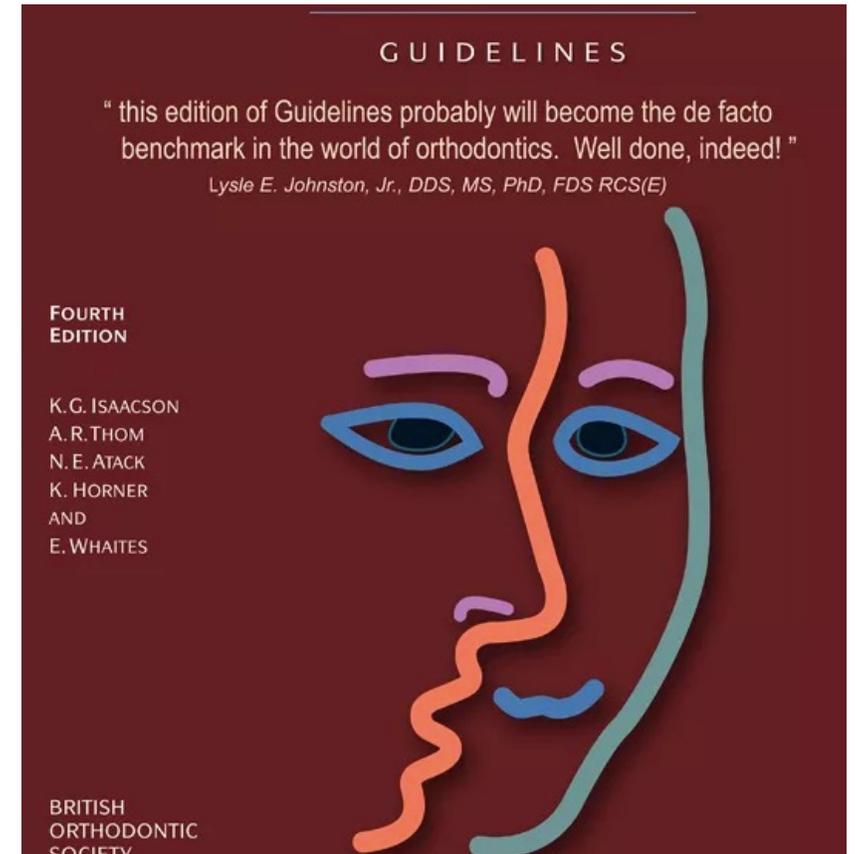
Occlusal radiographs

Lateral cephalogram

- Used to assess the position of skeletal bases and inclinations of dental structures


- Allows linear and angular measurements

Diagnosis

- Used in conjunction with clinical examination

- BOS Guidelines

- Used to determine aetiology of malocclusion

- Population norms used as a guide

GUIDELINES

" this edition of Guidelines probably will become the de facto benchmark in the world of orthodontics. Well done, indeed! "

Lysle E. Johnston, Jr., DDS, MS, PhD, FDS RCS(E)

FOURTH EDITION

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BRITISH ORTHODONTIC SOCIETY

Common cephalometric analyses

- Downs (1948)

- Steiner (1953)

- McNamara (1984)

- Eastman (1956)

- Wits (1975)
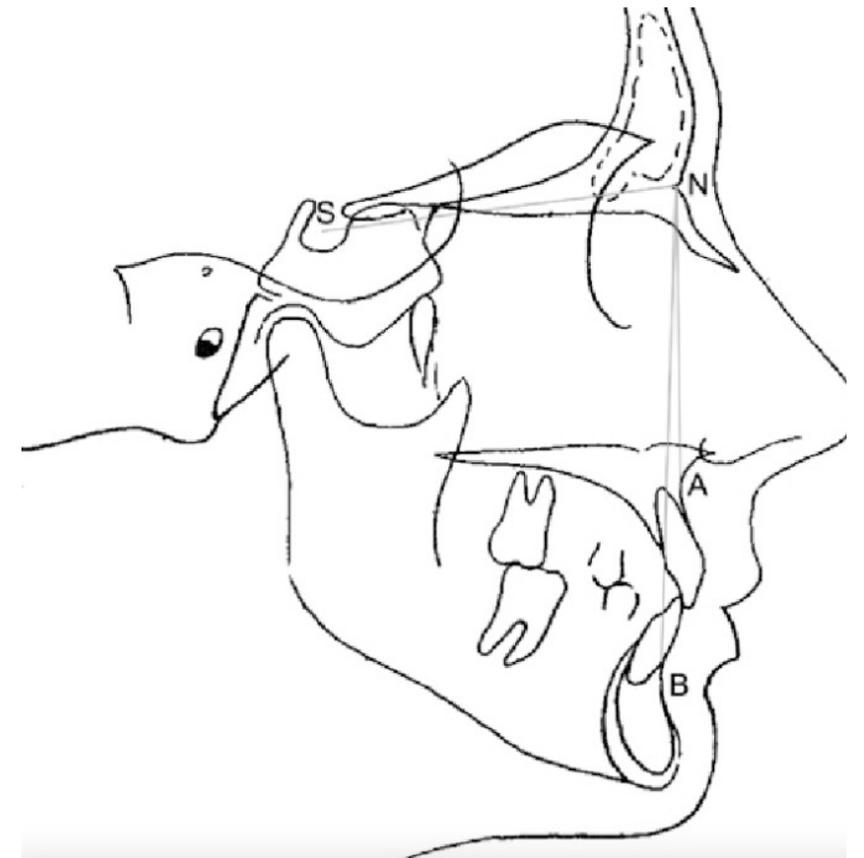
Eastman analysis

Measurement	Mean Value + Standard Deviation
SNA	81°±3°
SNB	78°±3°
ANB	3°±2°
UInc to MxPl	109°±6°
LInc to MnPl	93°±6°
Inter-incisal angle	135°±10°
MMPA	27°±4°
Facial proportion	55%±2%

Errors on cephalometry

- Errors of projection

- Landmark identification
- 'Envelope of error'

- Sella most reliable
- A and B point prone to error

Tracing a lateral cephalogram

- Hand traced

- Pencil and tracing paper

- Landmarks and tracing can be done digitally to produce analysis

- Opal/Dolphin

Horizontal reference planes

- Frankfort plane

- Sella-naison plane

- Maxillary plane

- Occlusal plane

- Mandibular plane

Assessing AP skeletal relationship

- ANB angle

- Wis appraisal

Assessing vertical skeletal relationship

- Maxillary-mandibular plane angle (MMPA)

- Frankfort-mandibular plane angle (FMPA)

- Anterior and posterior face heights

Assessing the dental relationship

- Maxillary incisor relationship

- Mandibular incisor relationship

- Interincisal angle

Landmarks

- Sella (S): the midpoint of the sella turcica (pituitary fossa).

- Nasion (N): the most anterior point on the frontonasal suture in the midline.
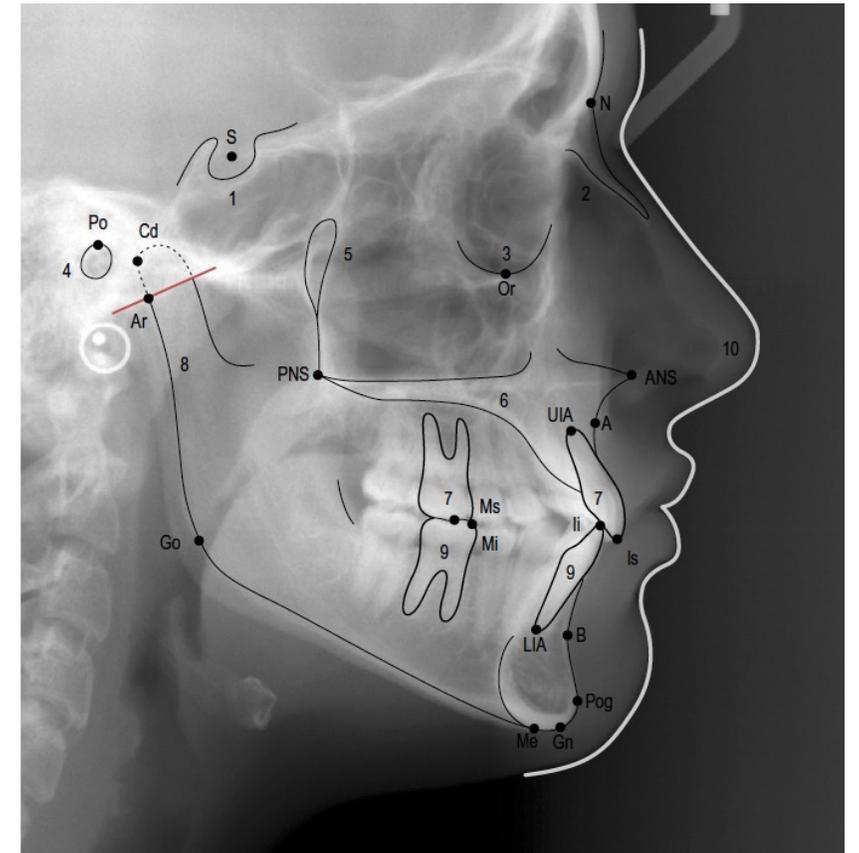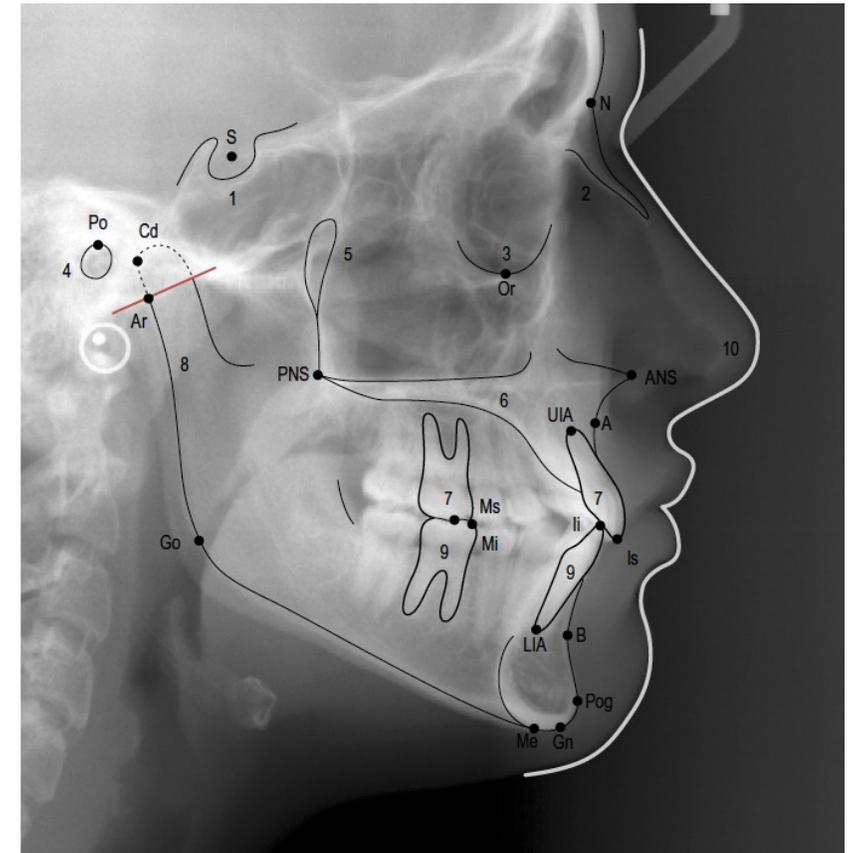
Landmarks

- Porion (Po): the upper- and outer-most point on the external auditory meatus.

- Orbitale (Or): the most inferior and anterior point on the orbital margin.

- Condylion (Cd): the most posterior and superior point on the mandibular condyle.

- Articulare (Ar): the point of intersection of the posterior margin of the ascending mandibular ramus and the outer margin of the posterior cranial base.
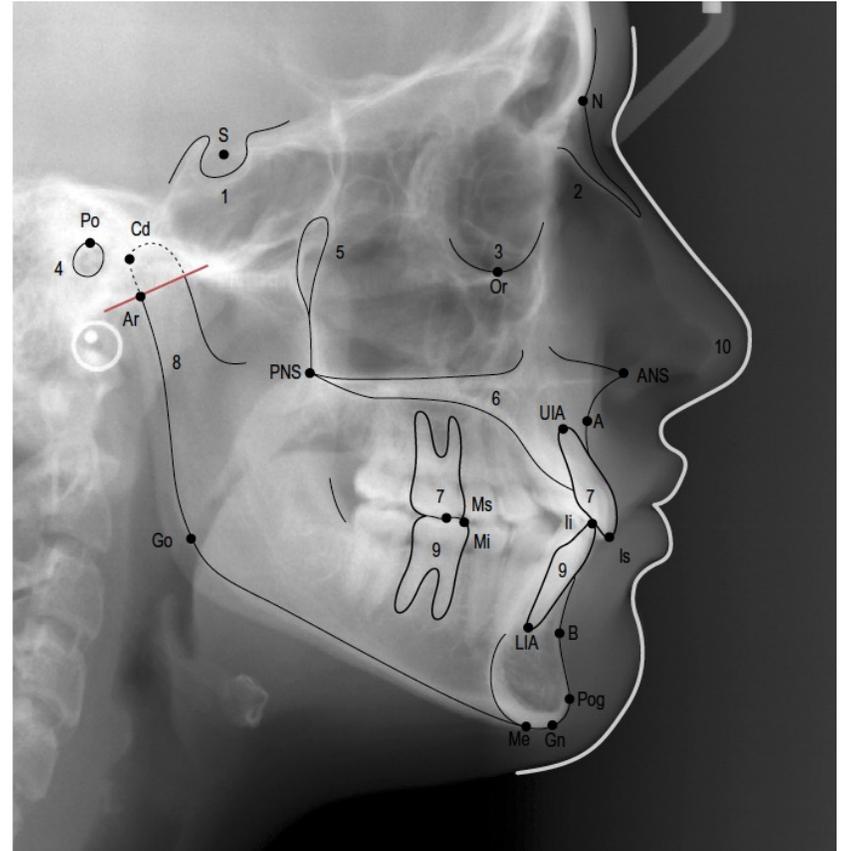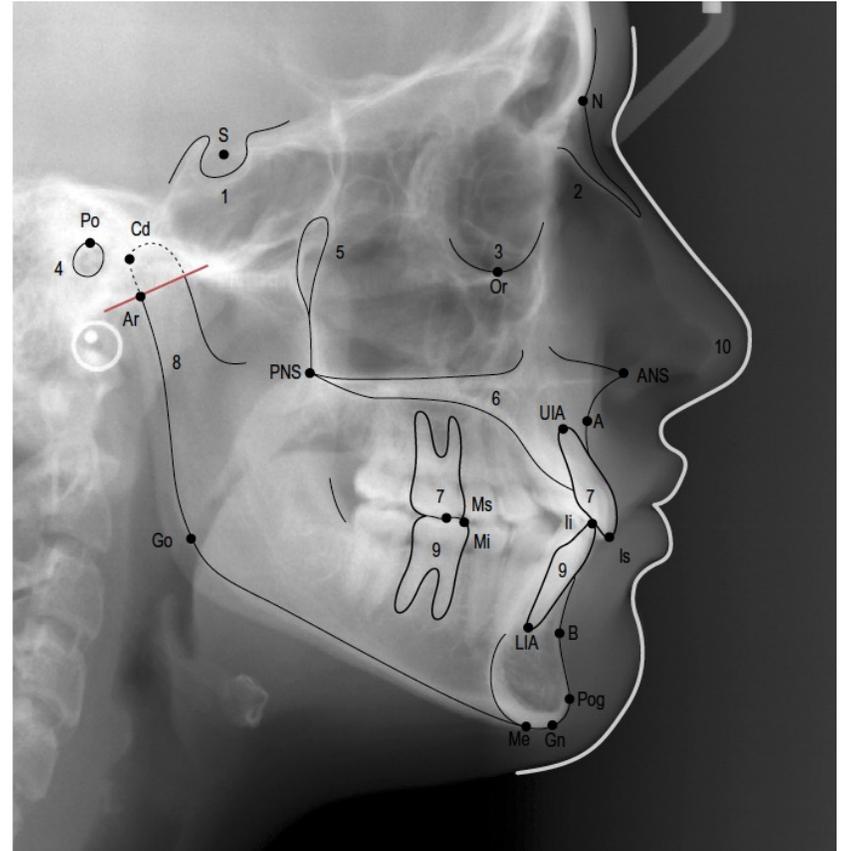
Landmarks

- Gnathion (Gn): the most anterior and inferior point on the bony chin.

- Menton (Me): the most inferior point of the mandibular symphysis in the midline.

- Pogonion (Pog): the most anterior point on the bony chin.

- Gonion (Go): the most posterior and inferior point on the angle of the mandible.
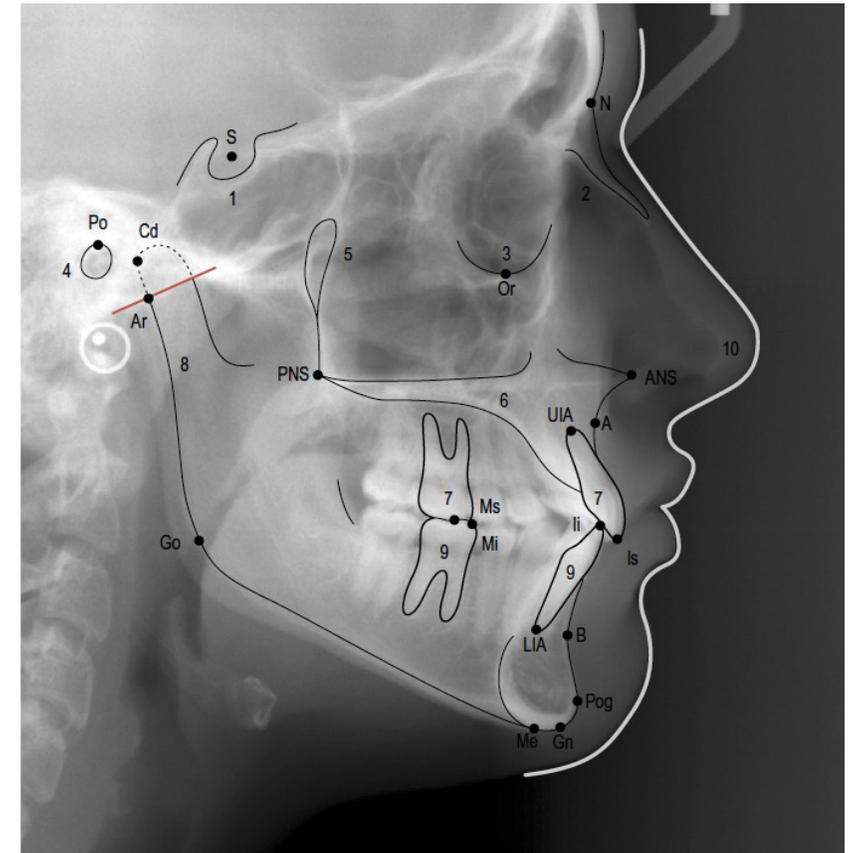
Landmarks

- Point A: The deepest point on the curved profile of the maxilla between the anterior nasal spine and alveolar crest.

- Point B: the deepest point on the curved profile of the mandible between the chin and alveolar crest.

Landmarks

- Anterior nasal spine (ANS): the tip of the bony anterior nasal spine in the midline.

- Posterior nasal spine (PNS): the tip of the posterior nasal spine in the midline (located as a continuation of the base of the pterygopalatine fossa where it intersects with the nasal floor).

Landmarks

- Incisor superius (Is): tip of the crown of the most anterior maxillary central incisor.
- Upper incisor apex (UIA): root apex of the most anterior maxillary central incisor.
- Incisor inferius (Ii): tip of the crown of the most anterior mandibular central incisor.
- Lower incisor apex (LIA): root apex of the most anterior mandibular central incisor.
- Molar superioris (Ms): the mesial cusp tip of the maxillary first molar.
- Molar inferioris (Mi): the mesial cusp tip of the mandibular first molar.
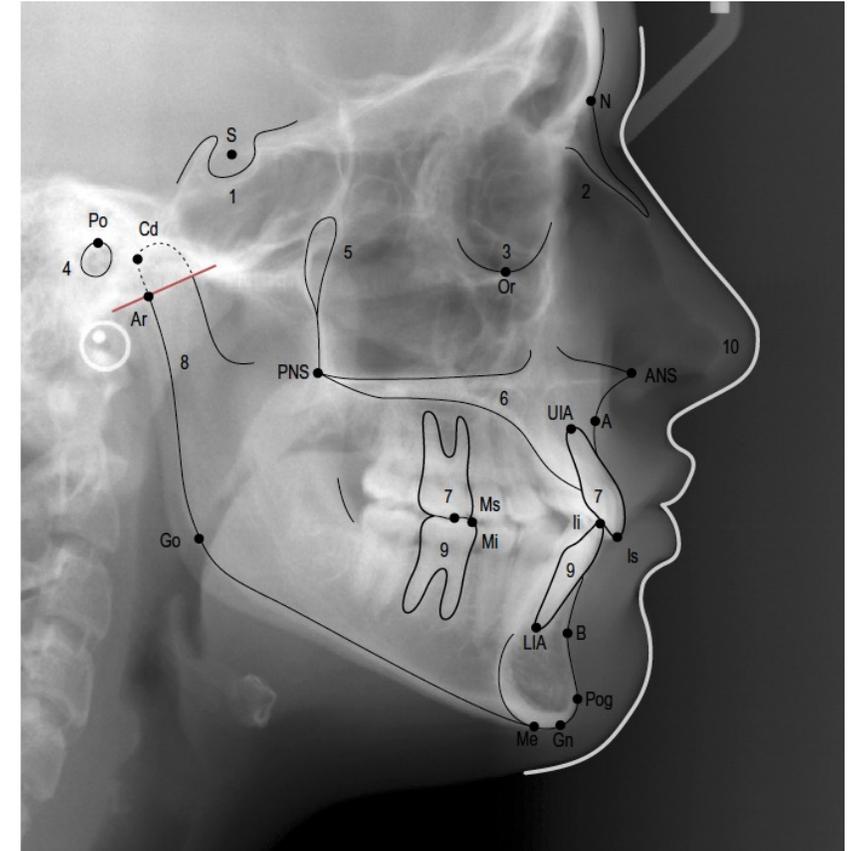
Cephalometric planes and relationships

- **SN line** The plane demonstrated by a line through the nasion and sella

- **Frankfort Plane** The plane demonstrated by a line through the orbitale and porion

- **Mandibular Plane (MnPl)** The plane demonstrated by a line through the gonion and menton. The definition varies slightly, but the plane is used to show the plane of the lower border of the mandible

- **Maxillary Plane (MxPl)** The plane demonstrated by a line through the anterior and posterior nasal spines

Cephalometric planes and relationships

- **SNA** This angle represents the relative anterioposterior position of the maxilla to the cranial base

- **SNB** This angle represents the relative anterioposterior position of the mandible to the cranial base

- **ANB** This angle represents the relative anterioposterior position of the maxilla to the mandible and can be used to determine skeletal class.

Cephalometric planes and relationships

- **Inter-Incisal Angle** The angle between the long axis of the maxillary incisors and the long axis of the mandibular incisors

- **Maxillary-mandibular plane angle (MMPA)** The angle formed between the Maxillary Plane and Mandibular Plane

- **Maxillary Incisal Inclination (UInc to MxPl)** The angle between the maxillary plane and the axis of the maxillary incisors (UInc)

- **Mandibular Incisal Inclination (LInc to MnPl)** The angle between the mandibular plane and the axis of the mandibular incisors (LInc)

Three-dimensional imaging

- Computed Tomography (CT)

- Cone Beam Computed Tomography (CBCT)

- Optical laser scanning

- Stereophotogrammetry

CBCT

- Field of view (FOV)

- 3D data set reconstructed

- Axial, coronal, sagittal

Selection criteria for CBCT

- Unerupted tooth localization

- External resorption in relation to unerupted teeth

- Cleft palate

- Orthognathic treatment planning

Indications for small volume CBCT

- Unerupted canines where conventional radiographs have failed to provide sufficient information to plan treatment

- Assessment of dilacerated teeth where root angulation will affect management

- Planning surgical removal of teeth close to neurovascular structures

- Alternative to medical CT in the assessment of cleft to assess volume of bony defect

Practical exercise

Cephalometric tracing and measurement

Opal tracing

- https://youtu.be/PX4mVvjd8Hc

Questions?