

# **Diagnosis of malocclusions. X-ray diagnosis. Cephalometrics**

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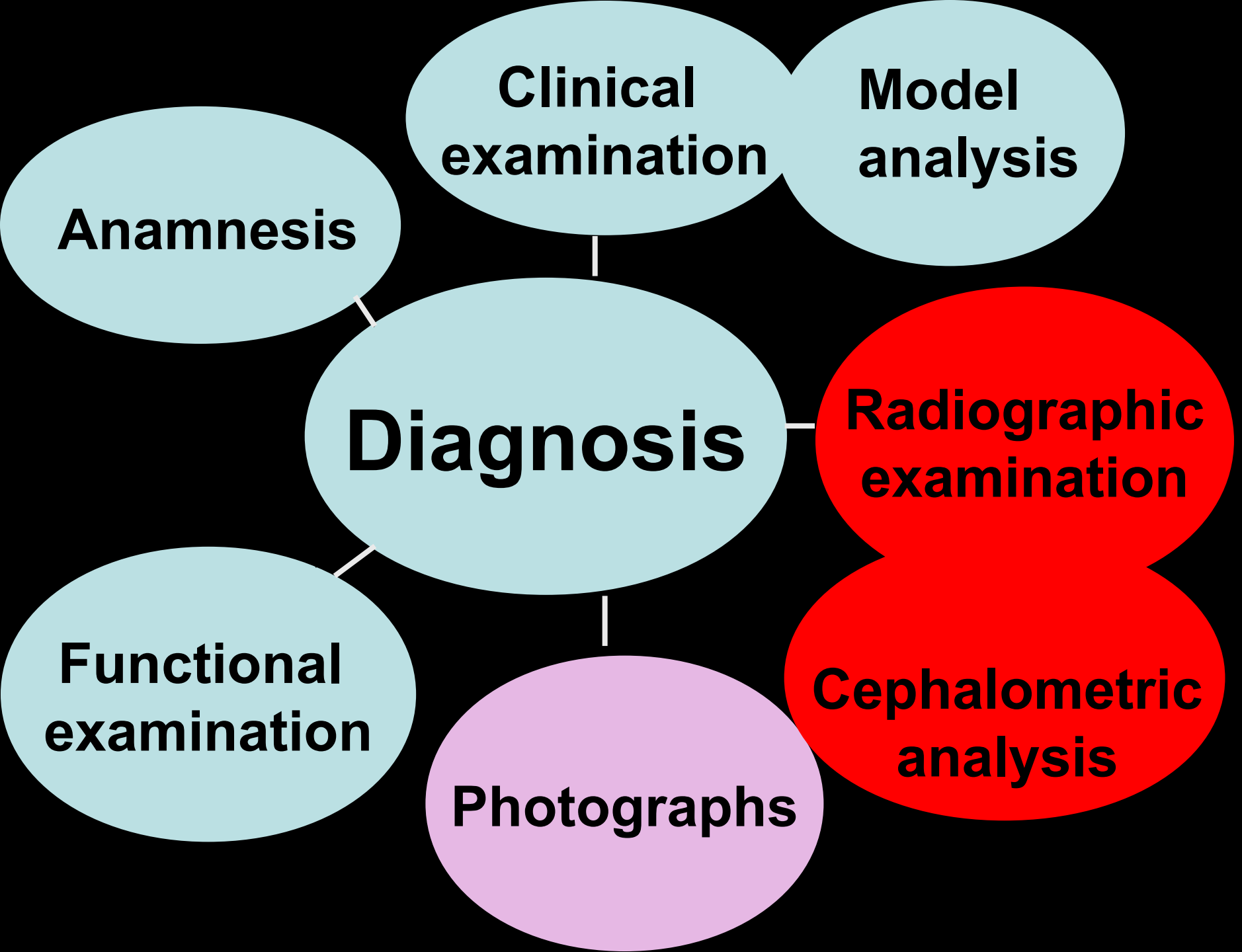
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**Semmelweis University**

**Budapest**



# **Radiographs - Orthodontic records**

## ***Role of orthodontic records***

- Diagnosis and treatment planning***
- Acting as an aide-memoire***
- Providing a legal document of treatment***
- Providing proof to commissioning bodies that treatment was justified and conducted to a good standard***
- Audit, teaching and research***

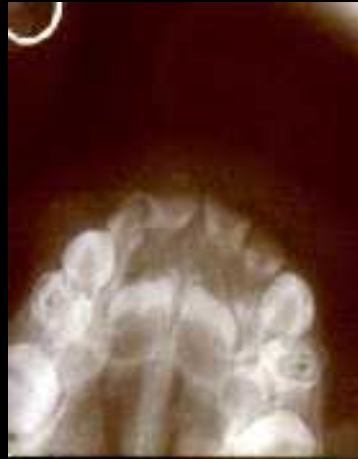
# Classification of X-rays

- **Intraoral X-rays**
  - Routine use in dentistry (cariology, endodontics)
- **Extraoral X-rays**
  - Important in the orthodontic diagnosis



# Intraoral X-rays

- **Periapical x-rays**
- **Bitewing x-rays**
- **Local x-rays**



# Extraoral X-rays

- **Panoramic tomogram-Orthopantomogram**
- **Antero-posterior cephalometric x-ray**
- **Handwrist and mesocarpal x-rays**
- **Cephalogram, lateral cephalometric x-rays**



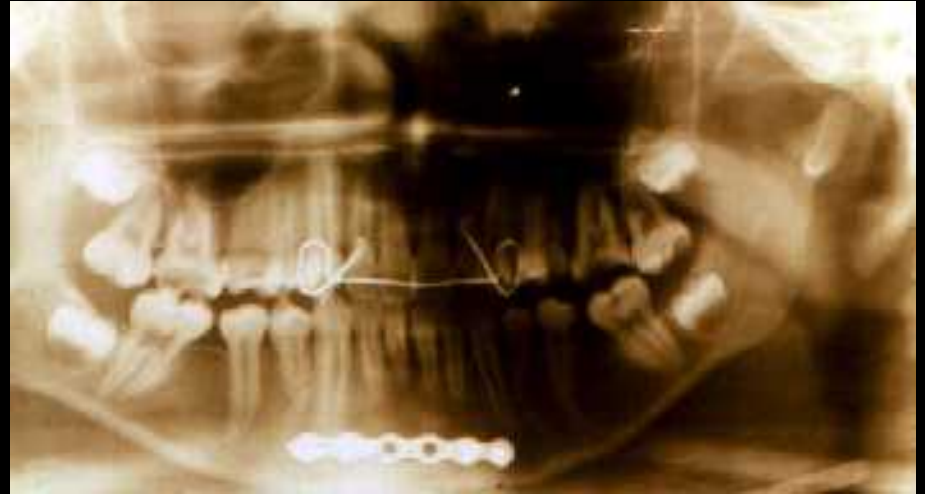
# Dental panoramic tomogram

- To identify general and dental pathology
- To assess dental development
- To localize unerupted teeth (!)
- To assess root length during diagnosis and treatment planning

*Before treatment and near the end of treatment  
to assess the root length & root parallelism*

*Limitation:* anterior maxillary region is not clearly visible → upper anterior occlusal view

# Orthopantomogram



- The main beam is always perpendicular to the dental arch
- The tube and the cassette are moving around the head controversially



# PA x-ray



**This technique is similar to the those of the lateral cephalometric X-ray, but the head is turned with 90°**

**- *Rarely* used in orthodontics, mostly to examine the asymmetry**

**-Fractures, tumors may also be seen**

# Hand-wrist radiographs

- **To determine skeletal age by assessment of pattern of ossification of bones within the hand**
- **Limited benefit of this technique**
- **It has been abandoned by number of clinicians**



# Handwrist x-rays...



**The radiographs are used in an attempt to identify ossification of the phalanxes and so assisting in the assessments of the pubertal growth spurt**

# Cephalometric radiography

- **Standardised and reproducible method of taking radiographs of the facial skeleton and cranial vault.**
- **Two cephalometric views:**
  - Lateral* cephalometric view – the most commonly used**
  - Postero-anterior* cephalometric view – used for the assessment of skeletal asymmetry**

# Rules of taking cephalometric X-rays

- The distance between the head's median-sagittal plane and the focus of the x-ray is 1.5m
- The main beam perpendicular to the head's median-sagittal plane
- The main beam pass through the two auditory meatus parallel to the head median sagittal plane /15-18 cm/



# Rules of taking cephalometric x-rays

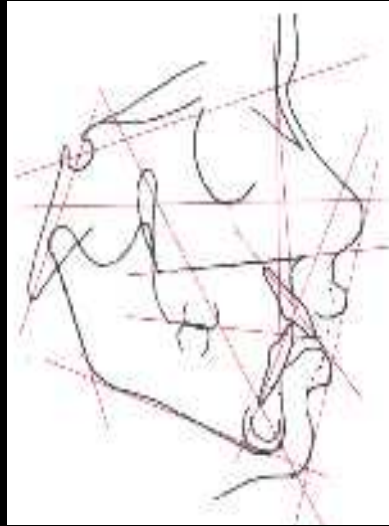


- **The Frankfurt horizontal plane is horizontal**
- **Central occlusion**
- **Lips and soft tissues have to be in natural position**

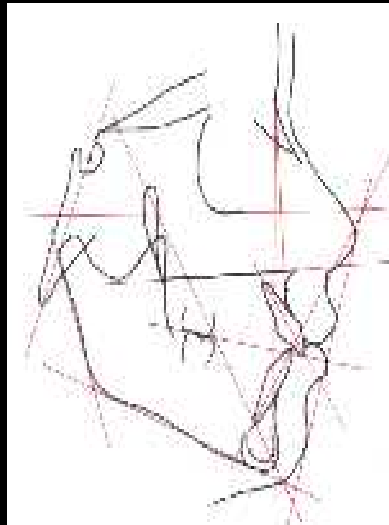
# **Use of lateral cephalometric**

- Diagnosis and treatment planning**
- Monitoring growth (serial radiographs)**
- Monitoring treatment changes (serial radiographs)**
- Monitoring stability following orthognatic surgery**
- Assisting in the localisation of unerupted teeth**
- Estimation of skeletal age by assessing development of the cervical vertebra**
- Audit, documentation, research and teaching**

# An example for the usage



**Before treatment**



**After treatment**



# **Lateral cephalometric analysis**

**Cephalometry should not be substitute for a detailed clinical examination. Occasionally the results of cephalometric analysis contradict clinical findings.**

***In doubt, greater creditability should be given to the results of clinical examination.***

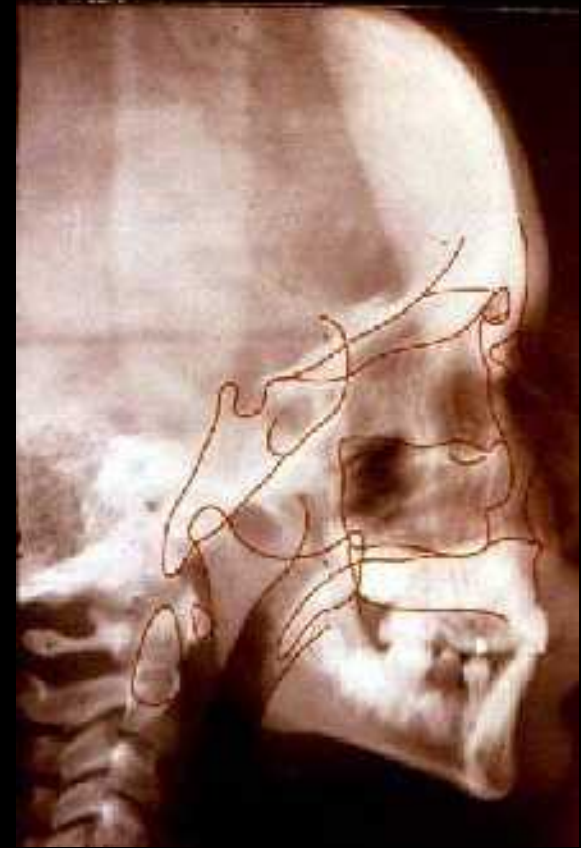
# Cephalometric estimations and relations

- Maxilla and the skull
- Mandibule and the skull
- Maxilla and the mandibule
- Upper teeth and the maxilla
- Lower teeth and the mandibule
- Upper and the lower teeth

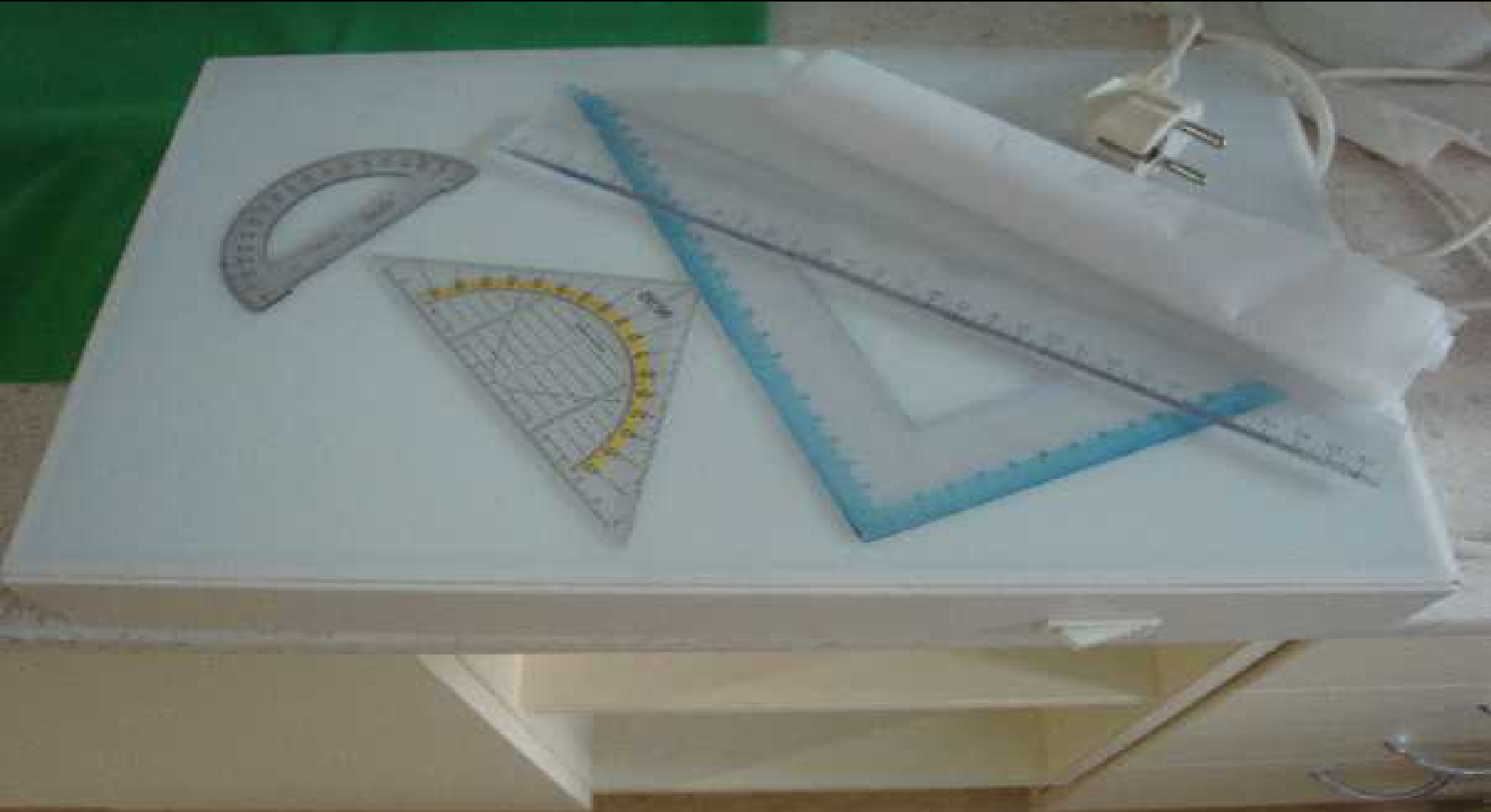


# The sequence of the estimation

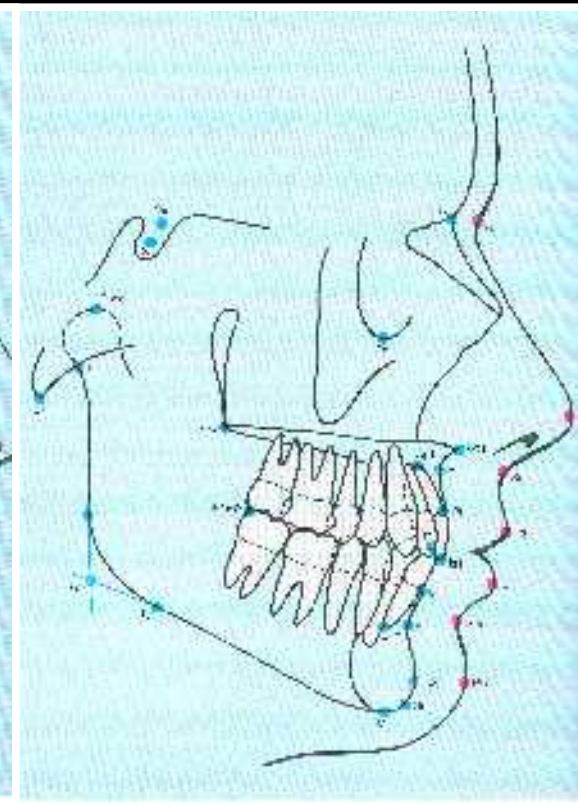
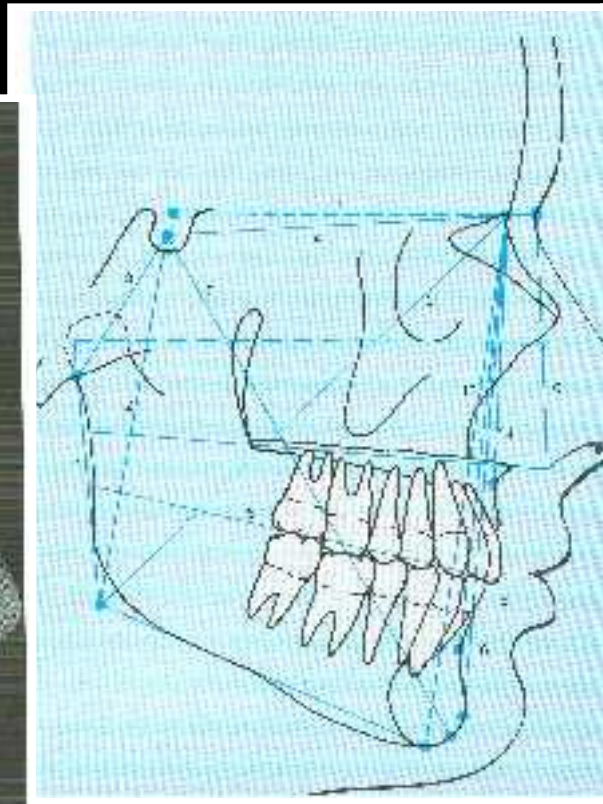
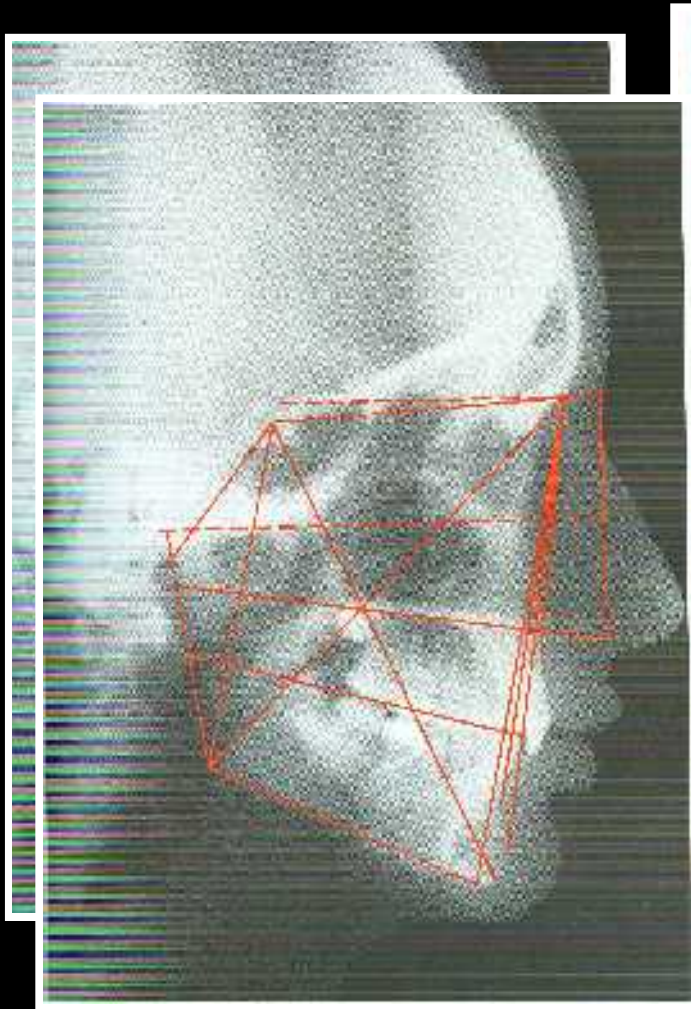
- **Visual control of the whole X-ray**
- **Superimposing the important landmarks**
- **Signs of the anatomical points and lines**
- **Measurement of the angles**
- **Linear measurements**



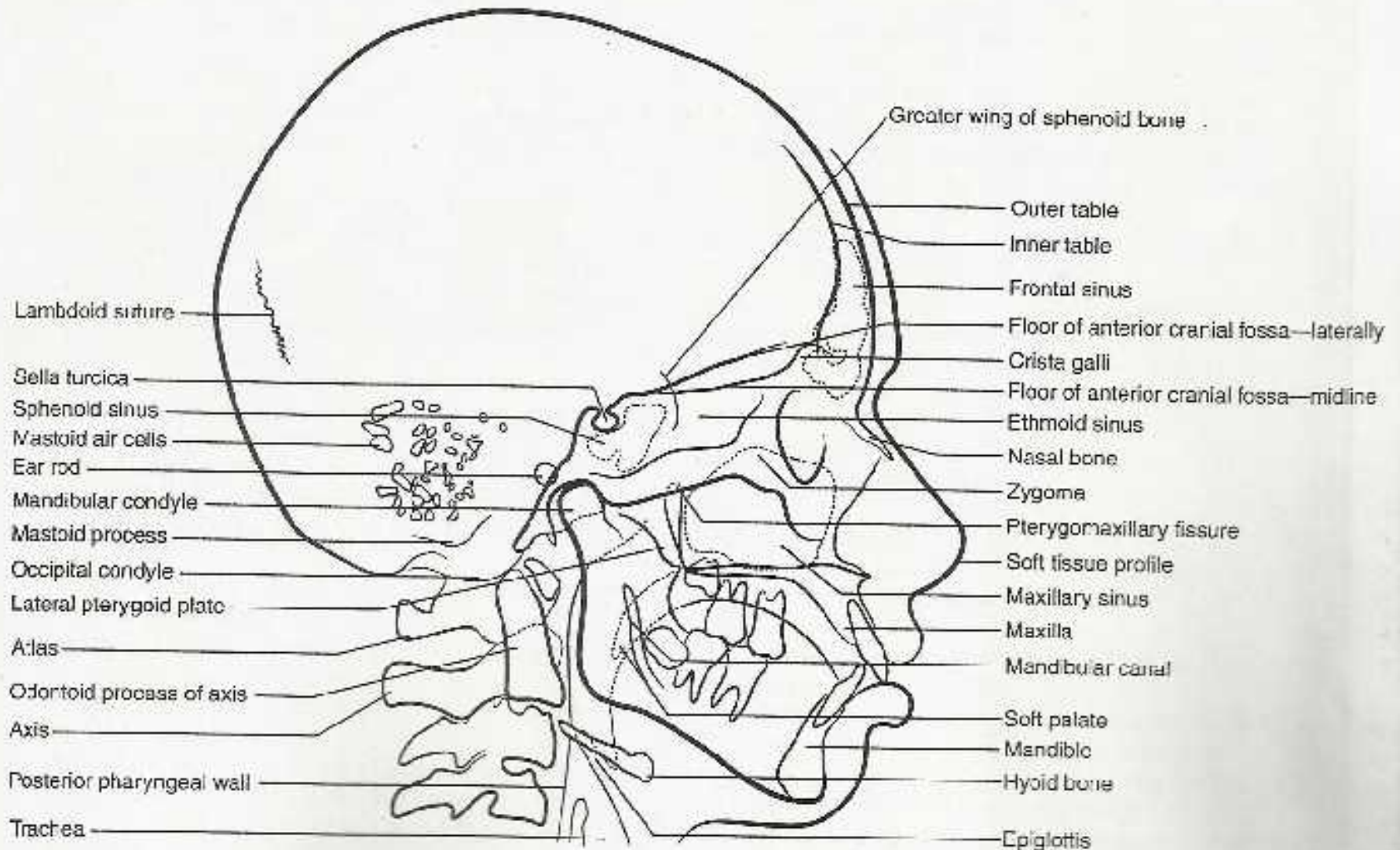
# Lateral cephalometric analysis



# Lateral cephalometric analysis

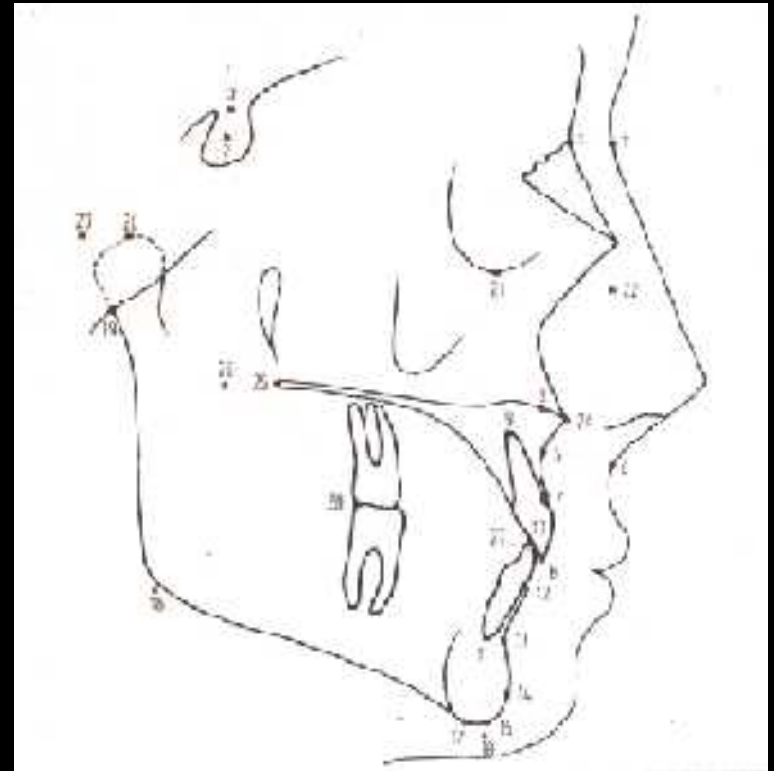


# Anatomic landmarks



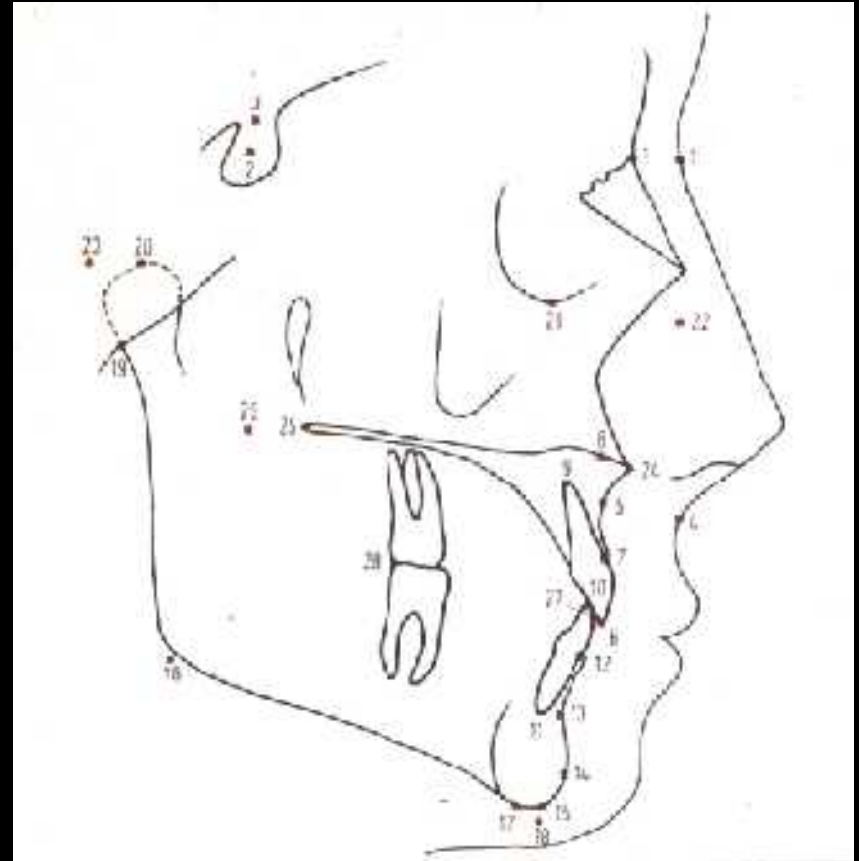
# Natural anatomical points

- **Nasion - N**
- **Orbitale - O**
- **Anterior nasal spine - Spa**
- **Posterior nasal spine - Spp**
- **Pogonion - Pog**
- **Gnathion - Gn**
- **Menton - M**
- **Gonion - Go**



# Arteficial anatomical points

- **Subspinale - A**
- **Supramentale - B**
- **Sella - S**
- **Porion - P**

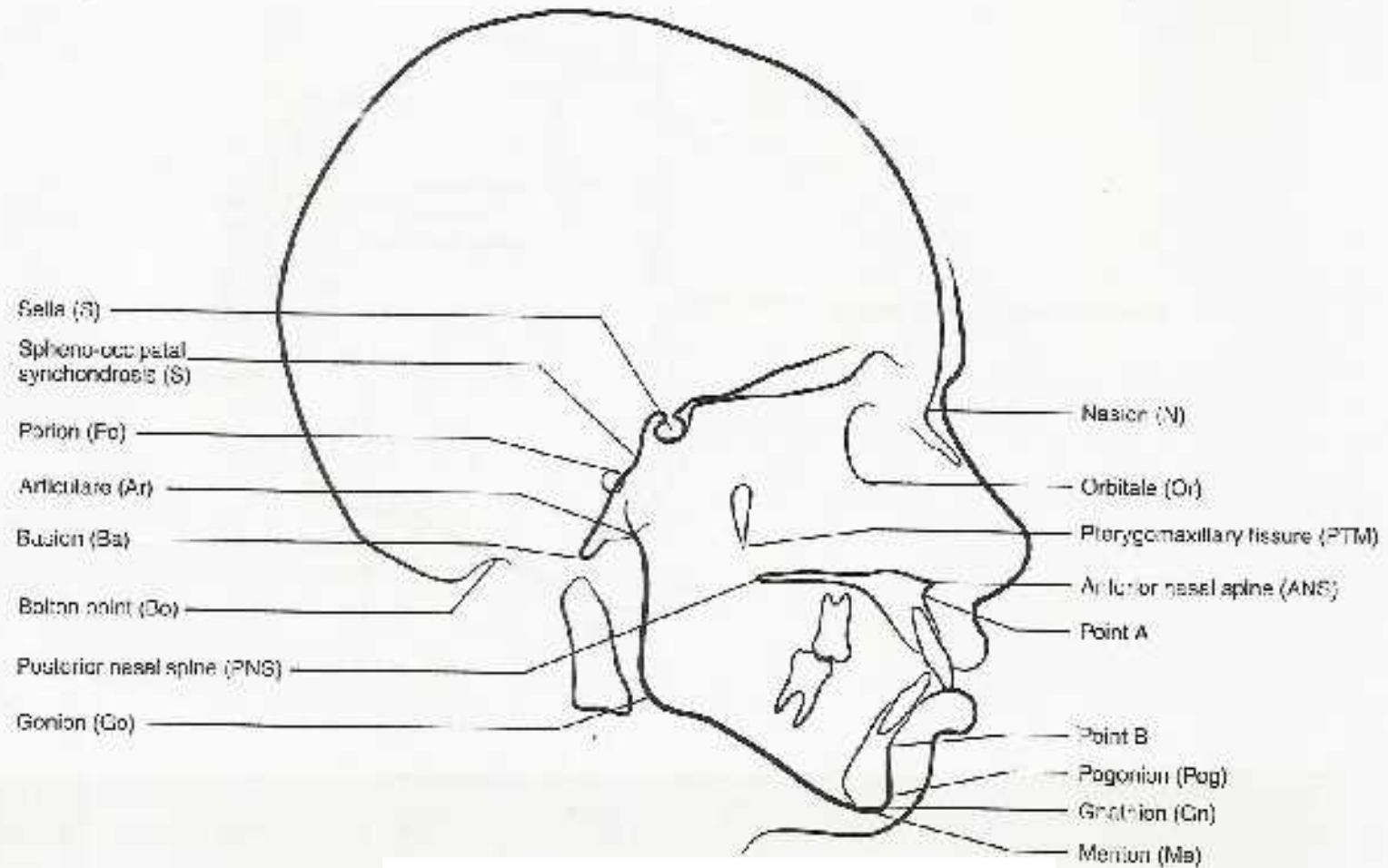




# Groups for cephalometric analysis

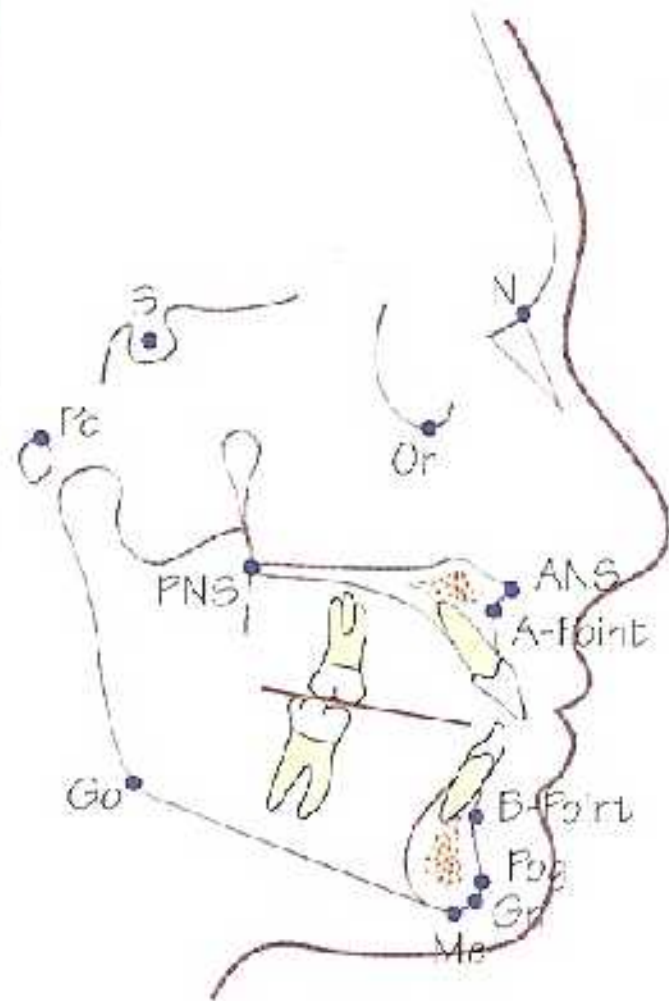
- **Hard tissue points**
- **Cephalometric planes**
- **Angles describing skeletal relationships**
- **Distances and angles describing dental relationships**
- **Soft tissue points and planes**

# Hard tissue points - definitions and locations



### Abbreviations

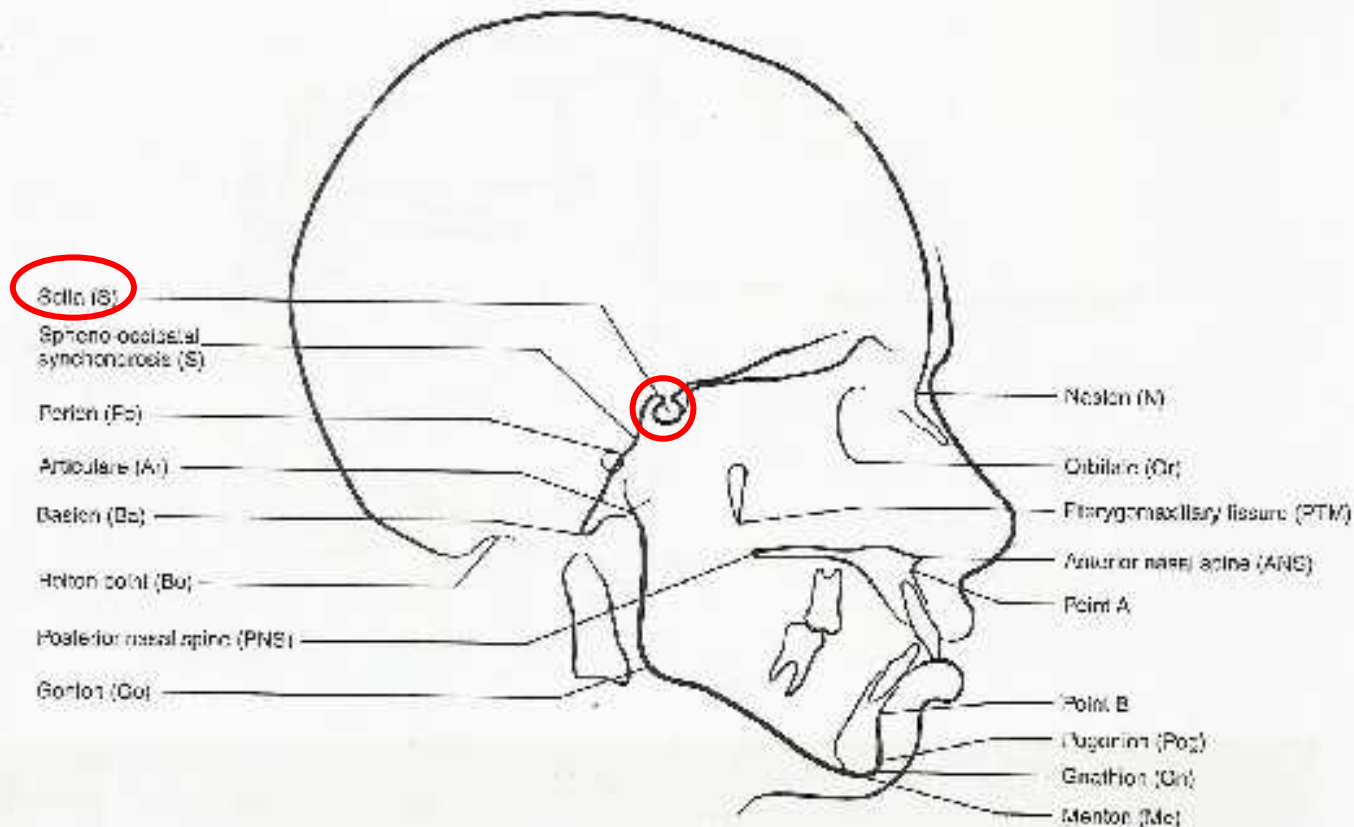
S	Sella
N	Nasion
Pc	Portion
Or	Orbitale
PNS	Posterior nasal spine
ANS	Anterior nasal spine
Go	Gonion
Pog	Pogonion
Gn	Gnathion
Me	Menton



# Hard tissue points

## Sella (S):

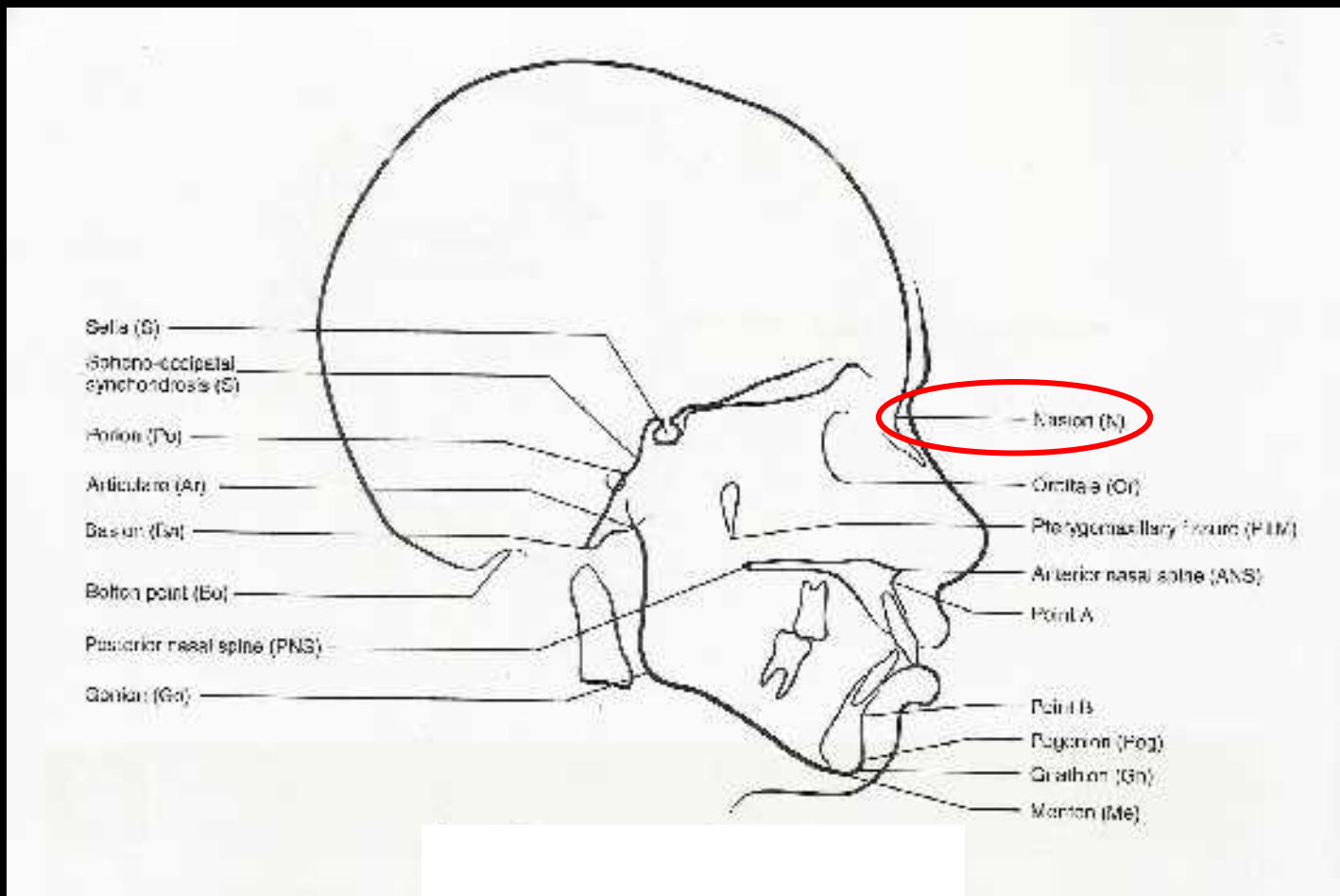
located in the centre of the sella turcica. Locating the point before tracing the shadow of the anterior and posterior clinoid processes and floor of the fossa is probably more accurate than locating the point after tracing the structure.



# Hard tissue points

## Nasion (N):

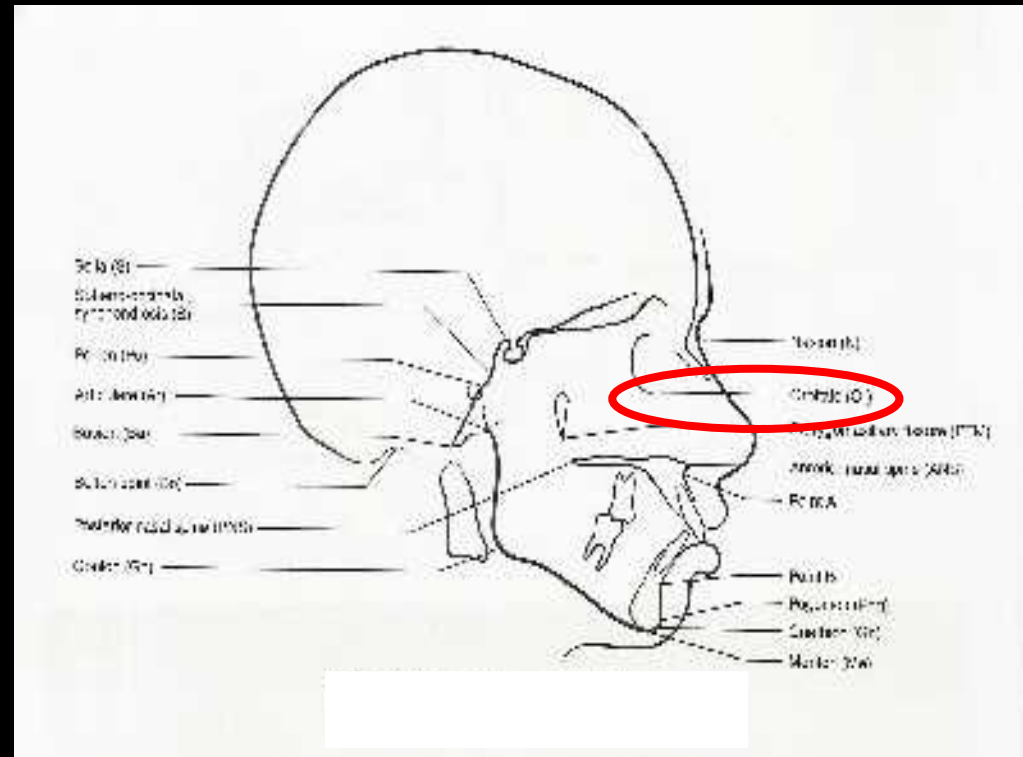
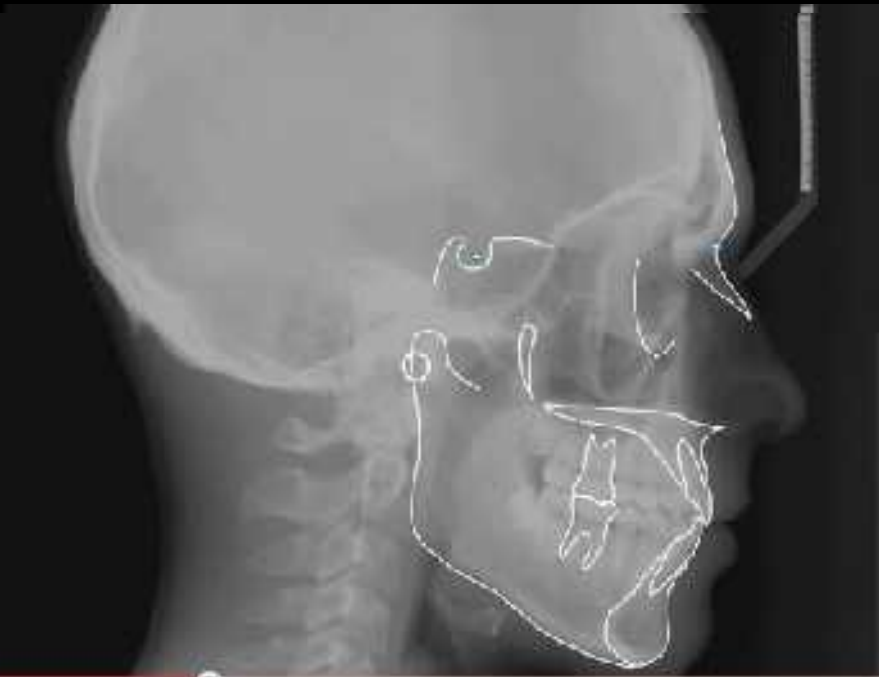
it is located at the most inferior, anterior point on the frontal bone adjacent to frontonasal suture. Again, point location should precede tracing of the bony outlines.



# Hard tissue points

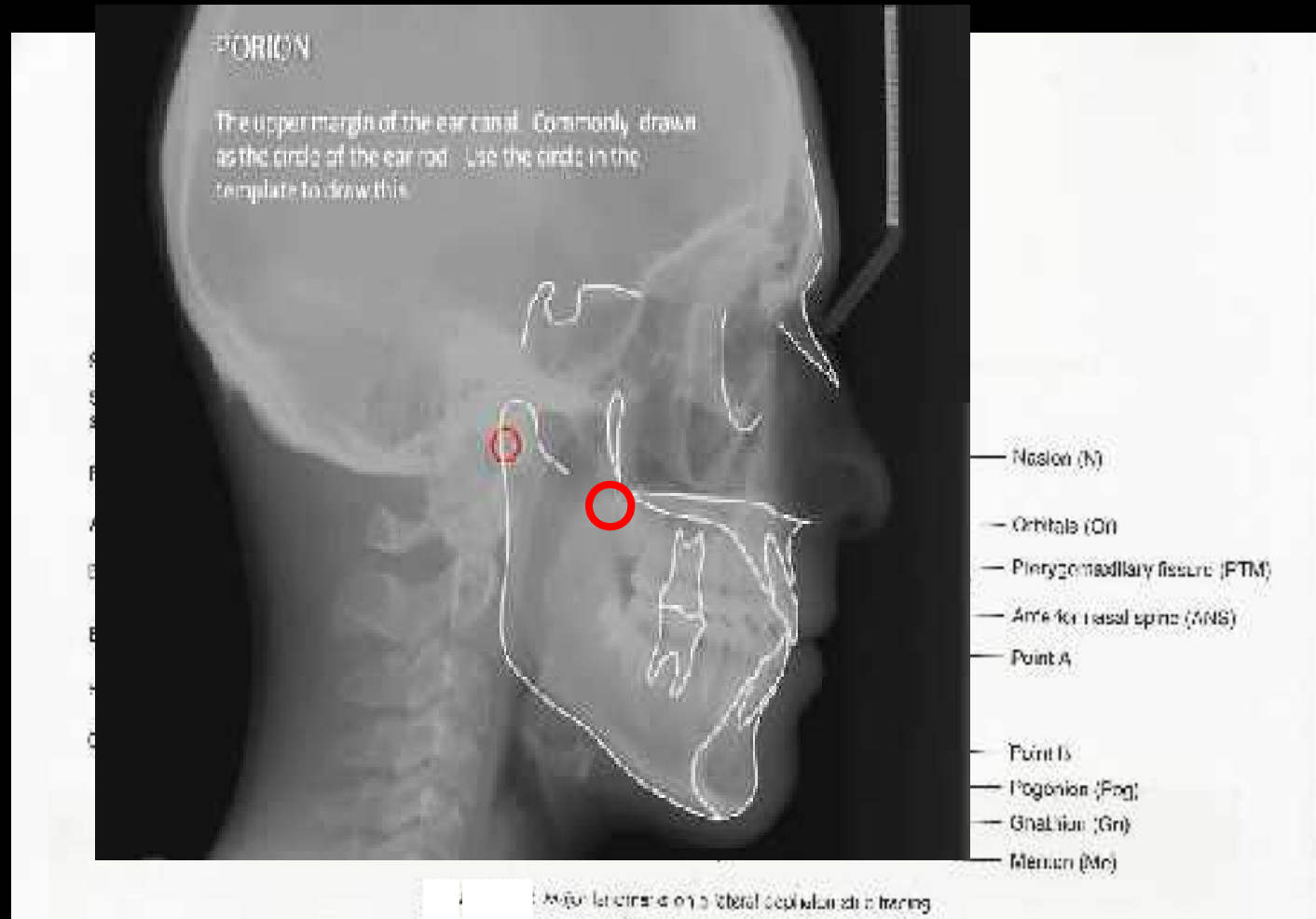
## Orbitale (O):

is located on the lowest point on the outline of the bony orbit. Usually both right and left orbital outlines are visible. Orbitale is then located at the bisection of the two orbit outlines. Orbitale may be difficult to locate in some subjects.



# Hard tissue points

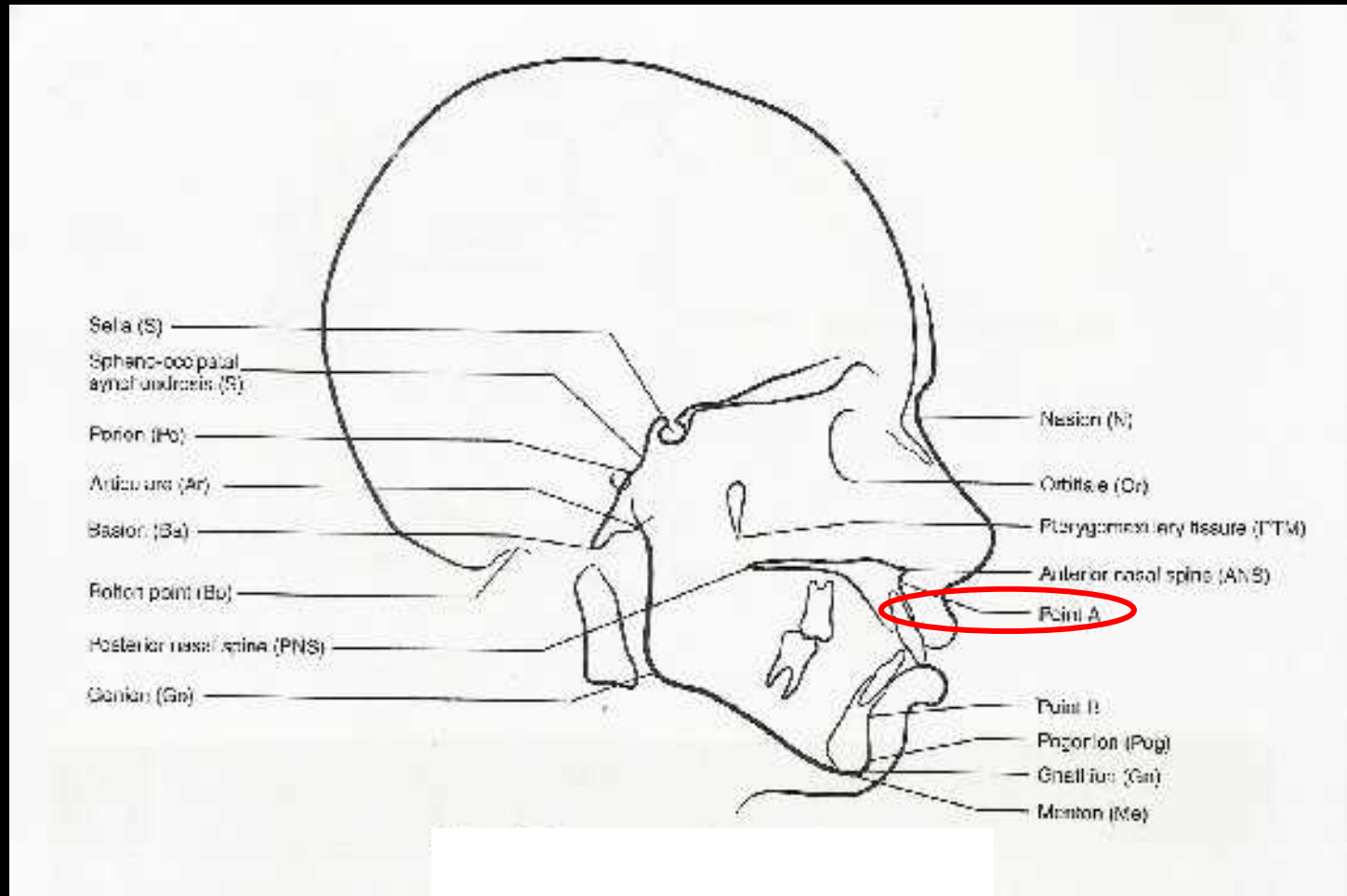
**Porion (Po):** located at the most superior point on the shadow of ear rod at the superior border of external auditory meatus. (The correct location of porion is thus directly dependent on the placement of the ear rods at the time x-ray film exposure.)



# Hard tissue points

Point A (A) :

is located at the most posterior part of the anterior shadow of the maxilla, usually near the apex of the central incisor root.

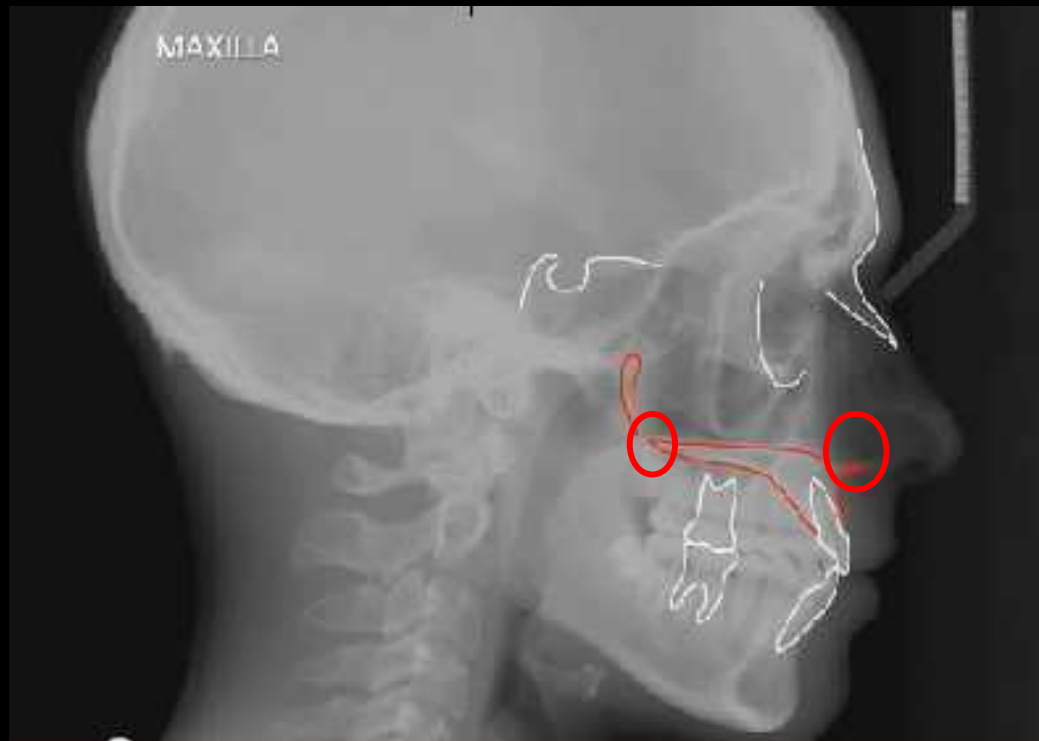




# Hard tissue points

**Spina nasalis *anterior*** : the tip of the bony anterior nasal spina at the inferior margin of the piriform aperture in the midsagittal plane

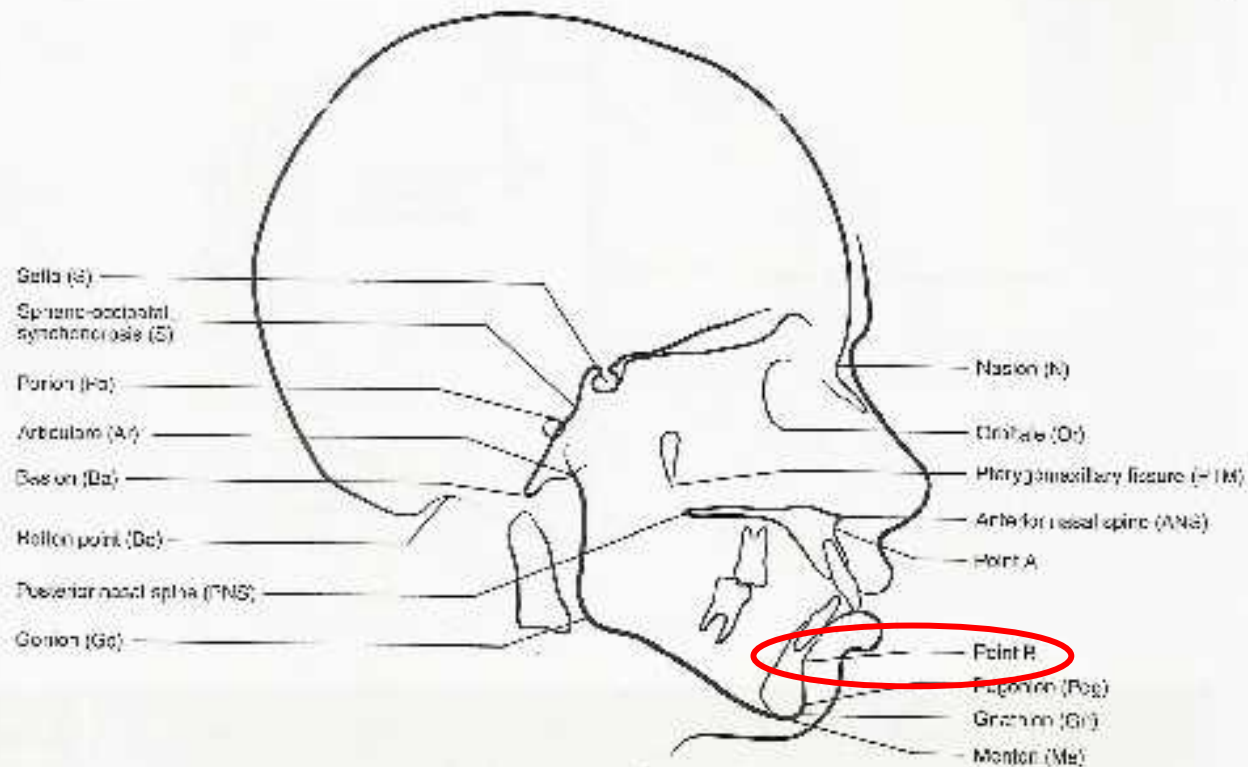
***posterior***: the most posterior point of the bony hard palate in the midsagittal plane



# Hard tissue points

## Point B (B):

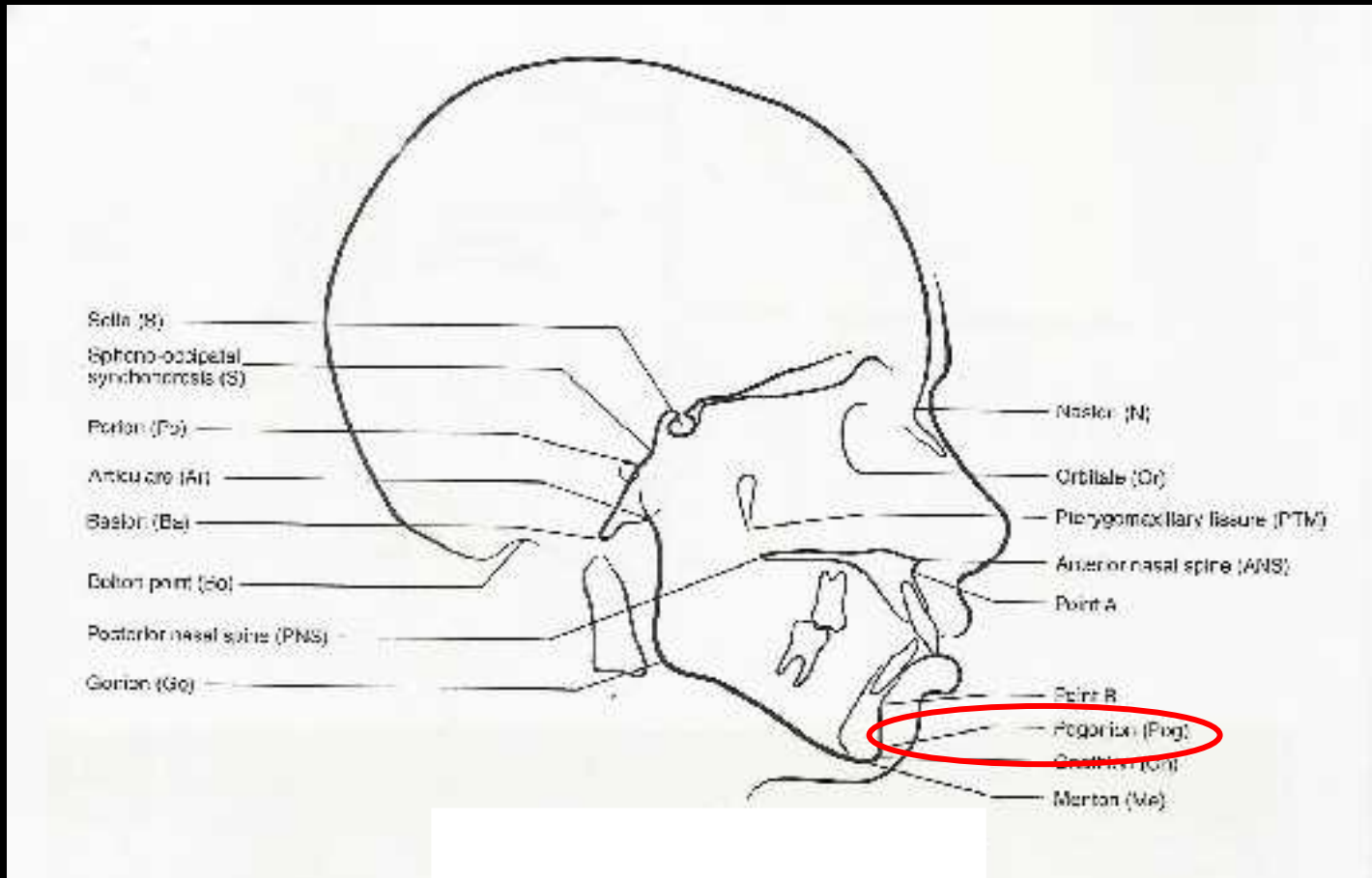
is located at the most posterior point on the shadow of the anterior border of the mandible, usually near the apex of the central incisor root.



# Hard tissue points

## Pogonion (Pog):

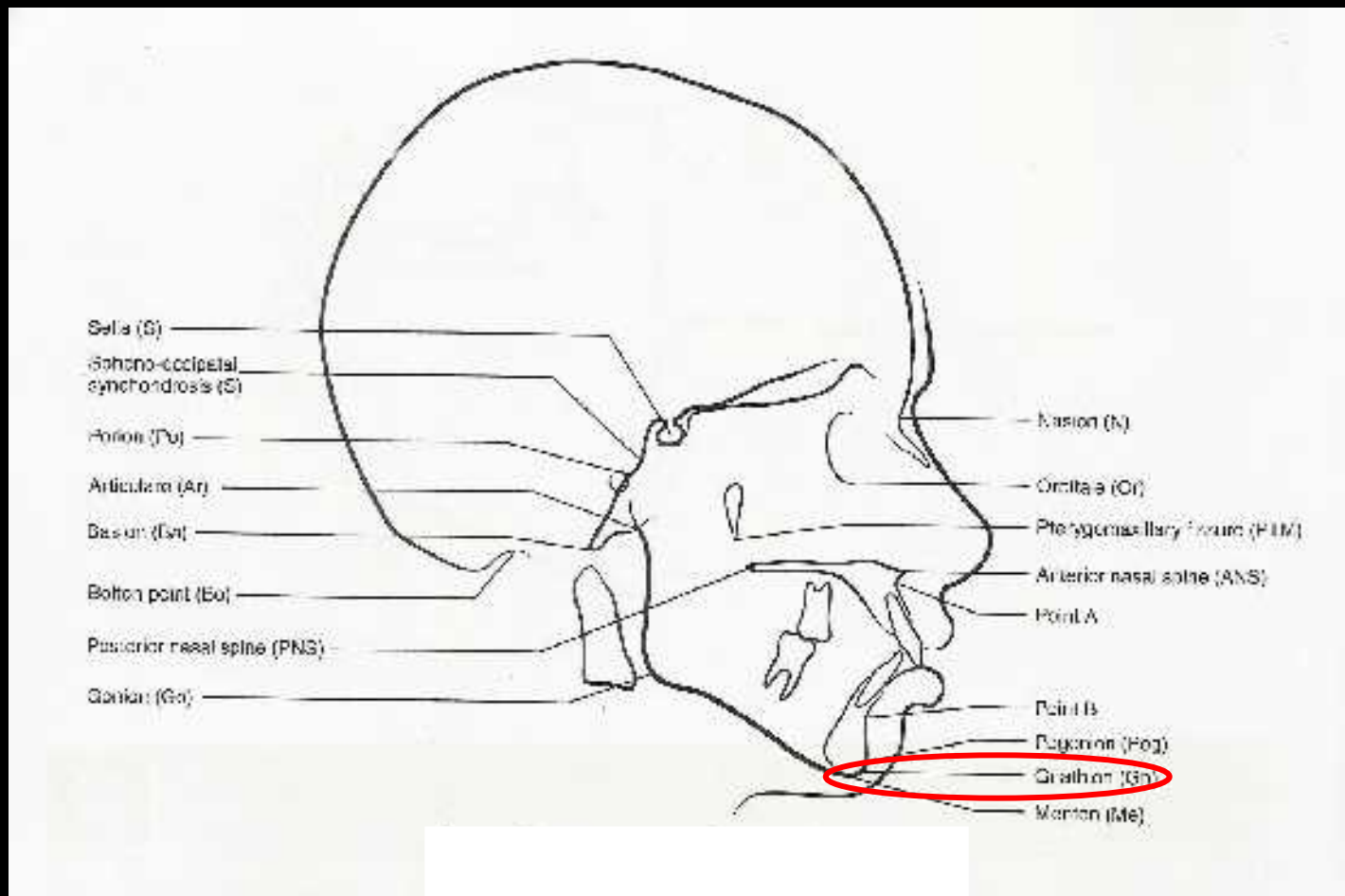
is located at the most anterior point on the shadow of the chin.



# Hard tissue points

## Gnation (Gn):

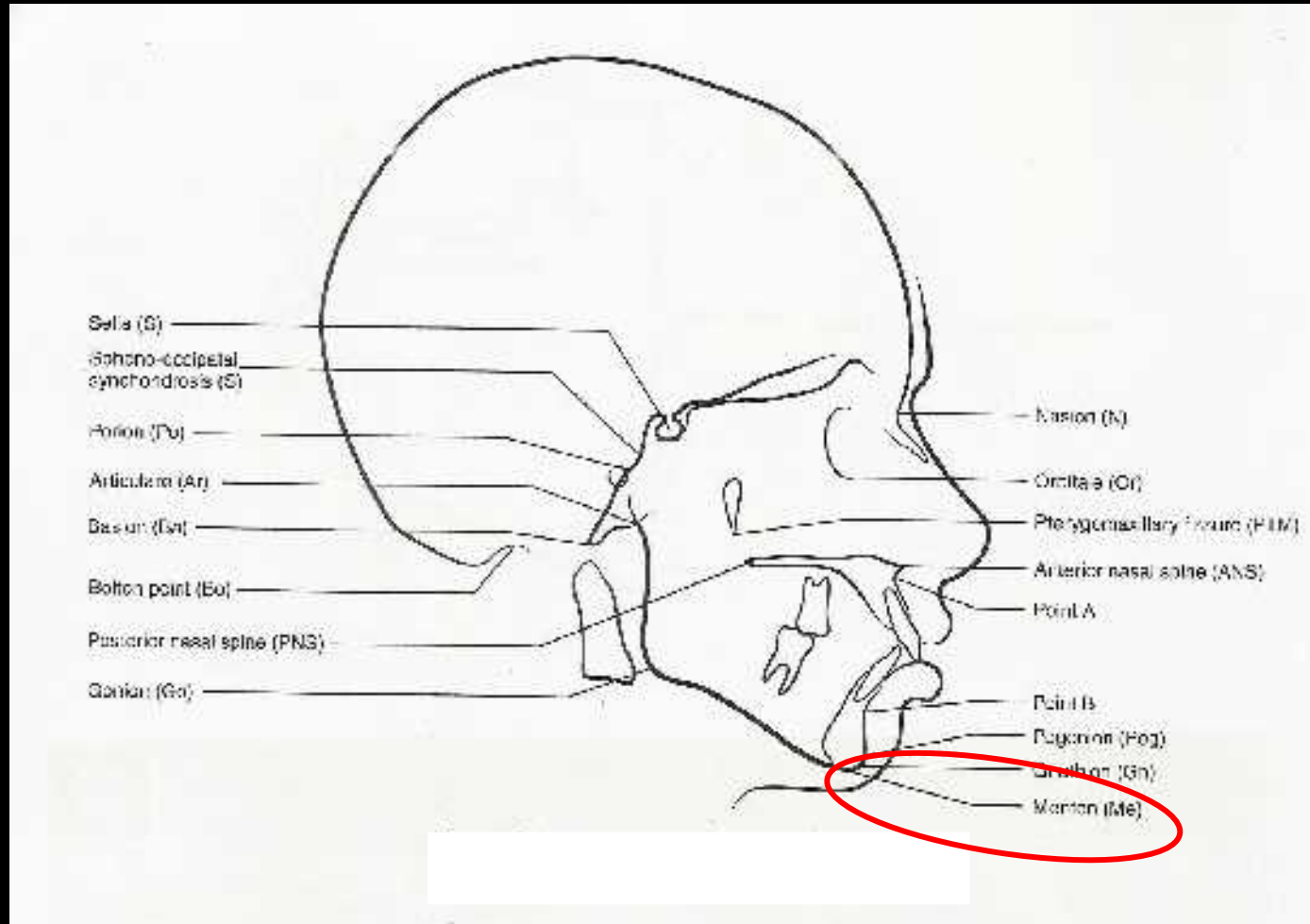
is located at a point on the shadow of the chin midway between pogonion and menton.



# Hard tissue points

## Menton (Me):

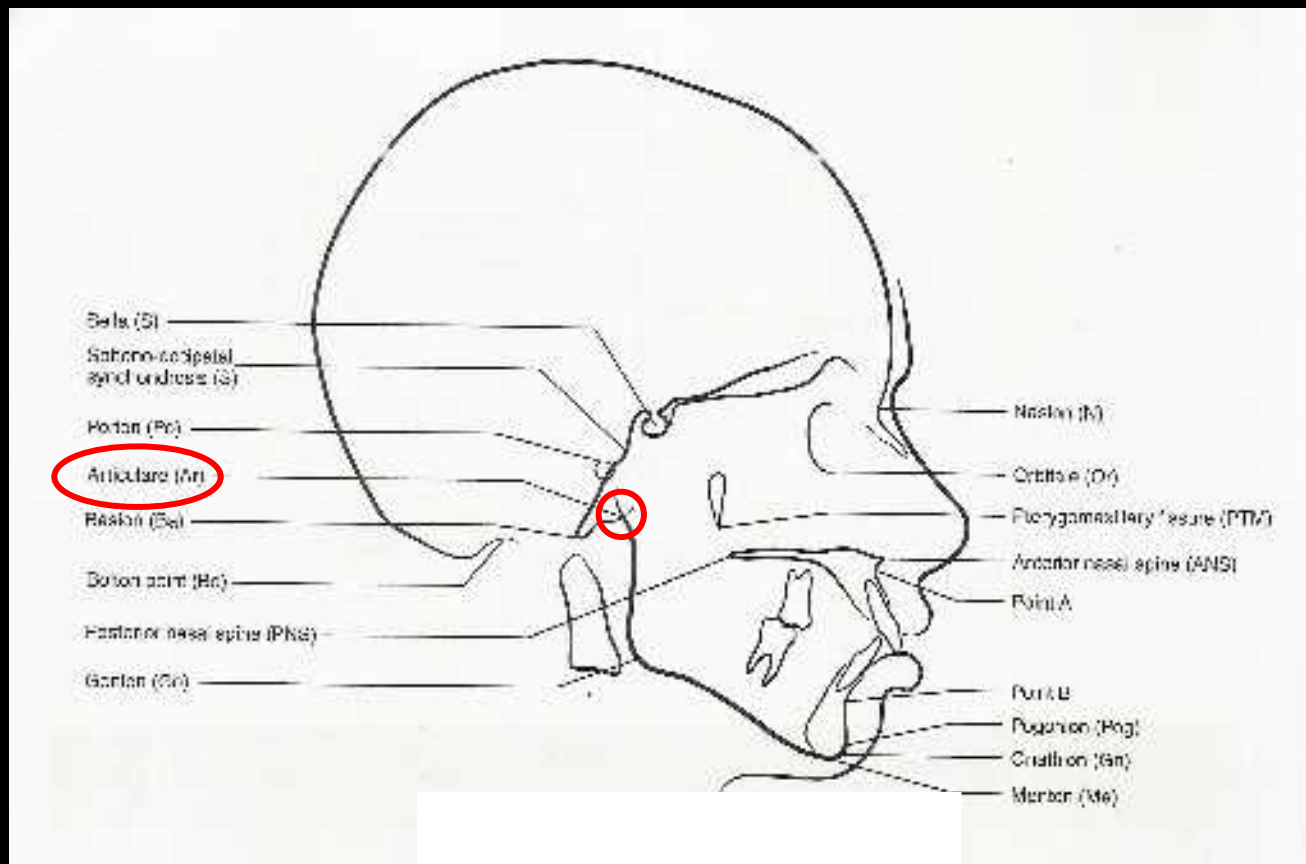
is located at the most inferior point on the shadow of the chin.



# Hard tissue points

## Articulare (Ar):

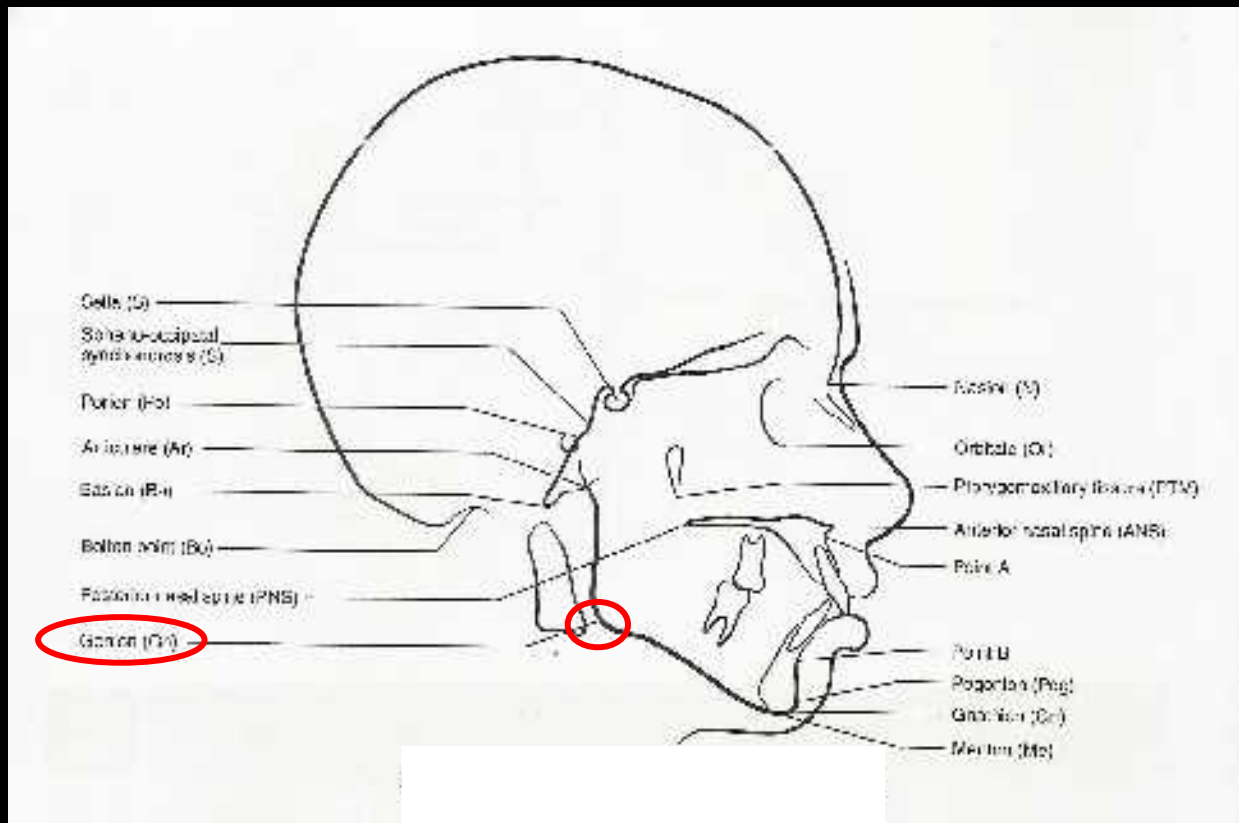
is the point of intersection of the inferior border of the cranial base and averaged posterior surface of the mandibular condyles.

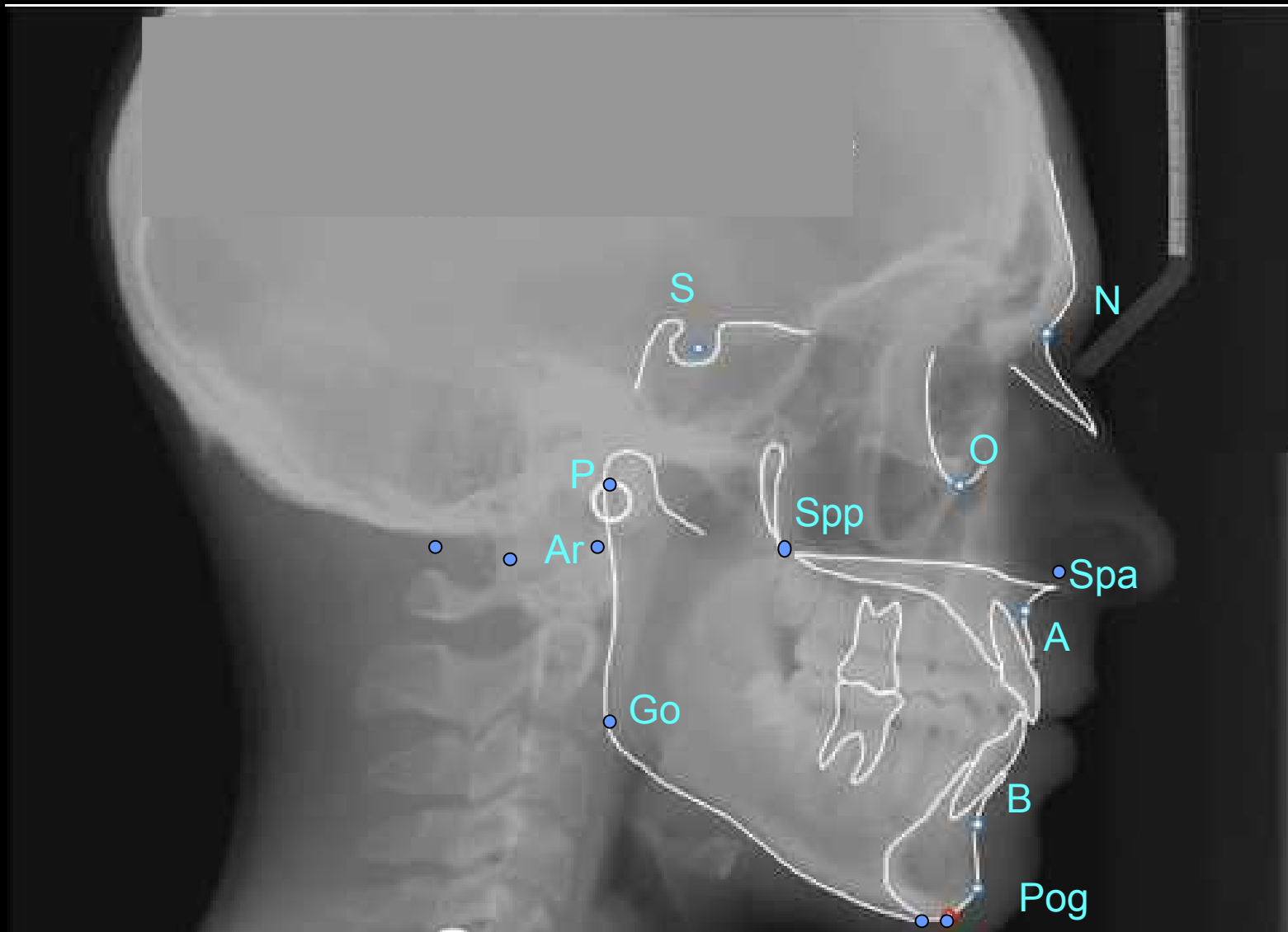


# Hard tissue points

## Gonion (Go):

is the midpoint of the angle of the mandible found by bisecting the angle formed by the mandibular and ramus planes.





S

N

O

P

Spp

Ar

Spa

A

Go

B

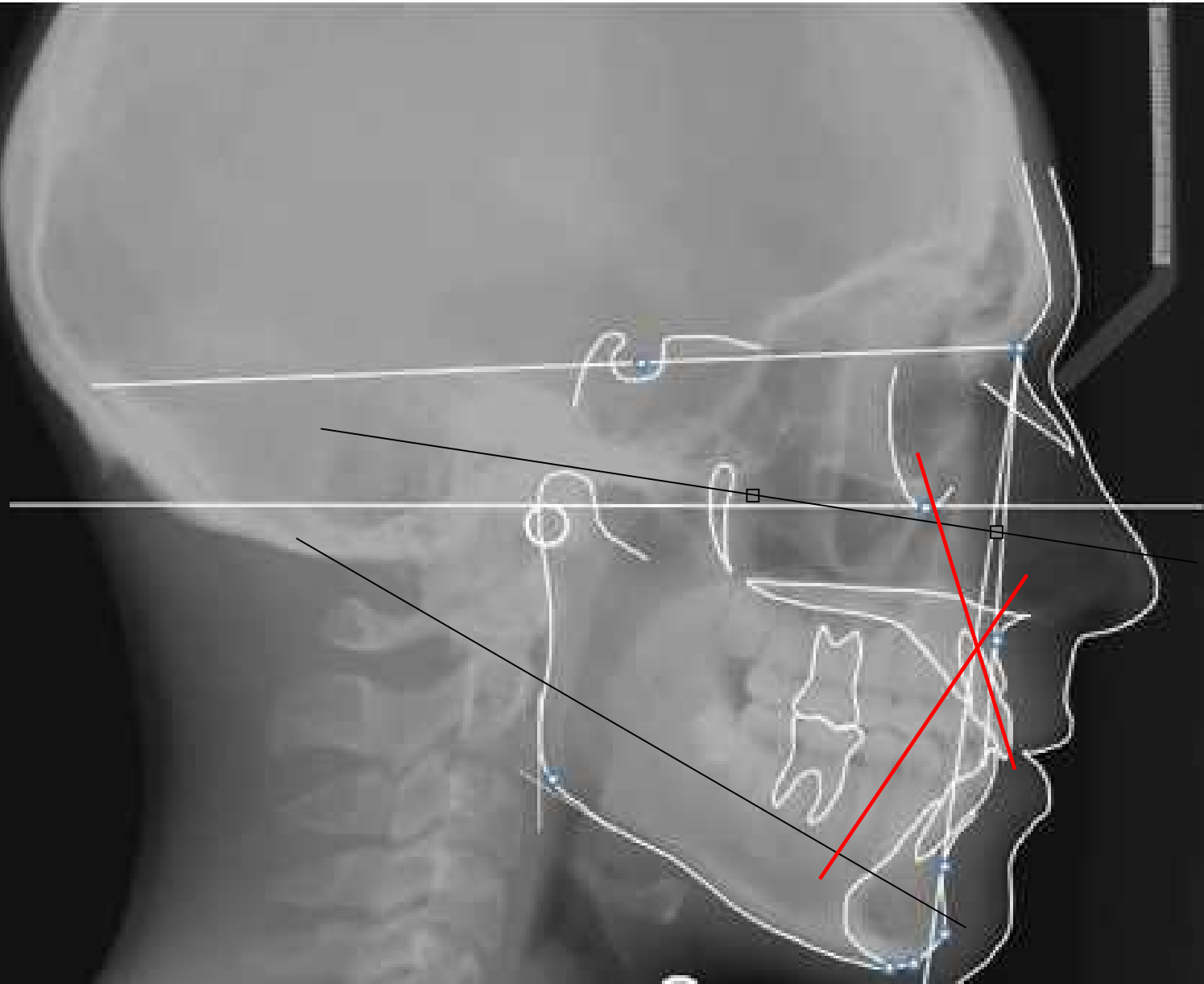
Pog

Gn

Me

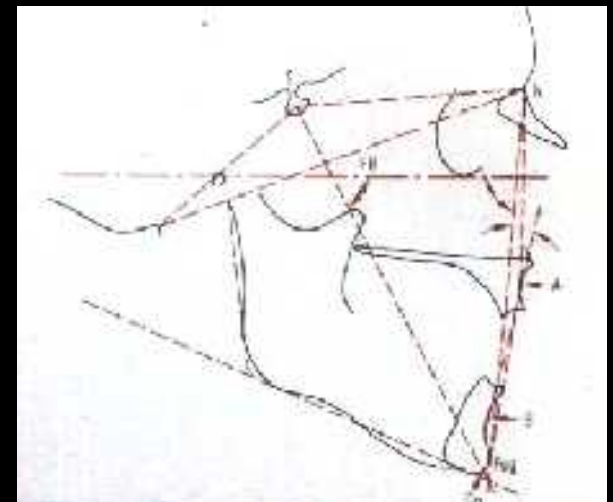
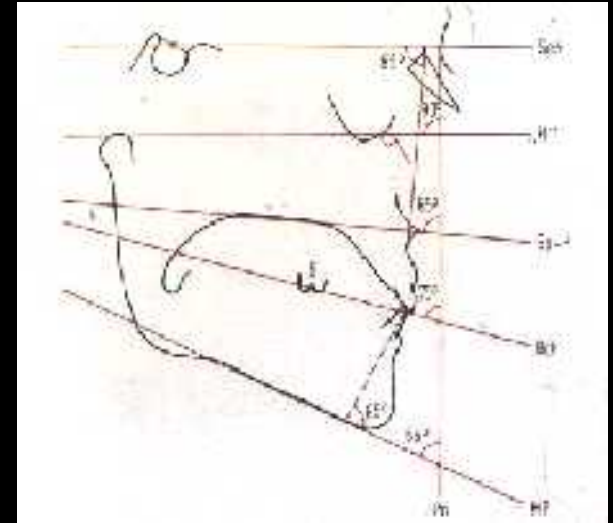


# Cephalometric planes

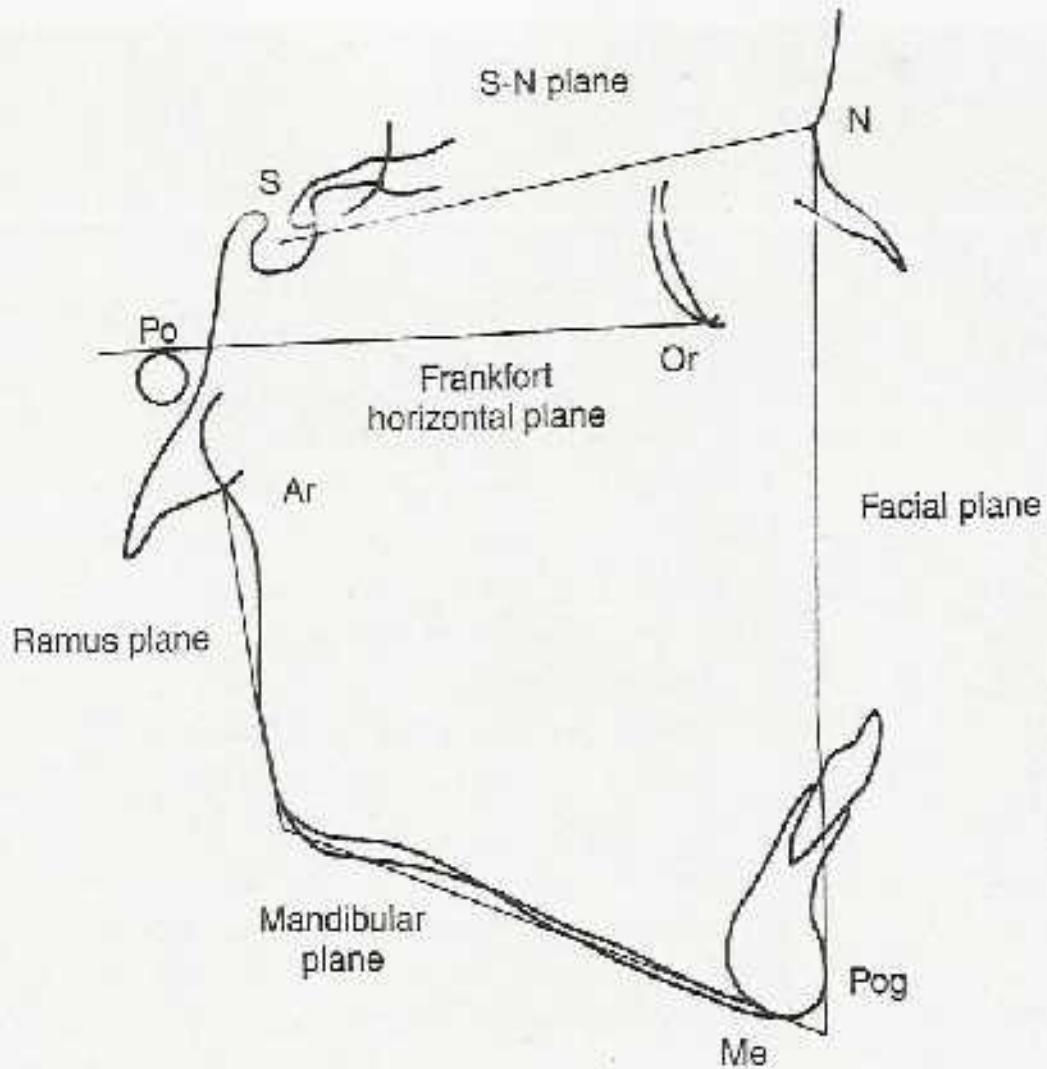


# Evaluation of the cephalometric X-ray planes

- **Sagittal dimension**
- **Vertical dimension**



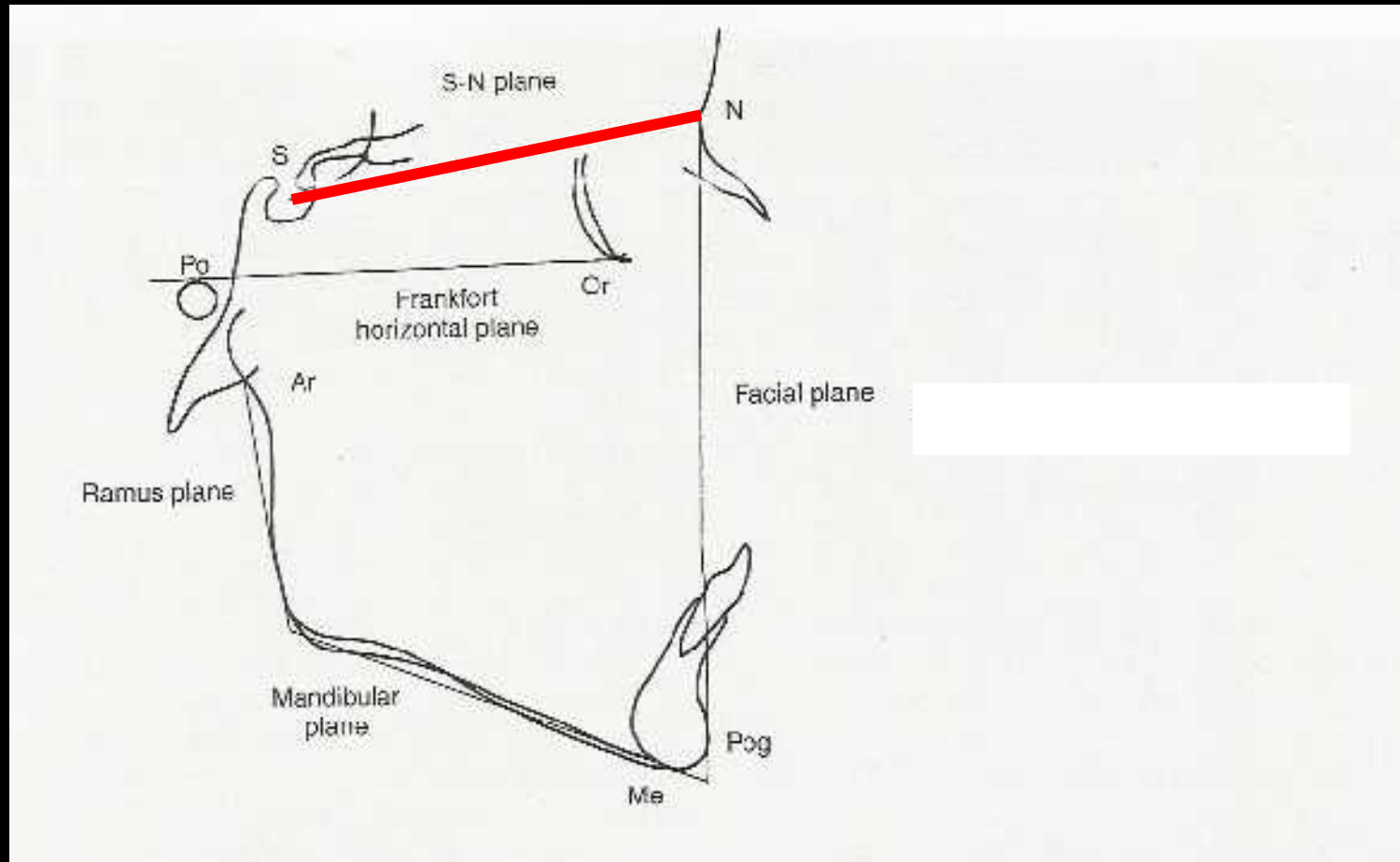
# Cephalometric planes



# Cephalometric planes

## Sella-nasion plane (S-N):

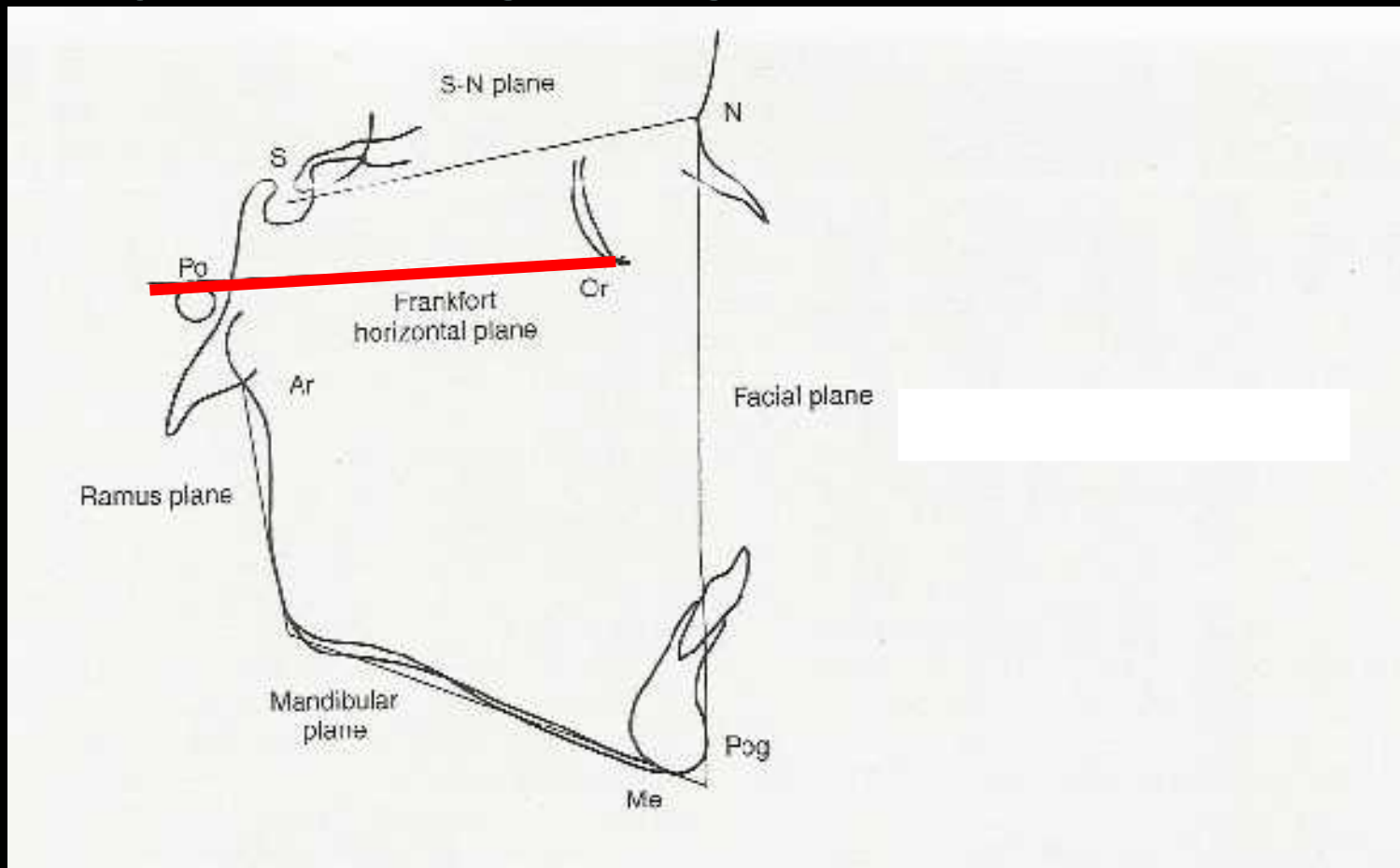
easily located and has been used for superimposition of tracings from two or more sequentially exposed cephalograms



# Cephalometric planes

Frankfort horizontal plane (Po-Or):

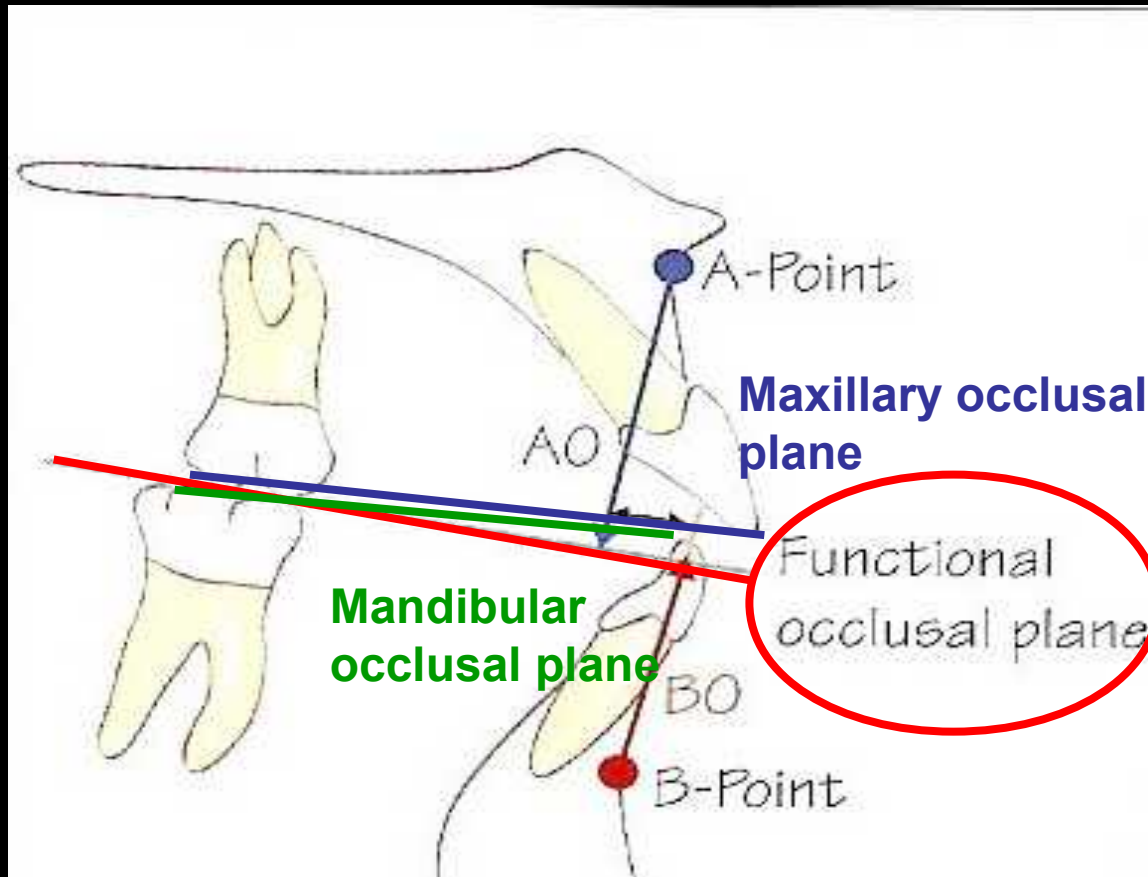
formed by line passing through points porion and orbitale



# Cephalometric planes

Functional occlusal plane:

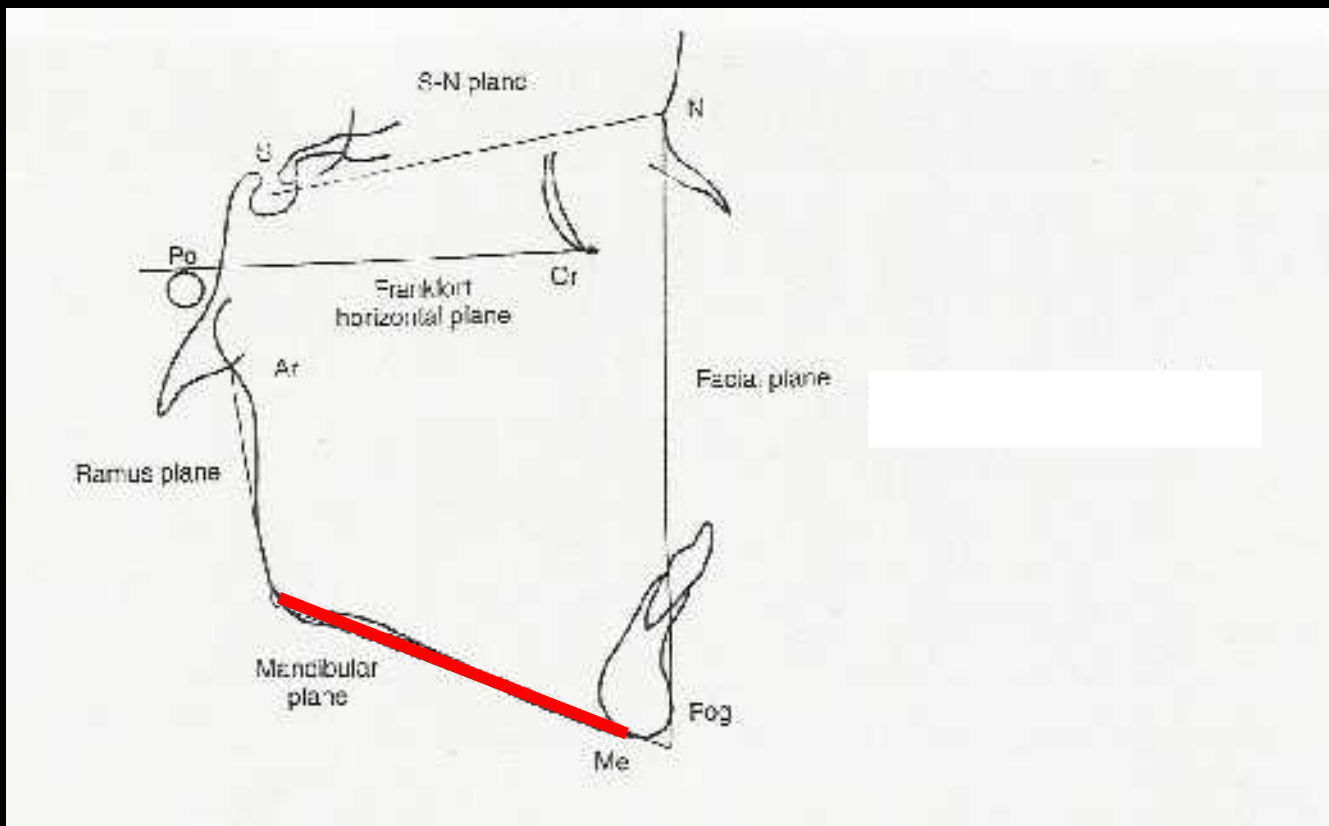
occlusal surfaces of the maxillary and mandibular 1<sup>st</sup> permanent molars and 1<sup>st</sup> and second praemolars



# Cephalometric planes

## Mandibular plane (Go-Me):

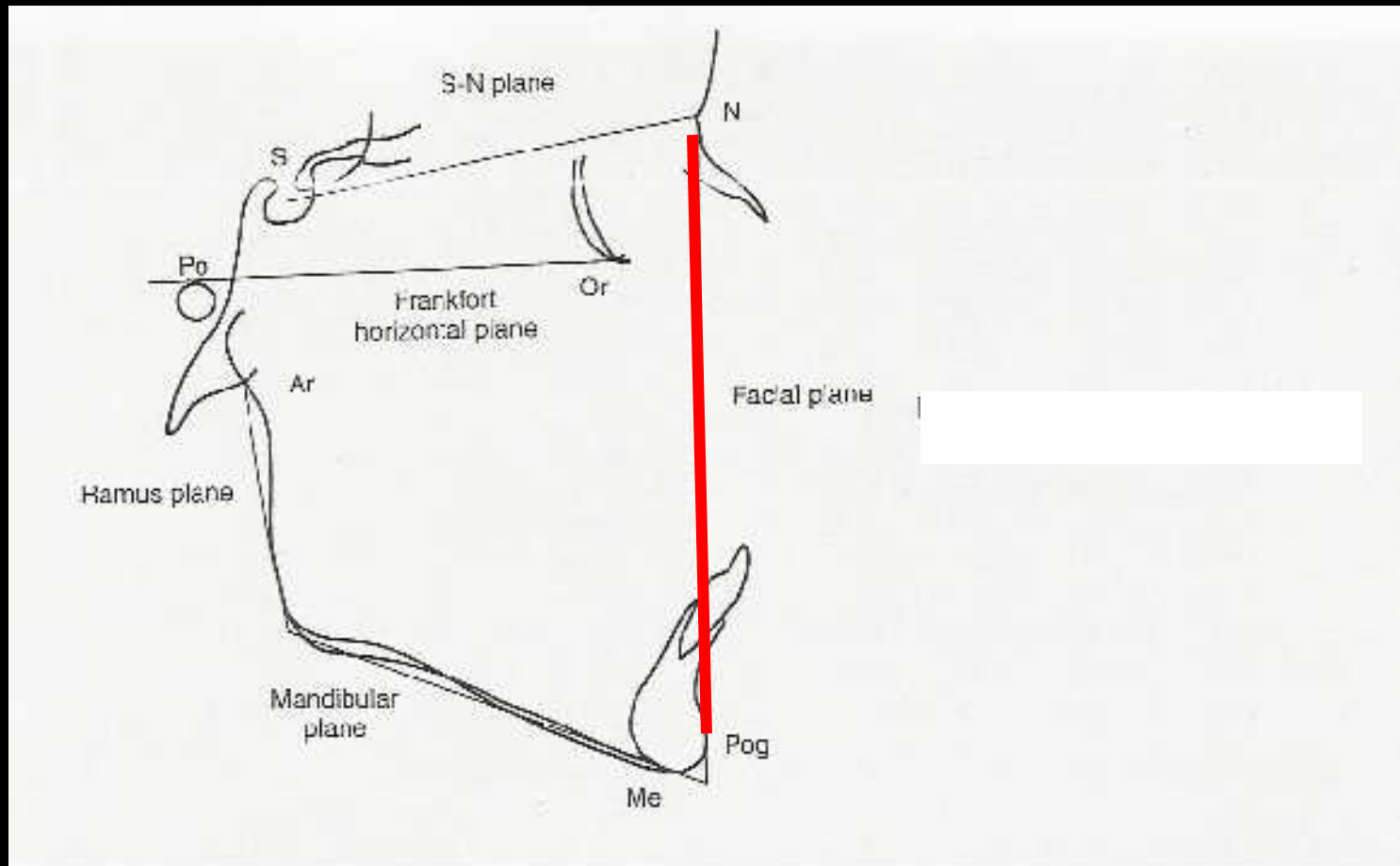
drawn between menton and Gonion (a point tangent to the posterior portion of the lower border of the mandible just as it turns upward to the posterior border of the ramus)



# Cephalometric planes

Facial plane (N-Pog):

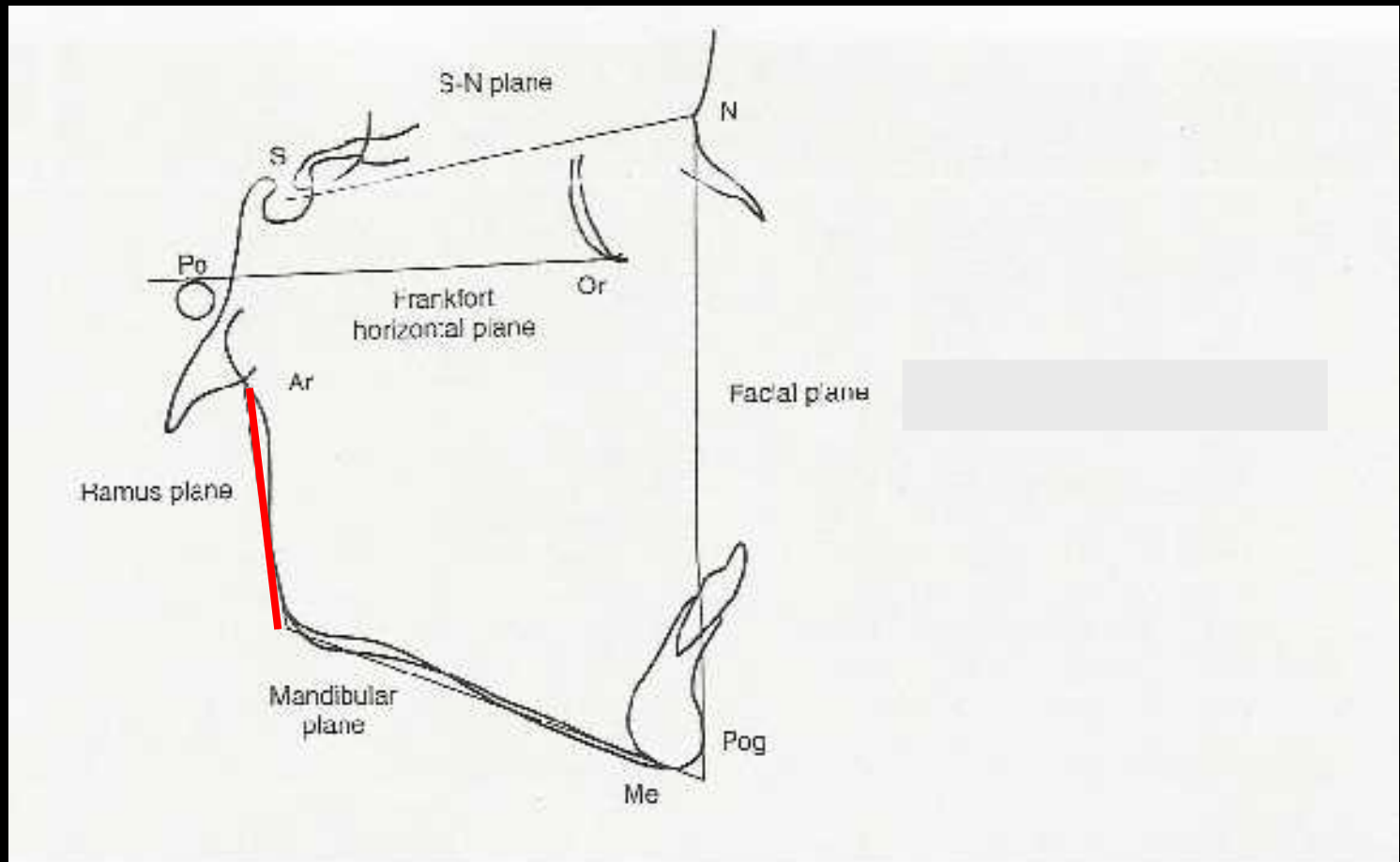
formed by passing a line through the nasion and pogonion points





# Cephalometric planes

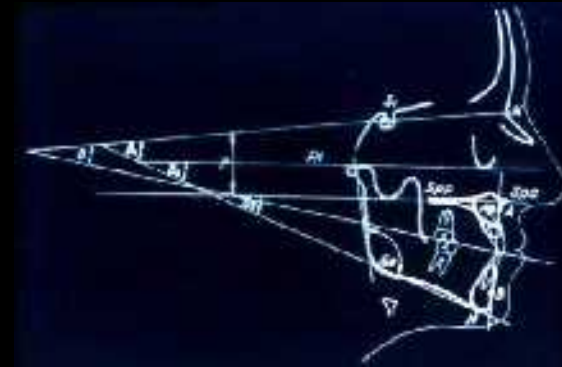
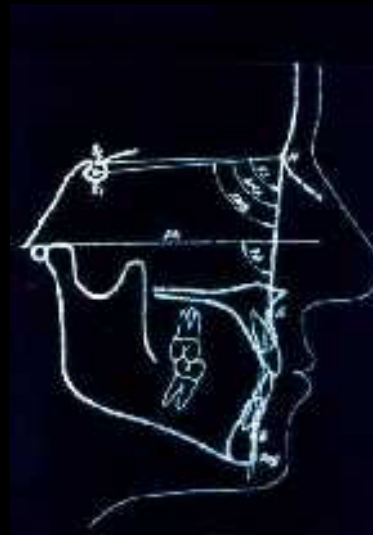
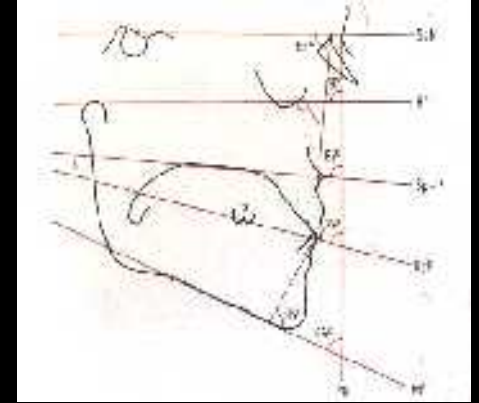
## Ramus plane (condylus – angulus)



# Measurement of the angles

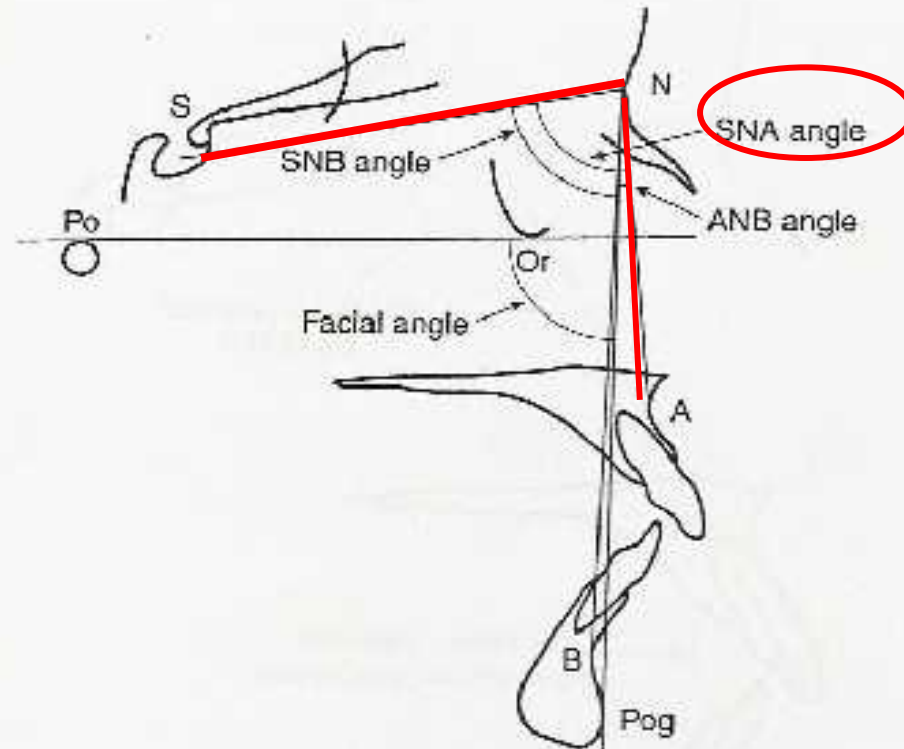
## Relations

- The position of the maxilla and the mandibule correlates to the skull in *sagittal and vertical* planes
- The relation and position of the incisors



# Angles describing skeletal relationships

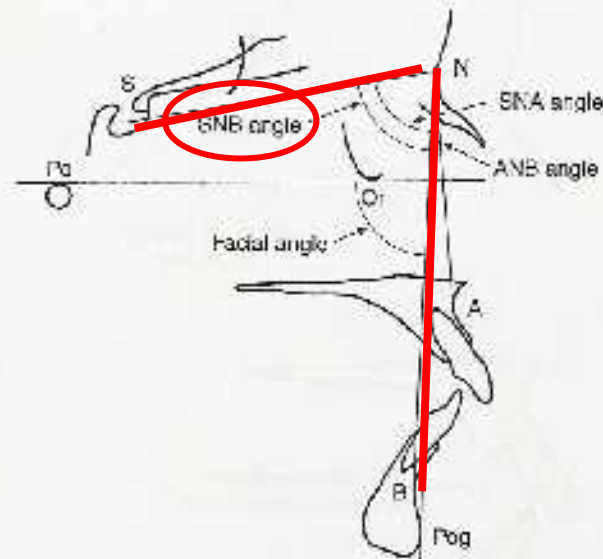
**SNA angle** : relates the antero-posterior position of the maxillary apical base to a line passing through the anterior cranial base



# Angles describing skeletal relationships

## SNB angle:

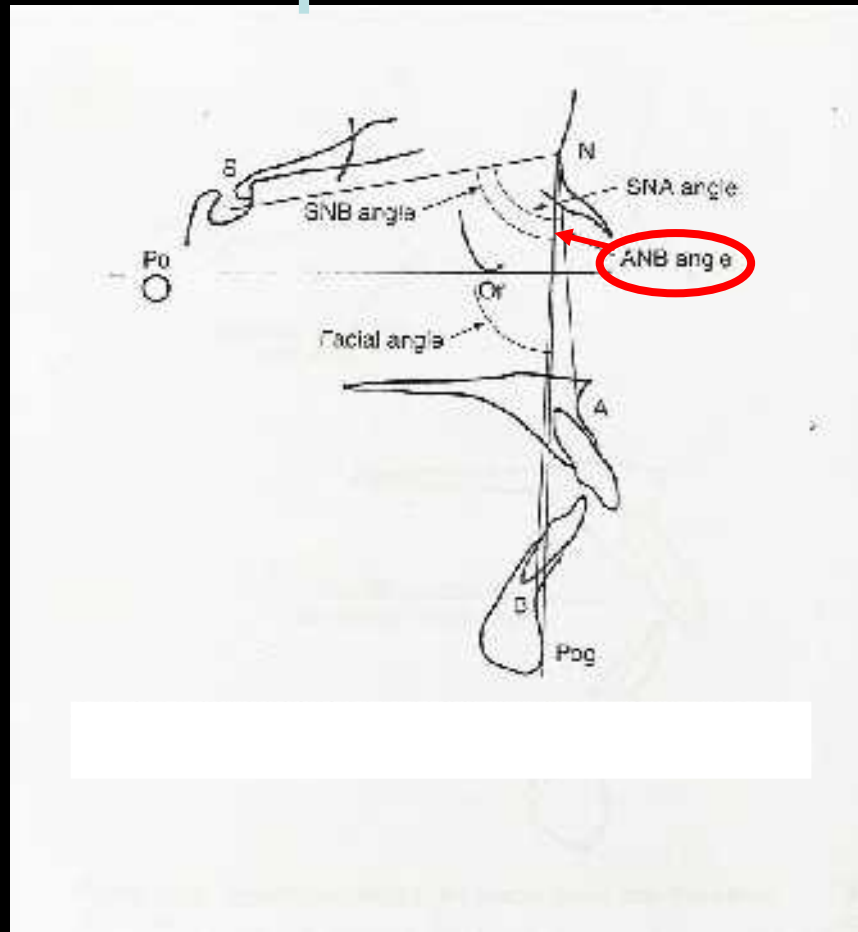
relates the antero-posterior position of the mandibular apical base to a line passing through the anterior cranial base



# Angles describing skeletal relationships

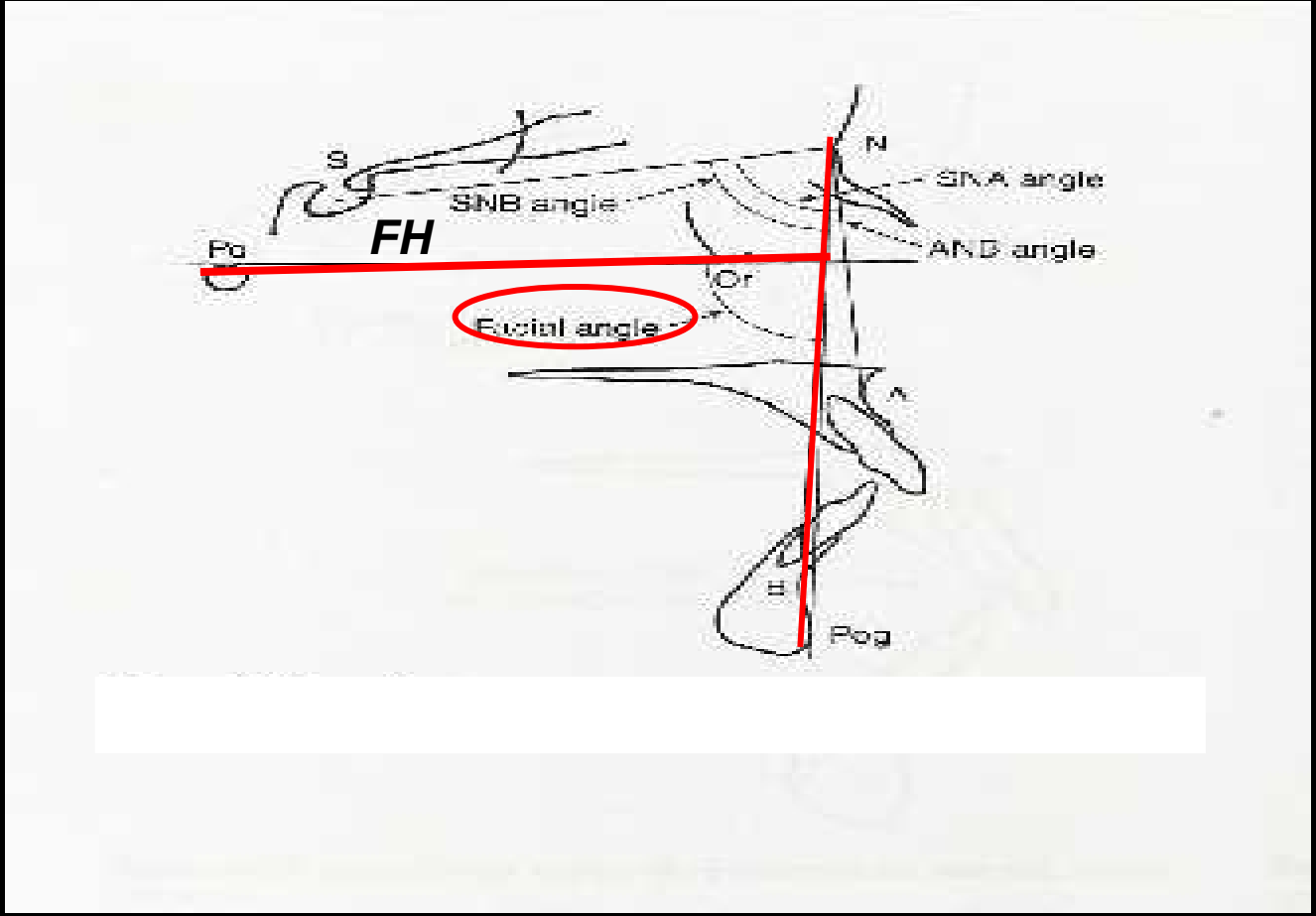
ANB angle (SNA-SNB) :

relates the antero-posterior position of the maxilla to the anteroposterior position of the mandible



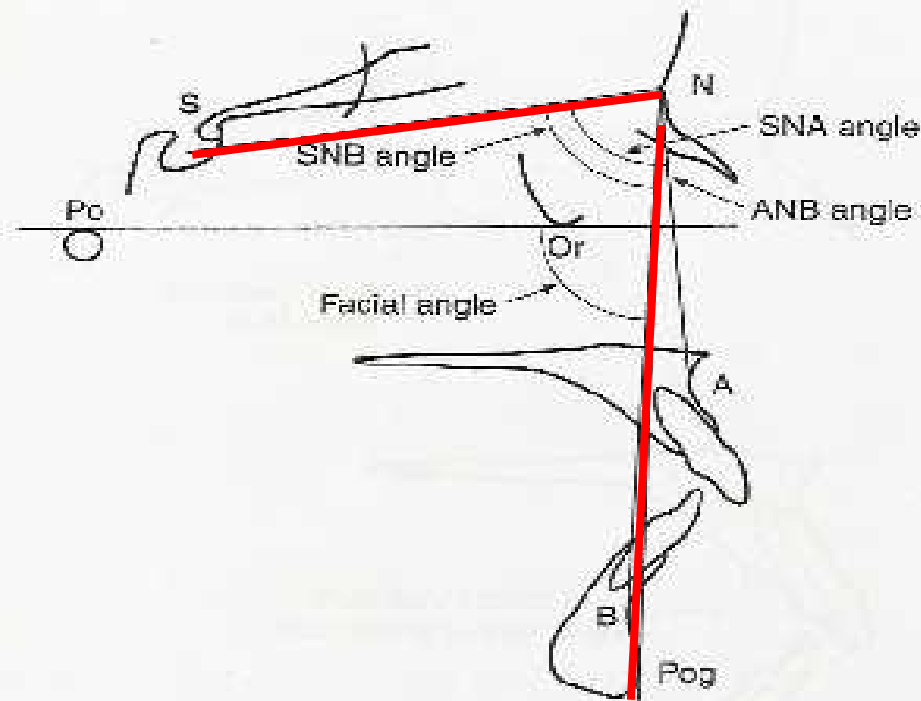
# Angles describing skeletal relationships

Facial angle (N-Pog:FH): relates the antero-posterior position of the chin to the Frankfort horizontal plane



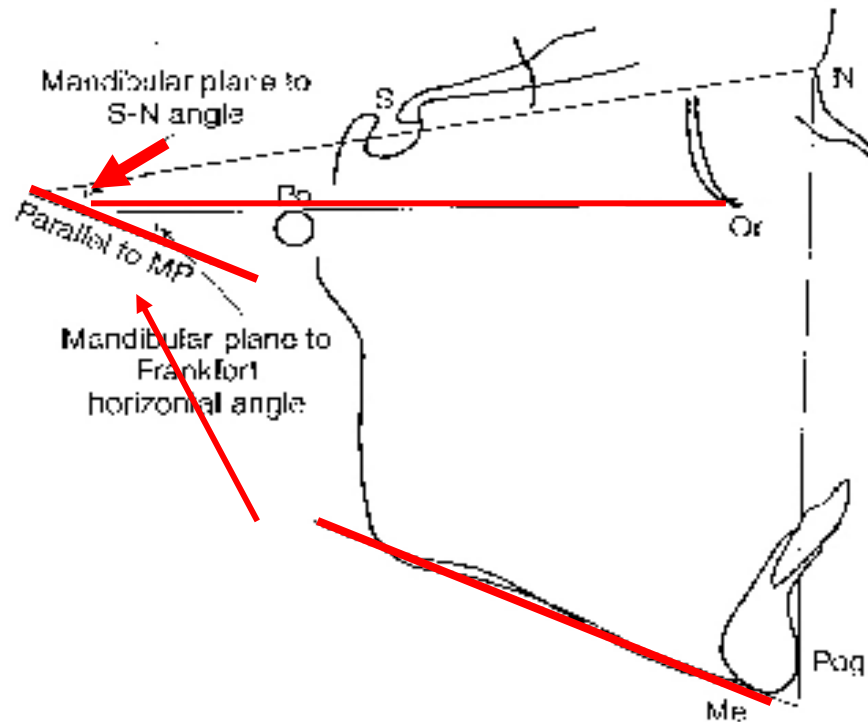
# Angles describing skeletal relationships

**SN-Pog angle** : relates the antero-posterior position of the chin to the line passing through the anterior cranial base



# Angles describing skeletal relationships

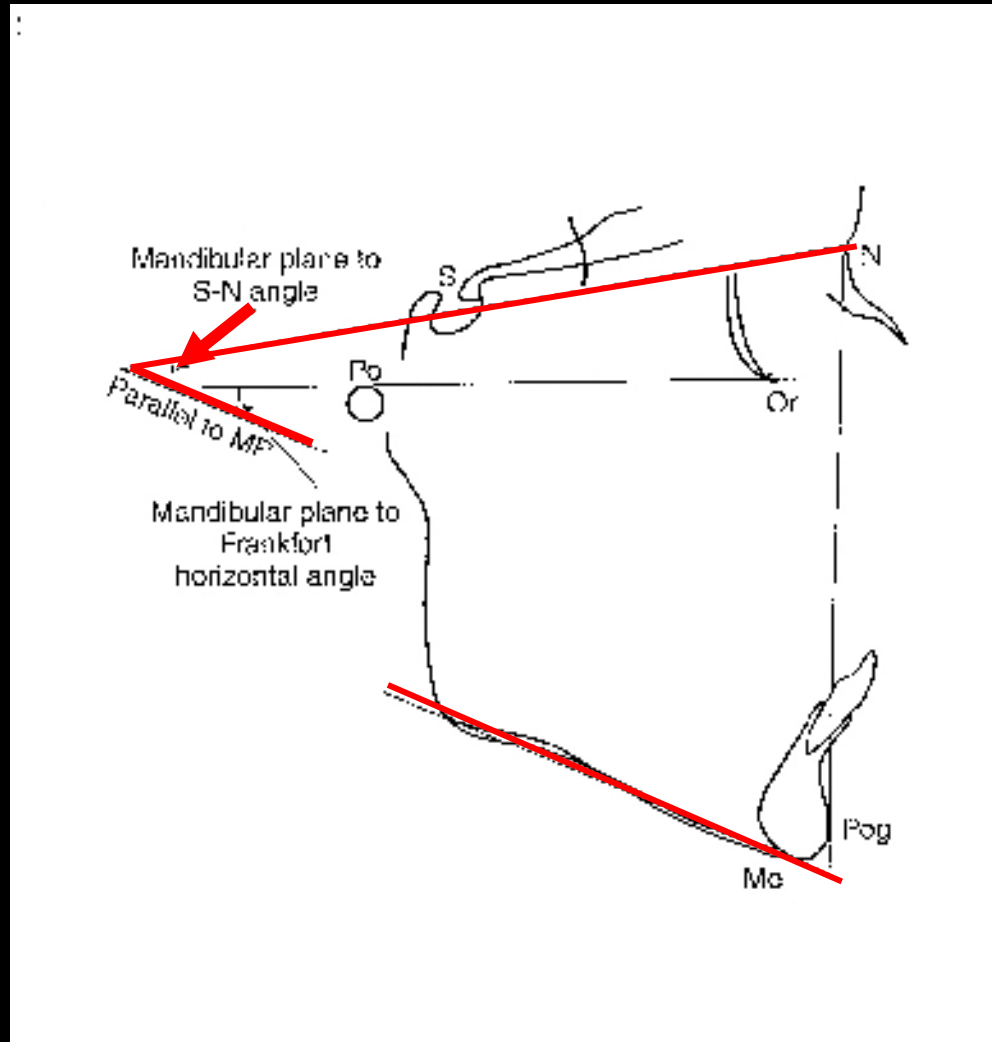
**Mandibular plane-Frankfort horizontal plane angle: (FMA or MP-FH):relates the cant of the mandibular plane to the Frankfort horizontal plane**





# Angles describing skeletal relationships

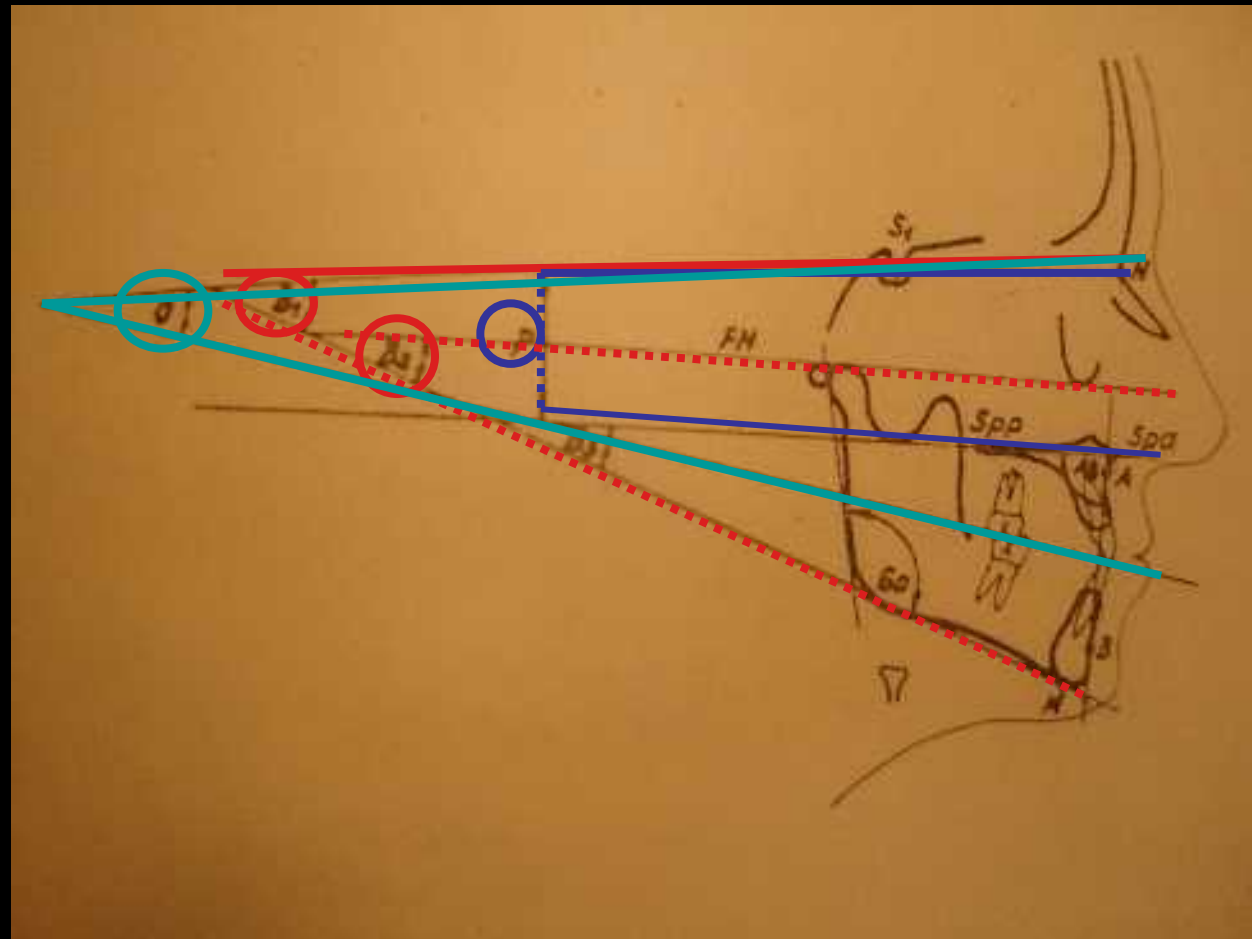
**Mandibular plane-S-N plane angle (MP-SN):** relates the cant of the mandibular plane to a line passing through the anterior cranial base



# Angles describing skeletal relationships

The maxilla and the mandibula position correlate to the scal in the vertical plane ( $B_1, B_2, P, O$ )

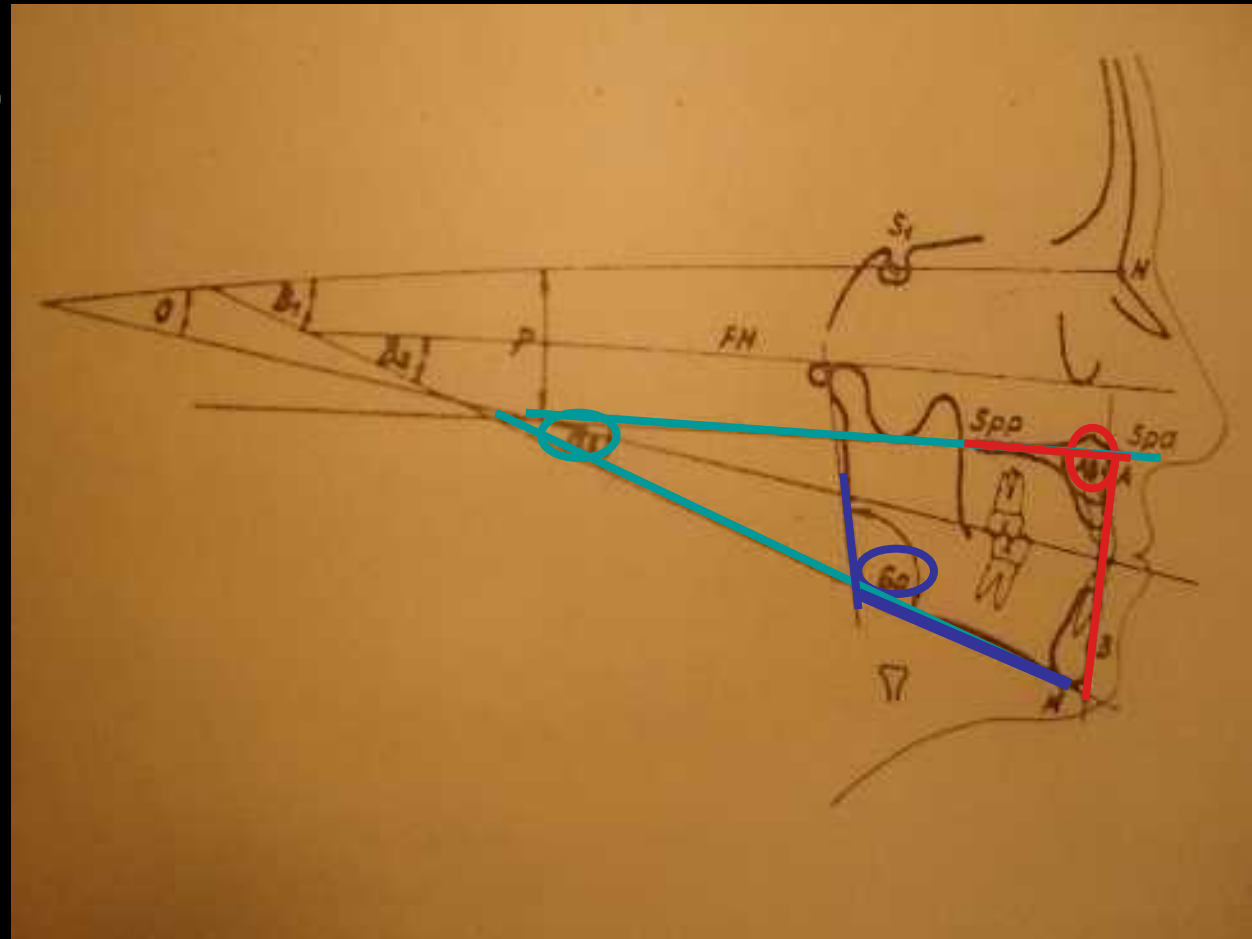
- $B_1$ : SN-GoM ( $32^\circ$ )
- $B_2$ : FH-GoM ( $25^\circ$ )
- P: SN - Spa-Spp ( $12^\circ$ )
- O: SN-occlusal plane ( $15^\circ$ )



# Angles describing skeletal relationships

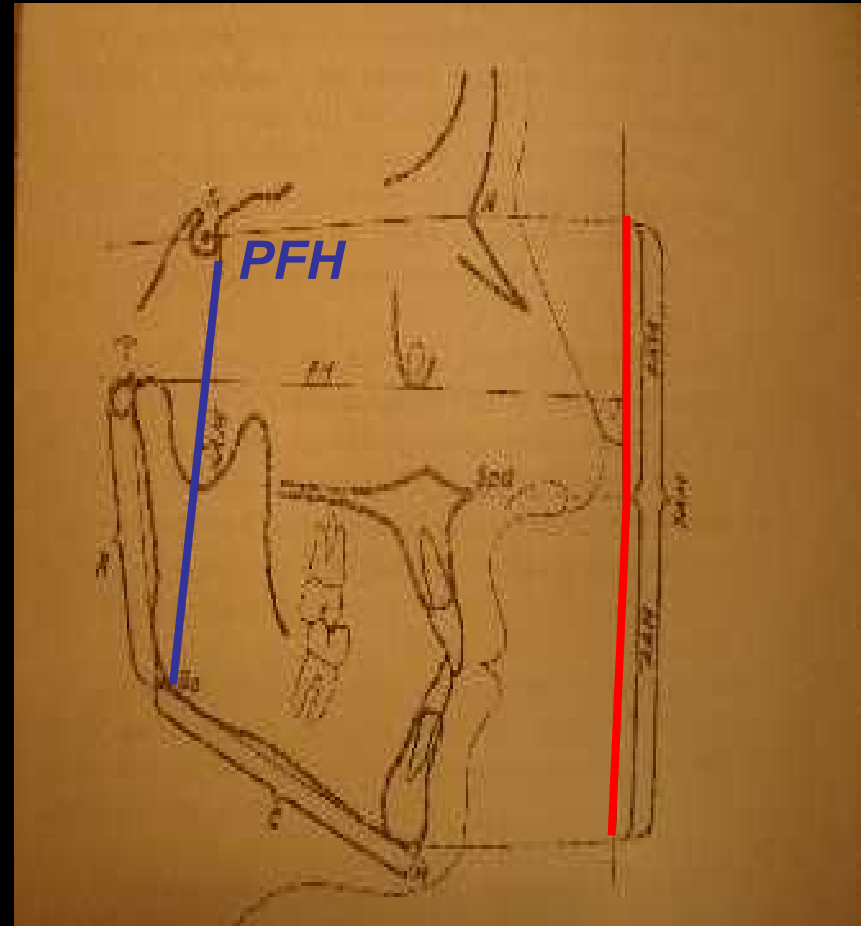
The position of the maxilla and the mandibula correlate to the skull in the sagittal plane  
( $B_3$ , AB), mandible angle (Go)

- $B_3$ : Spa-Spp-GoM ( $20^\circ$ )
- AB: Spa-Spp-AB ( $90^\circ$ )
- Go:  $123^\circ$



# Vertical proportions

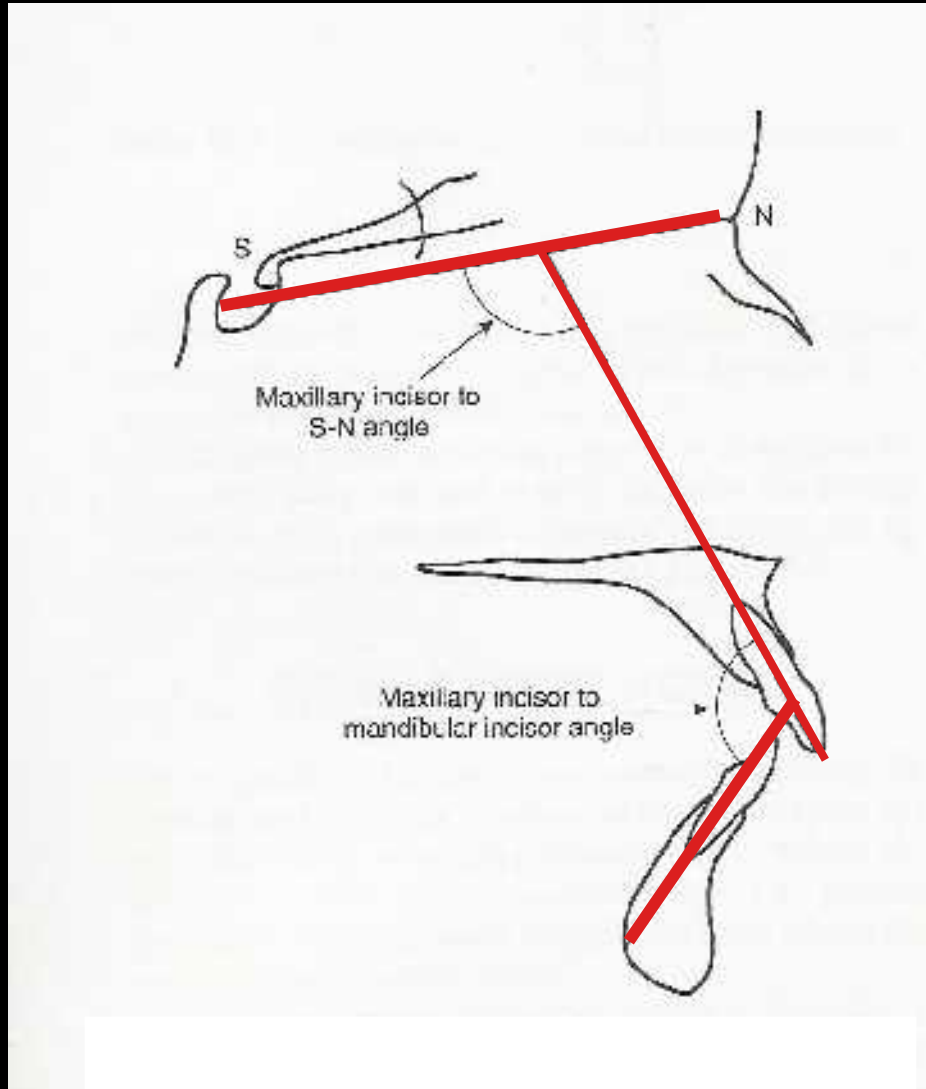
M. C:R	7:5	
	Men	Women
Upper/Total	0,54	0,48
Lower/Total	0,56	0,54
Post./Total	0,67	0,67



Facial heights:  
anterior (upper, lower, total)  
posterior

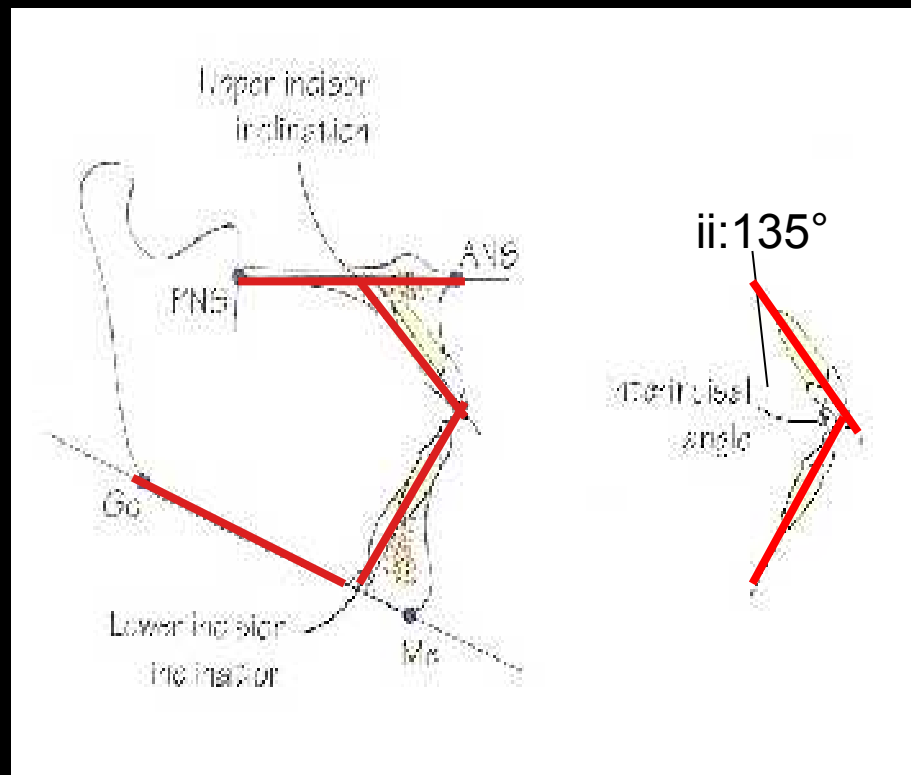
# Angles and distances describing dental relationships

## The relation and position of the incisors



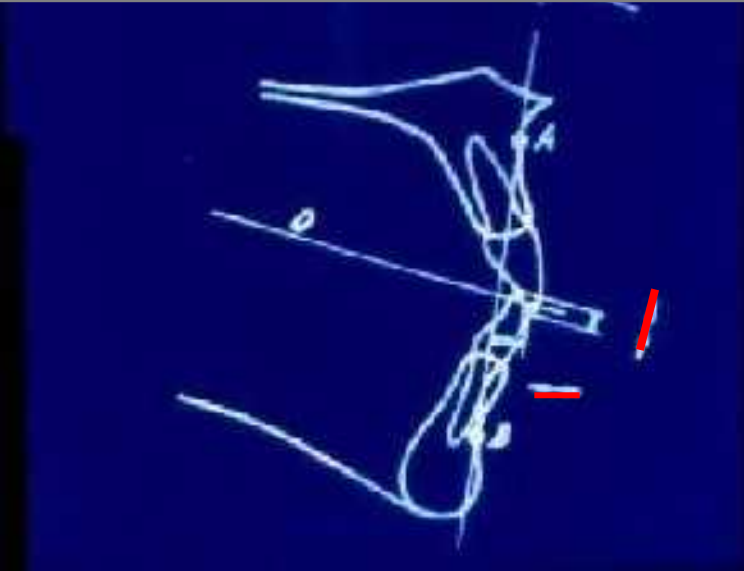
# Angles and distances describing dental relationships

## The relation and position of the incisors



**Inclination of incisors**

# Linear measurements



**Overjet, overbite**

# Average values

## Facial angles

- SNA: 82°
- SNB: 80°(79°)
- ANB: 2°(3°)
- FH-NPog: 87.5°)

## Basis angles

- B<sub>1</sub> (ML-NSL): 32°
- B<sub>2</sub> (Fr-ML): 25°
- B<sub>3</sub> (ML-NL): 23.5° (20°)
- SN-MP: 12 °
- SN-Occlusal plane: 15 °
- Go szög: 123 °
- Inclination of incisors
- $\alpha$ : 110°
- $\beta$ : 90° (92 °)
- $\text{ii}$ : 130° (135°)



# Cephalometric norms

## Cephalometric Standards for 12-Year-Old Males

Measurement	Mean	SD	Minimum	Maximum
<b>Skeletal Anteroposterior</b>				
SNA°	82	3.7	76	90
SNB°	80	3.7	73	86
ANB°	2	2.4	-2	6
SN:Pog'	81	4.2	72	88
HH:N-Pog'	86	4.5	79	94
<b>Skeletal Vertical</b>				
N:Me mm	122	6.0	113	135
S:Go mm	90	6.8	80	102
S:Go/N:Me%	74	6.5	61	87
MP:SN°	28	7.2	13	43
MP:FH°	23	7.4	7	42
<b>Dental Angular</b>				
∠I°	134	9.8	115	152
∠SN°	102	6.3	89	115
T:PH°	62	10.9	48	85
T:MP°	96	9.2	78	108
<b>Dental Linear</b>				
∠:A-Pog mm	4	1.9	0	7
T:NB mm	4	2.5	-1	9

# Cephalometric norms

## Cephalometric Standards for 14-Year-Old Females

Measurement	Mean	SD	Minimum	Maximum
<b>Skeletal Anteroposterior</b>				
SNA°	80	3.8	74	90
SNB°	77	3.3	71	84
ANB°	3	2.1	0	7
SN:Pog°	77	3.3	72	84
FH:N-Pog°	84	2.5	79	89
<b>Skeletal Vertical</b>				
N:Me mm	107	5.0	96	116
S:Go mm	72	3.7	61	78
S:Go/N:Me%	68	3.5	63	75
MP:SN°	34	4.2	24	39
MP:FH°	28	4.9	19	35
<b>Dental Angular</b>				
∠:T°	129	9.0	111	142
∠:SN°	102	5.4	96	110
T:FH°	58	6.5	46	65
T:MP°	95	5.5	86	106
<b>Dental Linear</b>				
I:A-Pog mm	6	1.7	3	9
T:NB mm	4	2.0	2	8

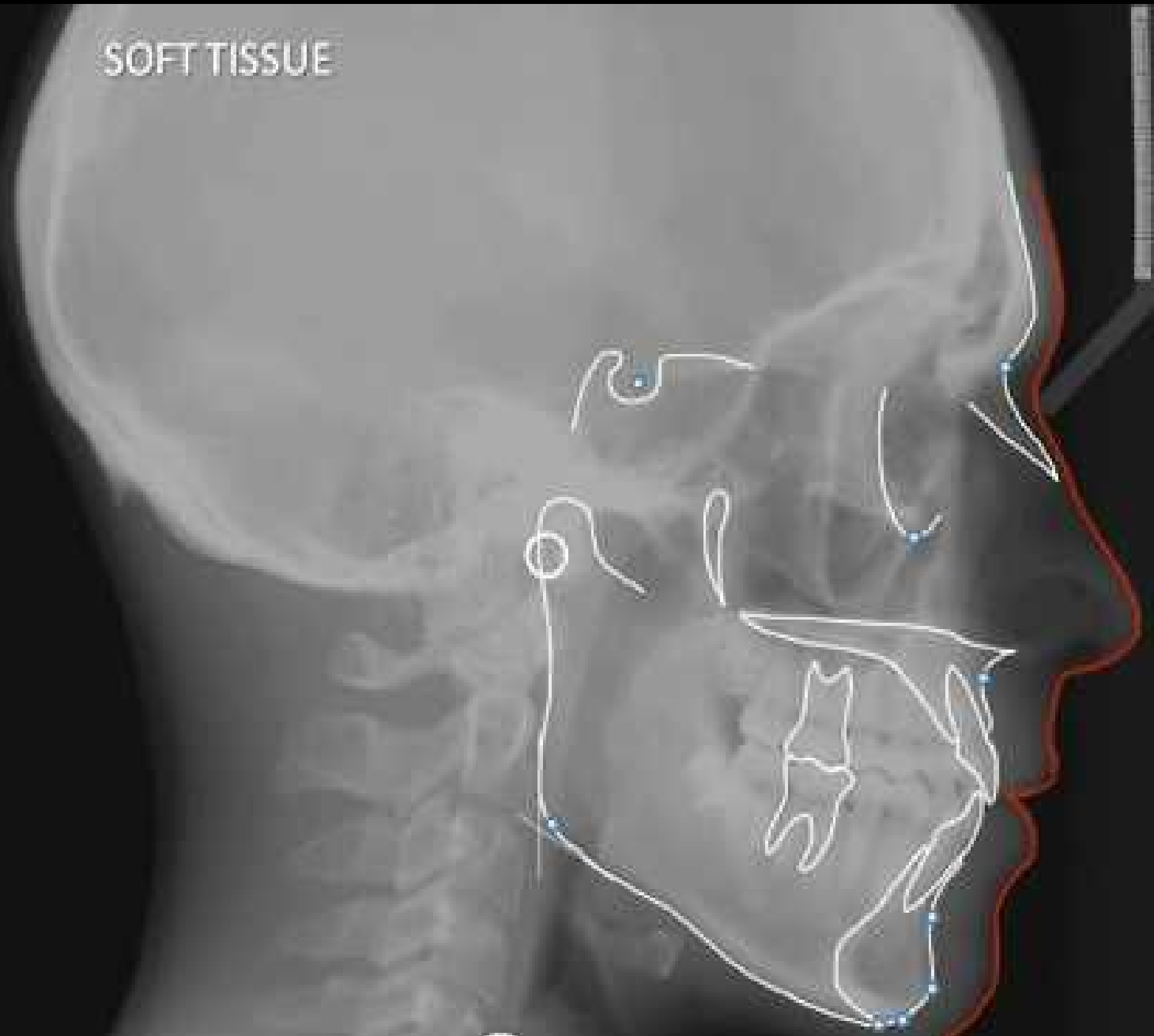
From Bishara SE: *Am J Orthod* 79:35-44, 1981.

SD, Standard deviation.

Normal (Eastman) values for Caucasians unless stated otherwise\*.

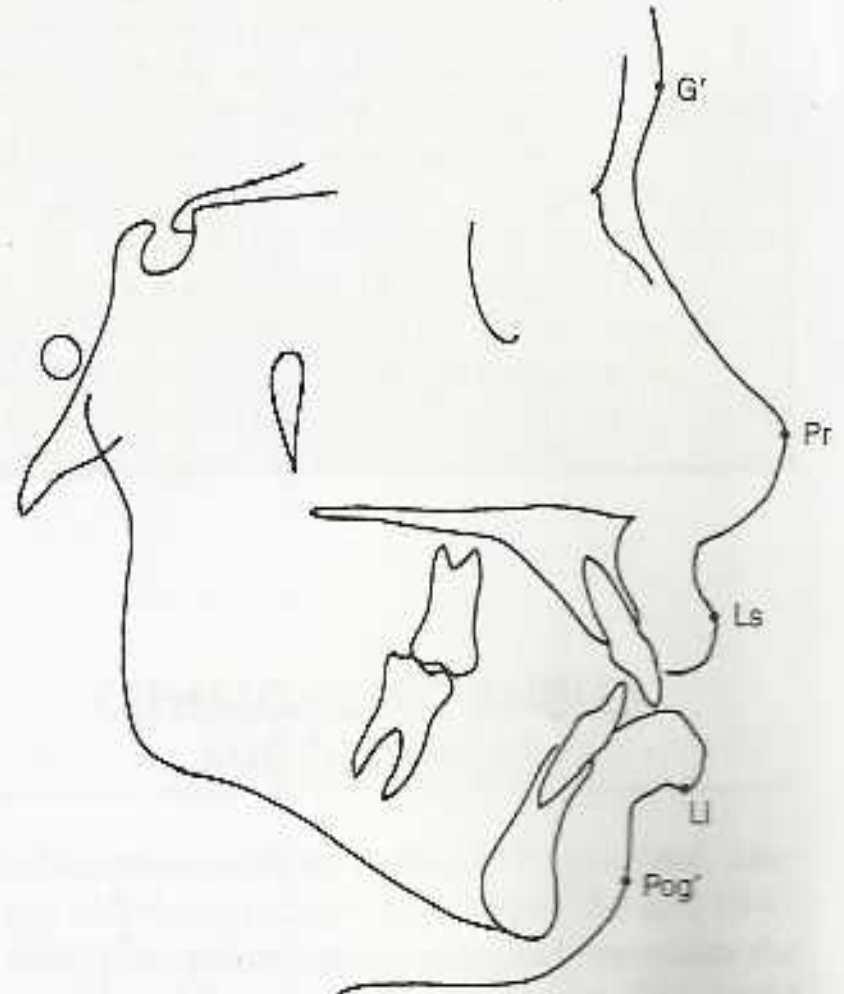
Measurement	Normal (SD)
SNA	81° (3°)
SNB	78° (3°)
ANB	3° (2°)
MMPA	27° (4°)
LAFH%	55% (2%)
U1–Maxillary plane	
Caucasians	109° (6°)
African Caribbeans•	118°
Chinese•	113°
L1–Maxillary plane	93° (6°)
Interincisal angle	135° (10°)

SOFT TISSUE

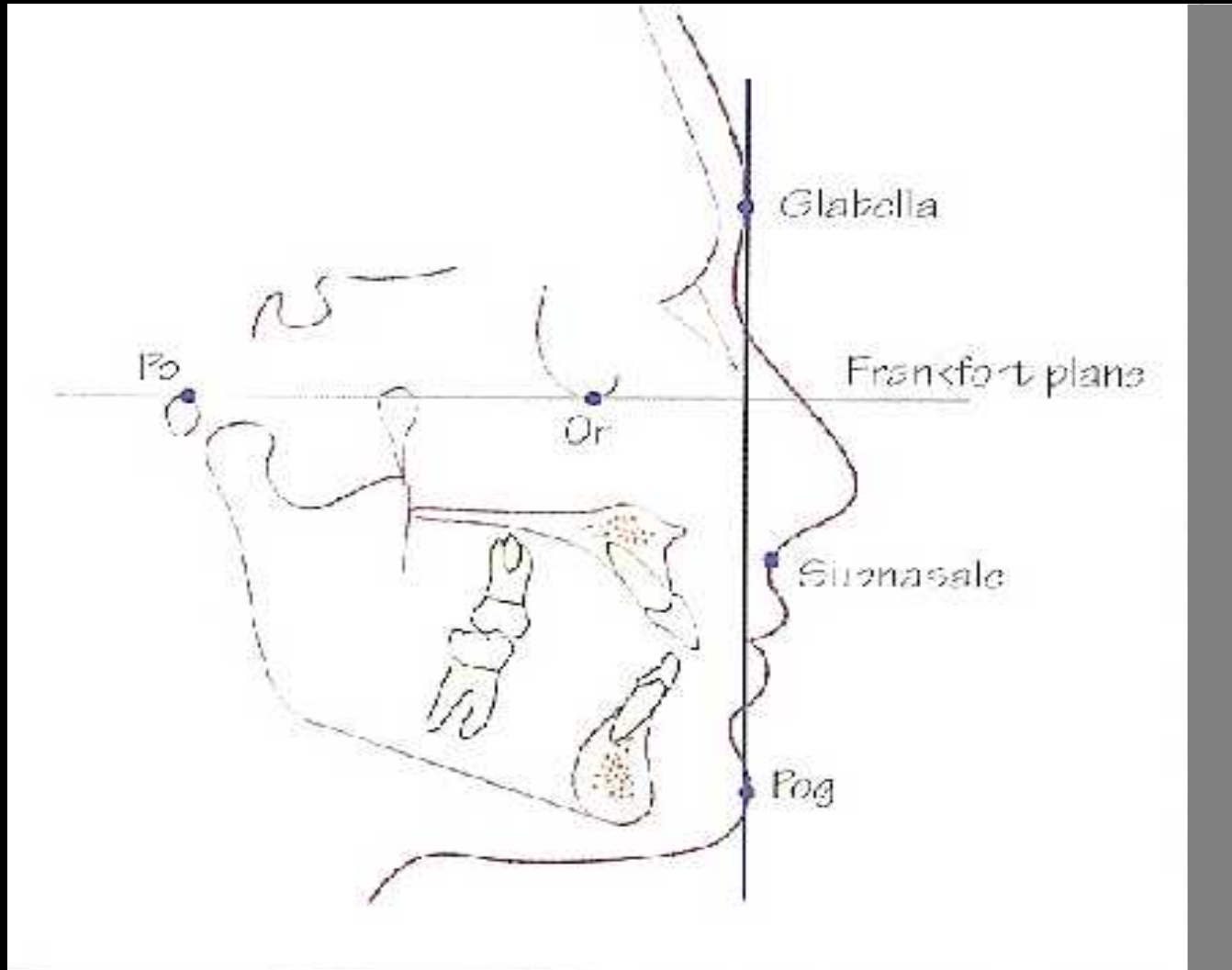


# Soft tissue points

Soft tissue profile points: glabella (*G'*), pronasale (*Pr*), labrale superius (*Ls*), labrale inferius (*Li*), and pogonion (*Pog'*).



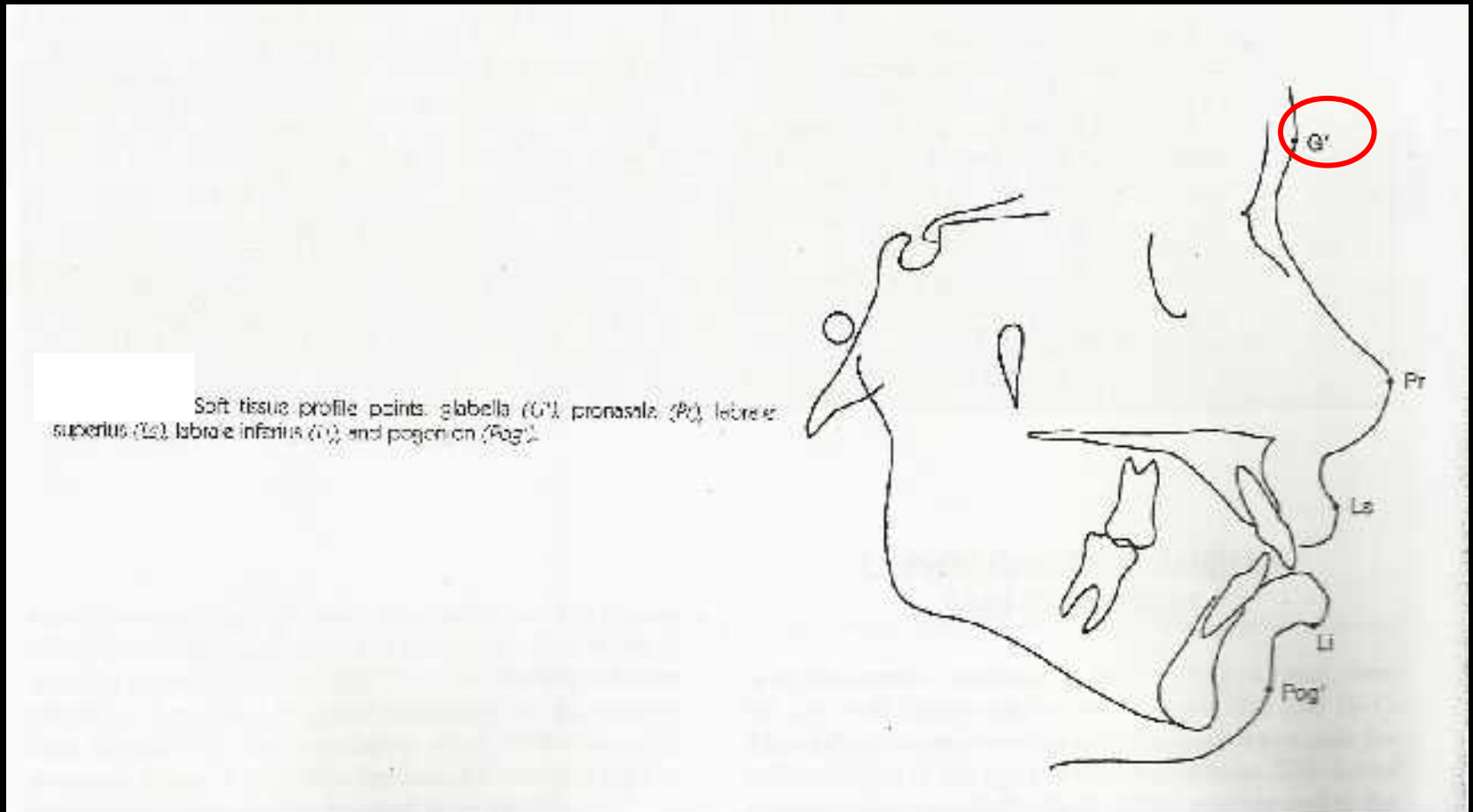
# Soft tissue analysis of maxillary and mandibular prominence



# Soft tissue points

## Soft tissue glabella (G')

The most prominent point in the midsagittal plane of the forehead

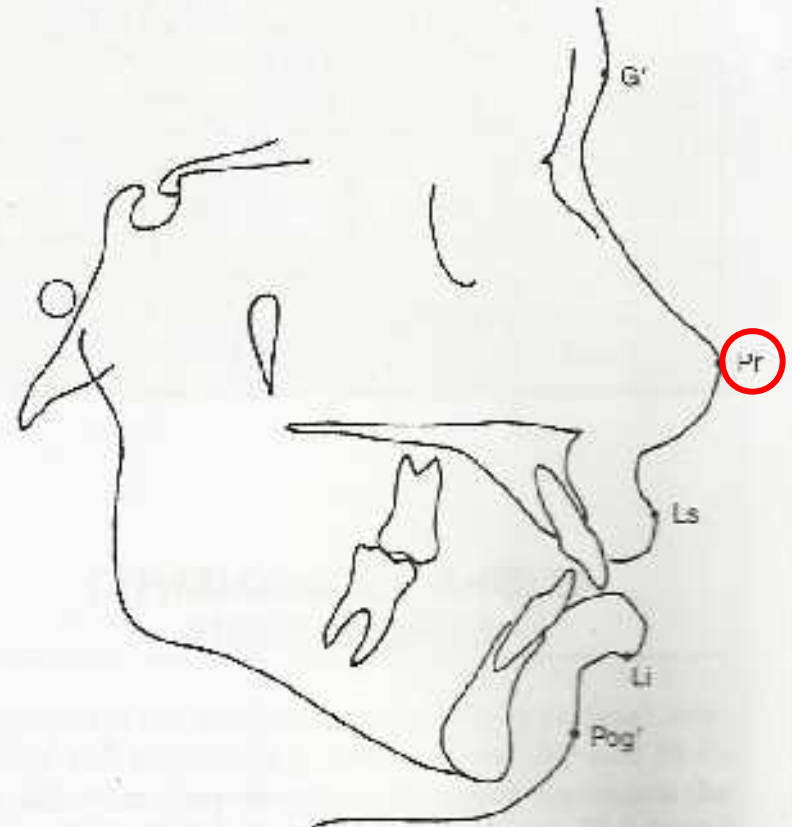


# Soft tissue points

## Pronasale (Pr):

the most prominent point on the tip of nose

Soft tissue profile points: gabella (G'), pronasale (Pr), labiale superius (Ls), labiale inferius (Li), and pogonion (Pog').



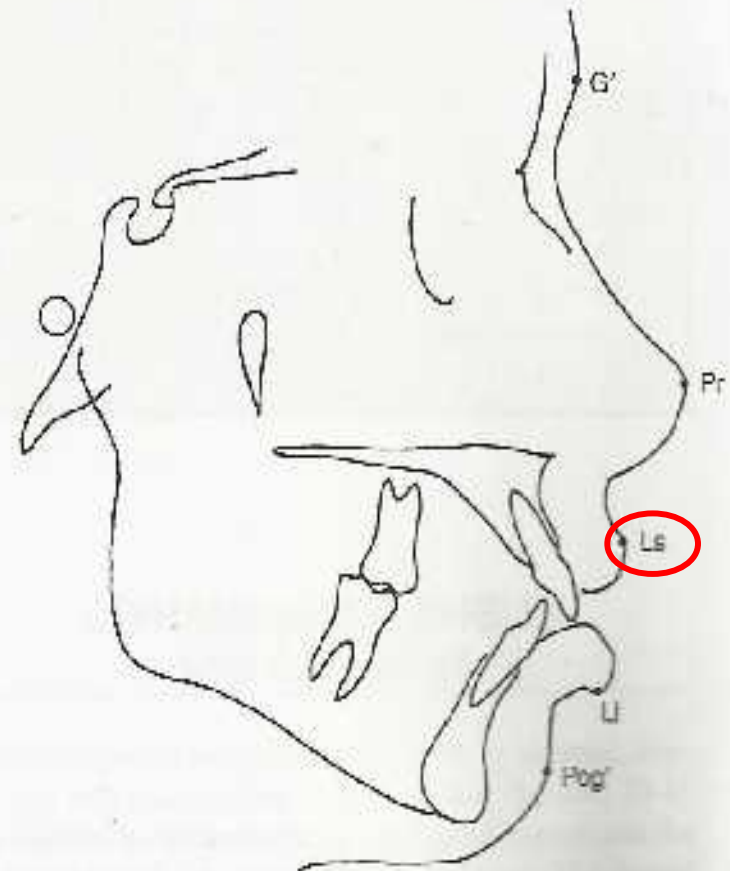


# Soft tissue points

Labrare superius (Ls):

the median point in the upper margin of the upper membranous lip

Soft tissue profile points: glabella (G'), pronasale (Pr), labiale superius (Ls), labiale inferius (Li), and pogonion (Pog').

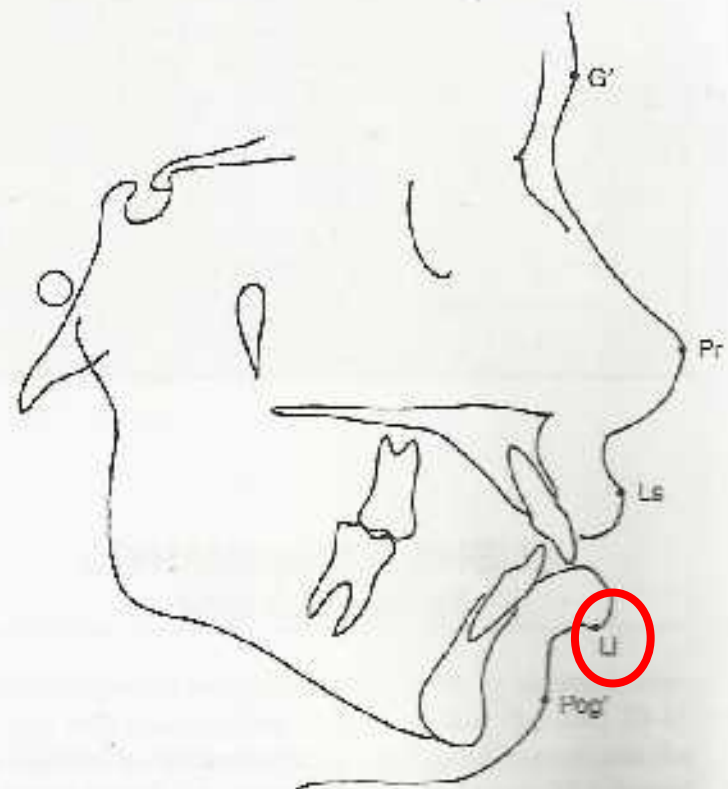


# Soft tissue points

## Labrare inferius (Li):

the median point in the lower margin of the lower membranous lip

Figure 10-10 Soft tissue profile points: glabella (G'), pronasale (Pr), labiale superius (Ls), labiale inferius (Li), and pogonion (Pog').

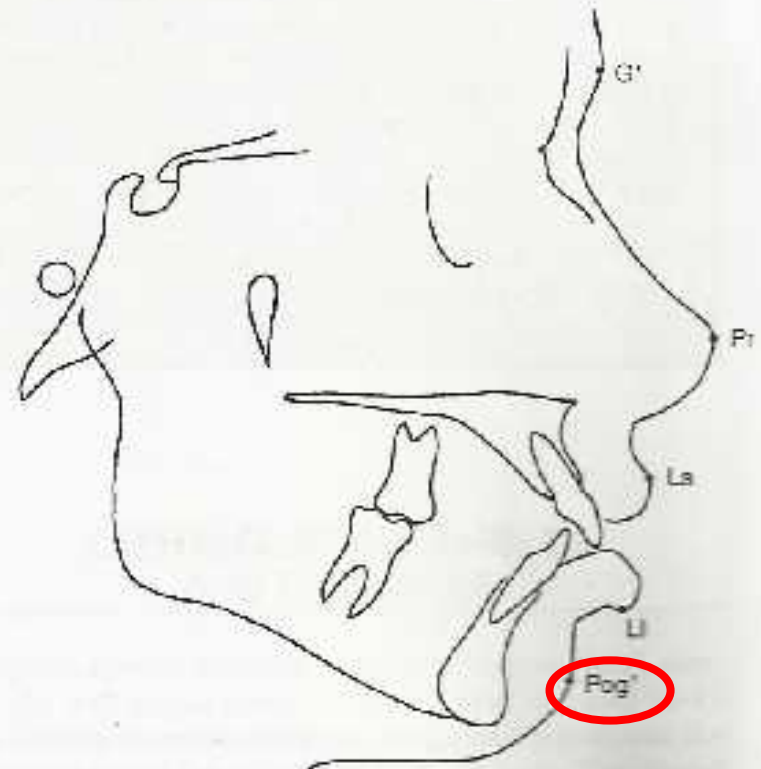


# Soft tissue points

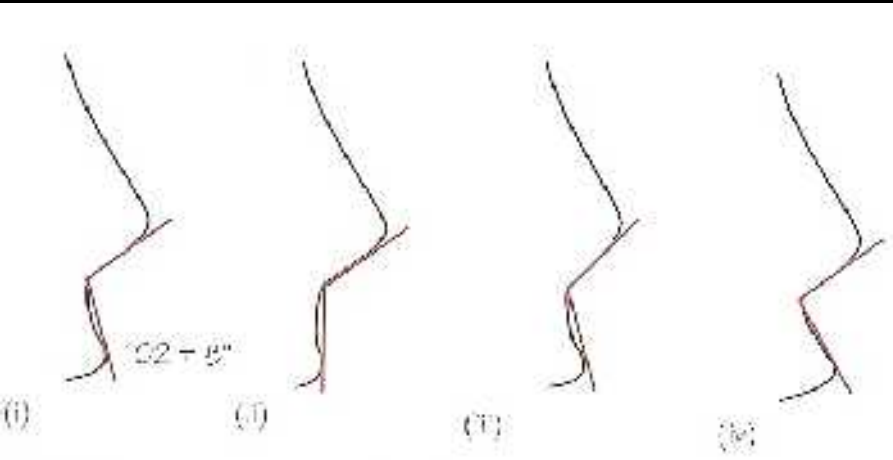
Soft tissue pogonion (Pog'):

the most prominent point on the soft tissue contour of the chin

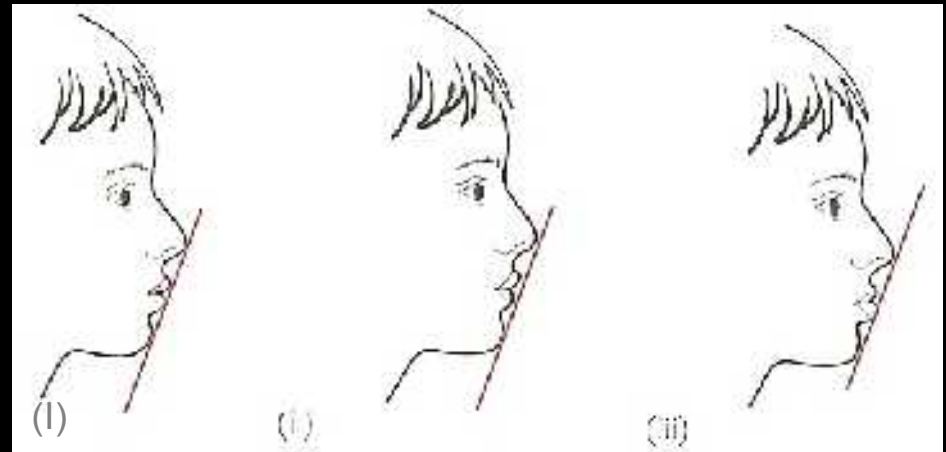
Soft tissue profile points: glabella (G'), pronasale (Pr), labrale superius (Ls), labrale inferius (Li), and pogonion (Pog').



# • Nasolabial angle



# Ricketts E (Esthetic)-line



**Normal:  $102.8^\circ$**

**Acute:  $<90^\circ$  (IV)**

**Obtuse:  $>90^\circ$  (II, III)**

**The tip of the nose  
and chin points**

**Straight, retrusive (II),  
protrusive**

# Con Beam Computer Tomography (CBCT)

Three dimensional hard and soft tissue scans

- To examine facial morphology, monitor grows and treatment progress



CBCT may be increasingly used in the future for the assessment of impacted teeth, skeletal discrepancies and the mandibular condyles.

*Thank you for your attention!*