CEPHALOMETRIC RADIOGRAPHY

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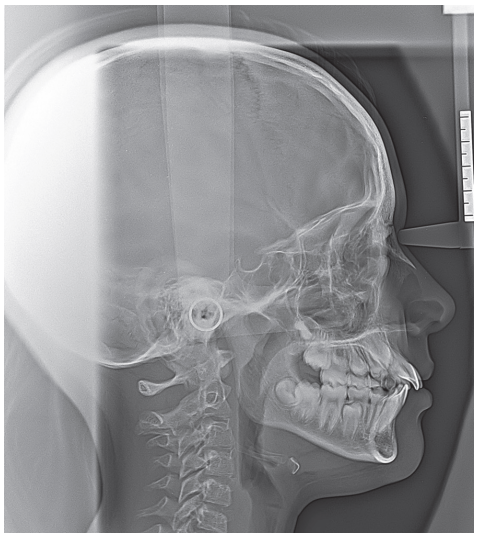
Cephalometric radiography is a specialized radiographic technique concerned with imaging the craniofacial region in a standardized and reproducible manner. A cephalometric analysis identifies defined anatomical landmarks on the film and measures the angular and linear relationships between them. This numerical assessment can provide detailed information on the relationship of skeletal, dental and soft tissue elements within the craniofacial region.

Types of Cephalogram

There are following two types of cephalograms

1. Lateral cephalogram: Lateral cephalogram provides a lateral view of the skull. It is taken with the head in a standardized reproducible position at a specified distance from the source of the x-ray. Lateral cephalogram commonly is used for cephalometric analysis.



2. Frontal cephalogram: This provides an antero-posteriorview of the skull.

Cephalometric analysis

Cephalometric analysis relies upon the production of a standardized lateral head film. This is achieved by using a cephalostat, which holds the mid-sagittal plane of the head at a fixed distance from both the X-ray source and film, keeping the magnification constant for every radiograph. For a cephalometric lateral skull radiograph, the mid-sagittal plane is orientated perpendicular to the X-ray beam and parallel to the film. Subjects are usually orientated in natural head posture.

Indications for cephalometric evaluation

An increasing awareness of the risks associated with X-rays has led clinicians to re-evaluate the indications for taking a cephalometric radiograph. The following are considered valid

- **An aid to diagnosis**

  It is possible to carry out successful orthodontic treatment without taking a cephalometric radiograph, particularly in Class I malocclusions. However, the information that cephalometric analysis yields is helpful in assessing the probable aetiology of a malocclusion and in planning treatment. Lateral cephalometric radiograph is best limited to patients with a skeletal discrepancy and/or where anteroposterior movement of the incisors is planned. In a small proportion of patients, it may be helpful to monitor growth to aid the planning and timing of treatment by taking serial cephalometric radiographs.

- **A pre-treatment record**

  A lateral cephalometric radiograph is useful in providing a baseline record prior to the placement of appliances, particularly where movement of the upper and lower incisors is planned.

- **Monitoring the progress of treatment**

  In the management of severe malocclusions, where tooth movement is occurring in all three planes of space (for example treatments involving functional appliances, or upper and lower fixed appliances), it may be helpful to take a lateral cephalometric radiograph during treatment to monitor incisor inclinations and anchorage requirements.

- **Research purposes**

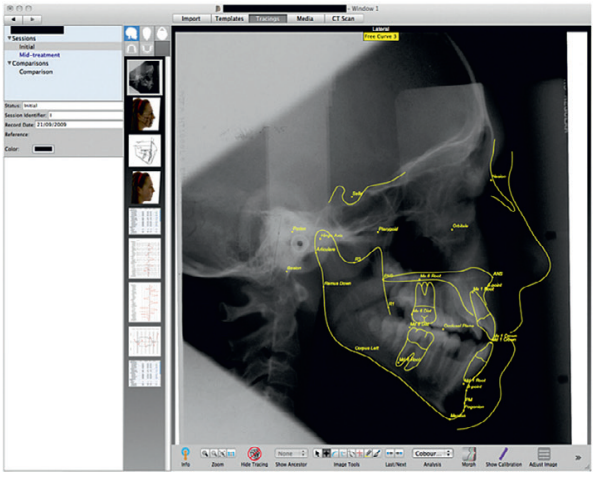
  A great deal of information has been obtained about growth and development by longitudinal studies which involved taking serial cephalometric radiographs from birth to the late teens or beyond.

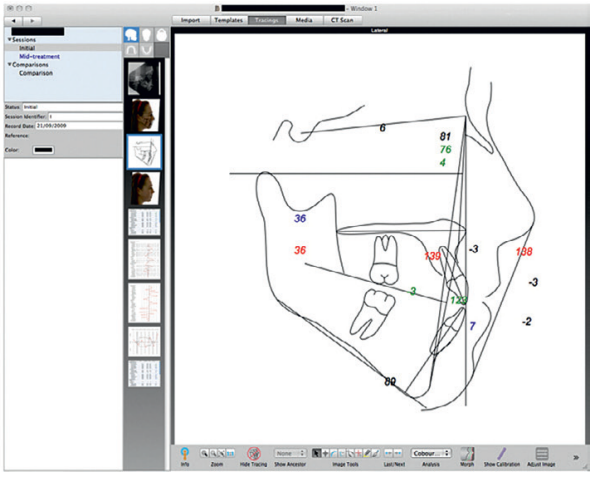
Tracing a lateral skull cephalometric radiograph

A lateral skull radiograph should be hand-traced in a darkened room with suitable back illumination using a hard pencil and high-quality tracing paper attached to the radiograph. The peripheral regions of the radiograph should be masked to highlight the cranial base and facial complex. Bilateral structures should be traced independently and then averaged.

Computer-based cephalometric analysis

The advent of personal computing has resulted in the development of many commercial and freely available software packages that allow the digitization and manipulation of imported cephalometric lateral skull radiographs. Although landmark identification is still largely under control of the user, measurement error is significantly reduced because the software carries it out. However, the main advantage of these programmes is the versatility they provide, allowing the user to generate numerous different analyses or even customize their own. In addition, they can perform superimpositions, undertake prediction planning for treatment outcome and are extremely useful for planning orthognathic surgery, with superimposition of profile photographs onto the cephalometric tracin.





Commonly used cephalometric points

The following hard tissue landmarks should be identified:

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

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

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.

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.

Point A (subspinale): the deepest point on the curved profile of the maxilla between the anterior nasal spine and alveolar crest.

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

Upper incisor apex (UIA): the root apex of the most anterior maxillary central incisor.

Incisor superius (Is): the tip of the crown of the most anterior maxillary central incisor.

Incisor inferius (Ii): the tip of the crown of the most anterior mandibular central incisor.

Lower incisor apex (LIA): the root apex of the most anterior mandibular central incisor

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).

Horizontal reference planes

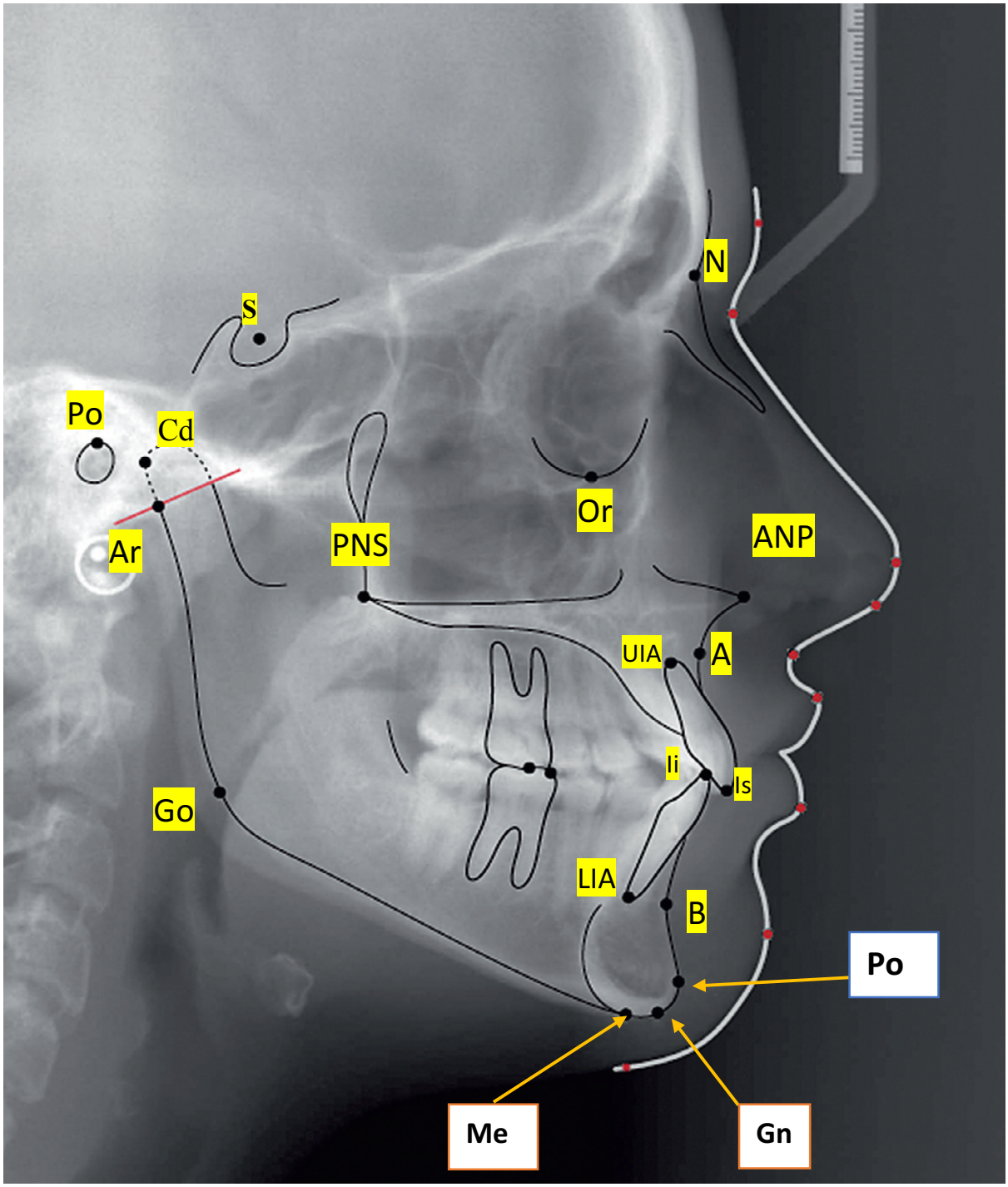
A number of horizontal planes are commonly used as references in the construction of other measurements or they are related to each other within a cephalometric analysis. In particular, they are used in the evaluation of skeletal relationships and the anteroposterior position of the dentition.

SN line: this line, connecting the midpoint of sella turcica with nasion, is taken to represent the cranial base.

Frankfort plane: this is the line joining porion and orbitale. This plane is difficult to define accurately because of the problems inherent in determining orbitale and porion.

Mandibular plane: The line joining gonion and menton.

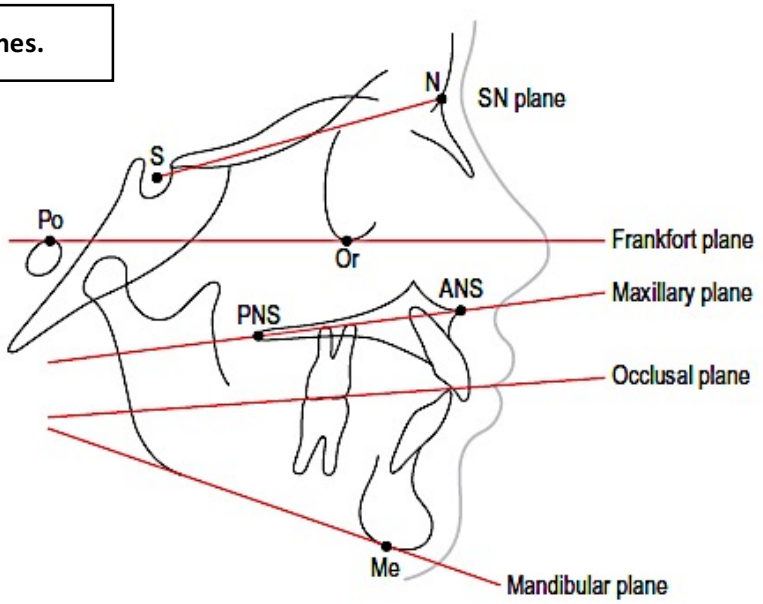
Maxillary plane: the line joining anterior nasal spine with posterior nasal spine. Where it is difficult to determine ANS and PNS accurately, a line parallel to the nasal floor can be used instead.



Functional occlusal plane: a line drawn between the cusp tips of the permanent molars and premolars (or deciduous molars in mixed dentition). It can be difficult to decide where to draw this line, particularly if there is an increased curve of Spee, or only the first permanent molars are in occlusion during the transition from mixed to permanent dentition. The functional plane can change orientation with growth and/or treatment, and so is not particularly reliable for longitudinal comparisons.

Horizontal reference planes.

ANS, anterior nasal spine; Me, menton; N, nasion; Or, orbitale; PNS, posterior nasal spine; Po, porion; S, sella.



Anteroposterior skeletal pattern

❖ ***Angle ANB***

This method was first described as part of a cephalometric analysis that relates the maxilla and mandible to the anterior cranial base.

The SN plane represents the anterior cranial base, whilst points A and B represent the anterior surfaces of the maxillary and mandibular apical bases, respectively;

• The anteroposterior position of the maxilla is calculated by measuring the angle SN to point A (SNA) (81° ± 3°);

• The anteroposterior position of the mandible is calculated by measuring the angle SN to point B (SNB) (78° ± 3°); and

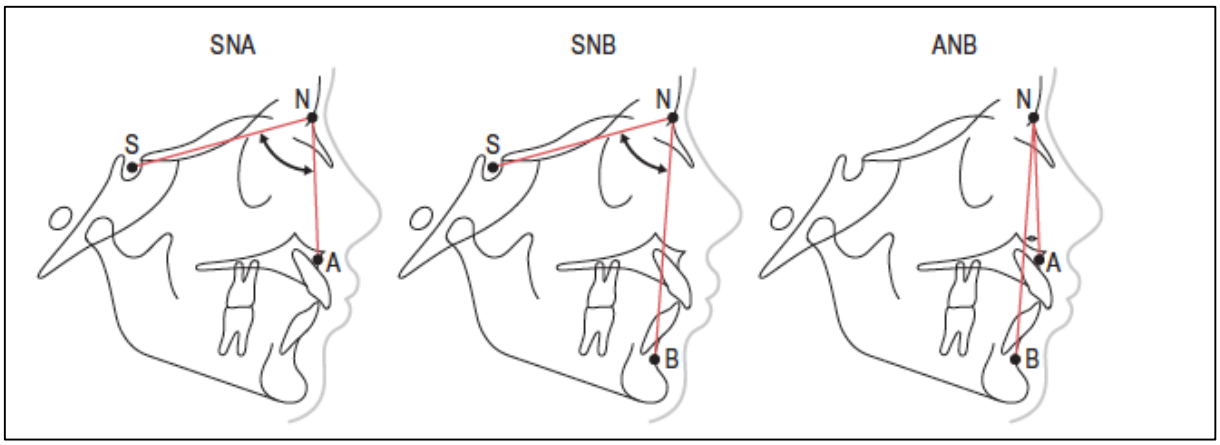
• The relative difference in the anteroposterior relationship of the maxilla and mandible is measured by the difference between the SNA and SNB angles, or ANB angle (3° ± 2°).

Classification of anteroposterior skeletal pattern using the ANB angle	
Skeletal class	**ANB angle**
Class I	**2–4°**
Class II	**>4°**
Class III	**<2°**

The ANB angle provides a relatively simple and commonly used assessment of anteroposterior jaw relations. However, it is not beyond criticism:

• Both points A and B are used primarily because they are relatively easy to identify on a cephalometric radiograph. In reality they do not represent the true anterior extent of the skeletal bases and their positions can alter as a result of alveolar bone remodelling that
occurs during orthodontic movement of the upper and lower incisor teeth; and

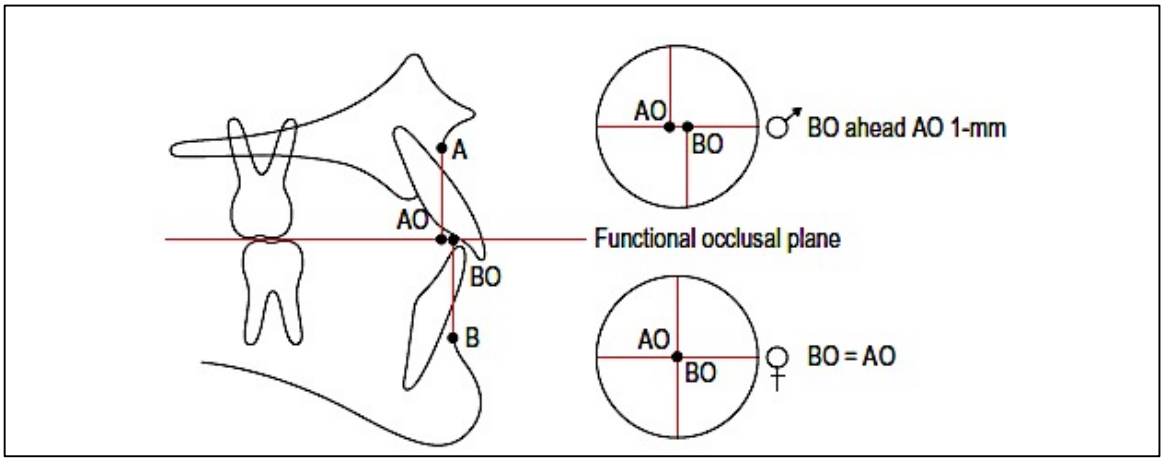
• Variations in the position of the anterior cranial base can also affect interpretation of the jaw position using this method.



❖ *Wits analysis*

(Wits derives from an abbreviation for University of the Witwatersrand in South Africa where Jacobsen was employed)

This analysis compares the relationship of the maxilla and mandible with the occlusal plane, which is known as the functional occlusal plane. Perpendicular lines from both point A and point B are dropped to the functional occlusal plane to give points AO and BO. The distance between AO and BO is then measured. The mean values are 1 mm (±1.9 mm) for males and 0 mm (±1.77 mm) for females.



Assessing the vertical skeletal relationship

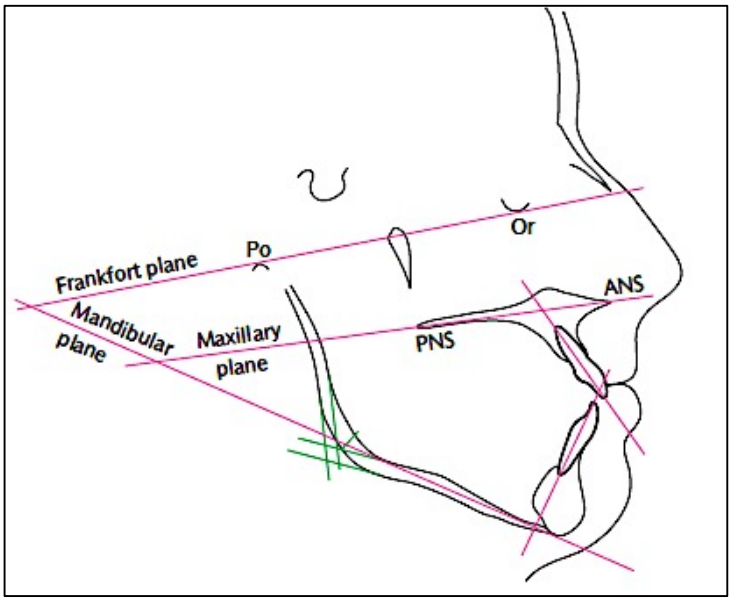
The vertical jaw relationship can also be assessed in a number of ways:

- **Maxillary–mandibular plane angle (MMPA)**

  The MMPA is a common method for evaluating the vertical jaw relationship, with horizontal reference planes that are easily located. The mean value is 27° ±5°.

- **Frankfort–mandibular plane angle (FMPA)**

  The FMPA uses the Frankfort plane as a horizontal reference to the mandibular plane. The mean value is 27° ±5°.



- **Anterior and posterior face heights**

Anterior and posterior face heights are also used as a measure of vertical facial relationships

• Total anterior face height (TAFH) extends from nasion to menton, with both lines constructed perpendicular to the maxillary plane (mean 119 mm in an adult male).

TAFH is further subdivided into:

• Upper anterior face height (UAFH); nasion to maxillary plane (mean 54 mm);

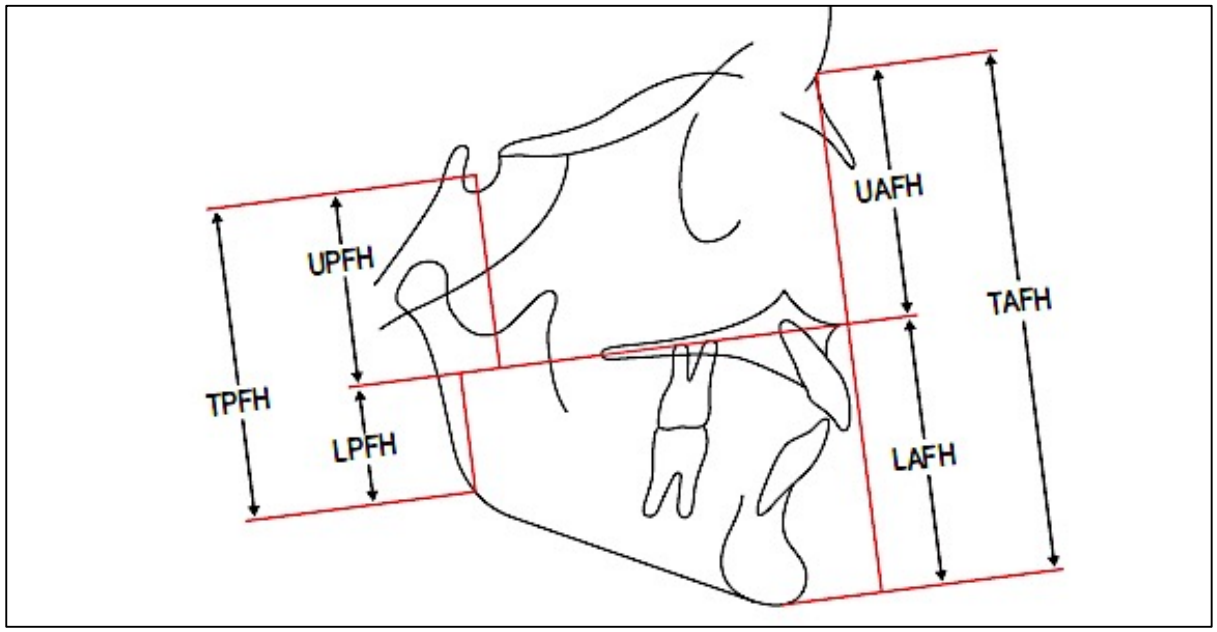
• Lower anterior face height (LAFH); maxillary plane to menton (mean 65 mm); and

• The LAFH should be approximately 55% of the TAFH.

• Total posterior face height (TPFH) extends from sella to gonion, with both lines constructed perpendicular to the maxillary plane (mean 79 mm in an adult male).

TPFH is therefore subdivided into:

• Upper posterior face height (UPFH); sella to maxillary plane (mean 46 mm);
• Lower posterior face height (LPFH); maxillary plane to gonion (mean 33 mm); and
• The TPFH should be approximately 65% of the TAFH.



Assessing the dental relationship

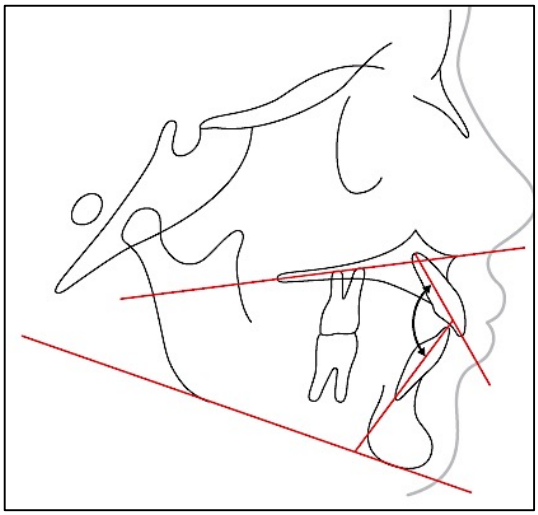
Several methods of assessment are available for positioning the maxillary and mandibular dentition in relation to the jaws and face.

- **Maxillary incisor relationship**

  The inclination of the most prominent maxillary incisor is constructed using a line through UIA–Is and measured in relation to the maxillary plane. The mean value is 109° ± 6°.

- **Mandibular incisor relationship**

  The inclination of the most prominent mandibular incisor is constructed using a line through LIA–Ii and measured in relation to the mandibular plane. The mean value is 93° ± 6°.



- **Interincisal angle**

  The interincisal angle is the angle formed between the most prominent maxillary and mandibular incisors. The mean value is 135° ± 10°.

Soft tissue cephalometric analysis

The soft tissue profile can also be seen on a lateral skull cephalometric radiograph, and various methods for measuring this have been described.

Ricketts' E-line

Ricketts' E-line is a line drawn from tip of the nose to soft tissue pogonion. The upper lip should be 4 mm and the lower lip 2 mm behind this line. This line is age-related, as the lips tend to become more retrusive with age.

Nasolabial angle

The nasolabial angle can also be identified from the soft tissue profile on a cephalometric radiograph. The mean value is 100° ± 8°.

Cephalometric errors

Cephalometric analysis has its limitations and should only be used as a supplement to the clinical assessment. Cephalometric errors can be sub-divided as follows.

- ✓ **Projection errors**

  Because a cephalometric radiograph is a slightly enlarged, two-dimensional representation of a three-dimensional patient, angular measurements are generally to be preferred to linear measurements.

- ✓ **Landmark identification**

  Accurate identification of cephalometric points is often difficult particularly if the radiograph is of poor quality. Some points are more difficult to locate than others, for example Porion is particularly problematic. Where reference planes are constructed between two points, the errors inherent in determining them are compounded.

- ✓ **Measurement errors**

  All analyses relate cephalometric points and planes to each other so any errors of landmark identification are multiplied. In addition, operator mistakes may contribute to measurement error.

Cephalometric norms for Caucasians	
SNA	81° ± 3°
SNB	78° ± 3°
ANB	3° ± 2°
SN Mx plane	8° ± 3°
WITS	BO + 1 mm ahead AO (males) BO = AO (females)
MMPA	27° ± 5°
UI Mx plane	109° ± 6°
LI Md plane	93° ± 6°
I/I	135° ± 10°
TAFH	Mean 119 mm
UAFH	Mean 54 mm
LAFH	Mean 65 mm
% LAFH Mean 55%	Mean 55%
NLA	100° ± 8°

You can download this lecture from E-MOODLE website

http://elearn.uobabylon.edu.iq

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