



Cephalometric Review

Highlights of Tracing, ABO Ceph Analysis, Regional
Anatomy, Superimposition Techniques & Interpretation

(rev. 3.14.2025)

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Disclaimer

The following is not a substitute for a thorough understanding of cranial anatomy, growth and development, treatment affects, or skeletal and dental diagnosis.

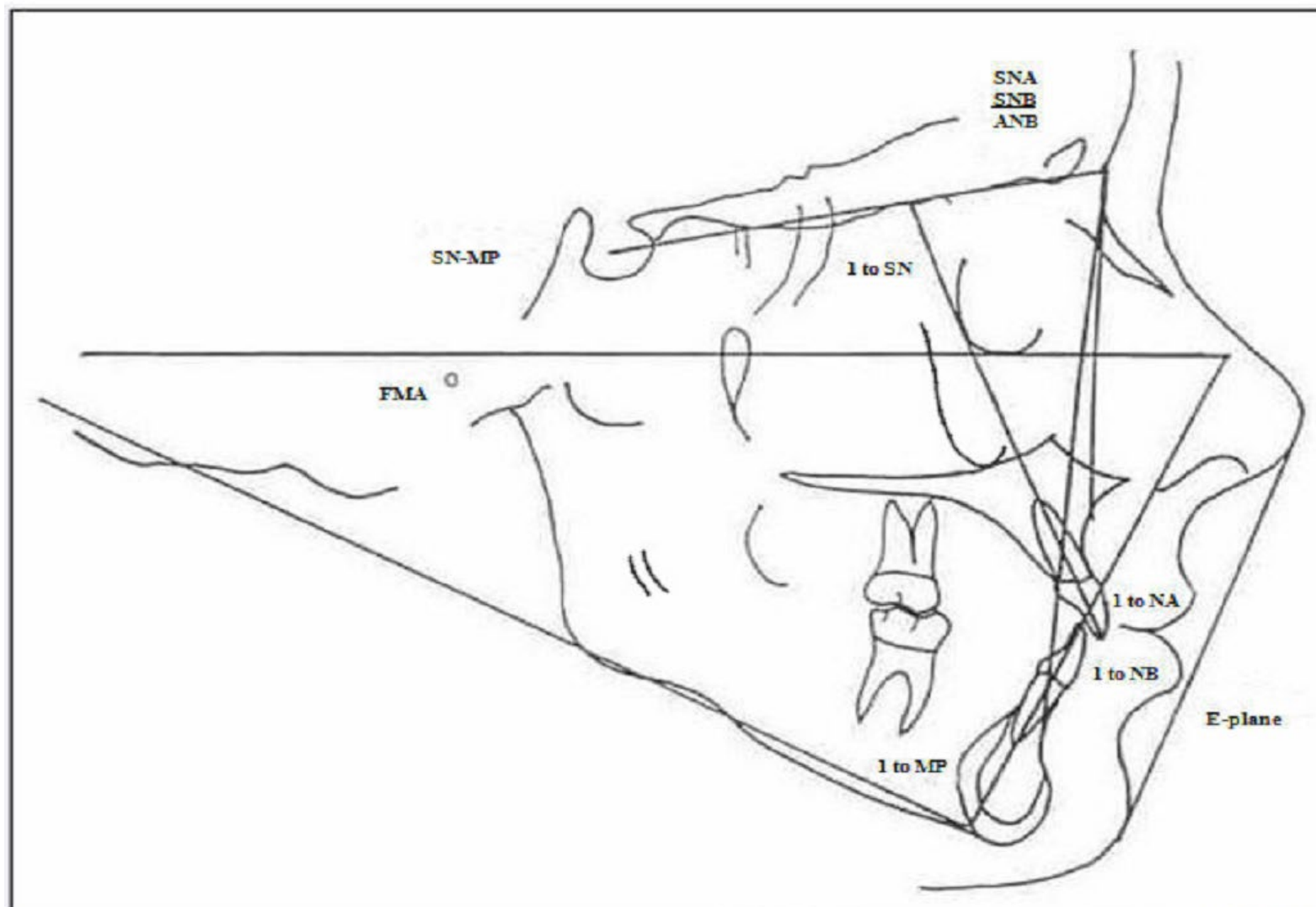


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ABO Cephalometric Guidelines

EXAMPLE 1 CEPHALOMETRIC TRACING REFERENCE

Tracing will be drawn in black, blue, or red, depending on the level of evaluation



- 
- Original tracing is black
 - Progress tracing is blue
 - Final tracing is red



ABO Cephalometric Measurements

- SNA
- SNB
- ANB
- SN MP
- FMA
- U1 TO SN
- U1 TO NA
- L1 TO MP
- L1 TO NB
- E-PLANE



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Cephalometric Landmark Definitions:

Sella S	midpoint of the sella turcica (hypophysial or pituitary fossa)
Nasion N	most anterior point of nasofrontal suture in the median plane
Porion Po	the upper- and outer-most point on the external auditory meatus
Orbitale Or	the most inferior and anterior point of the orbital margin
Point A	-subspinale, the deepest point on the curved profile of the anterior portion of the maxilla, between the anterior nasal spine and alveolar crest
Pogonion Pg	most anterior point of the bony chin, in the median plane
Menton Me	lowest point of the mandibular symphysis in the midline
Gnathion Gn	most anterior and inferior point of the bony chin (midpoint between pogonion and menton)
Point B	-supramentale, the deepest point on the curved profile of the mandible, between the ching and the alveolar crest
Condylion Cd	most posterior and superior point on the head of the 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
Gonion Go	the most posterior and inferior point on the angle of the mandible
Upper incisor apex	the root apex of the most anterior maxillary central incisor
Upper incisor tip	the tip of the crown of the most anterior maxillary central incisor
Lower incisor tip	the tip of the crown of the most anterior mandibular central incisor
Lower incisor apex	the root apex of the most anterior mandibular central incisor
ANS	anterior nasal spine, the tip of the bony anterior nasal spine in the midline
PNS	posterior nasal spine, the tip of the posterior nasal spine in the midline

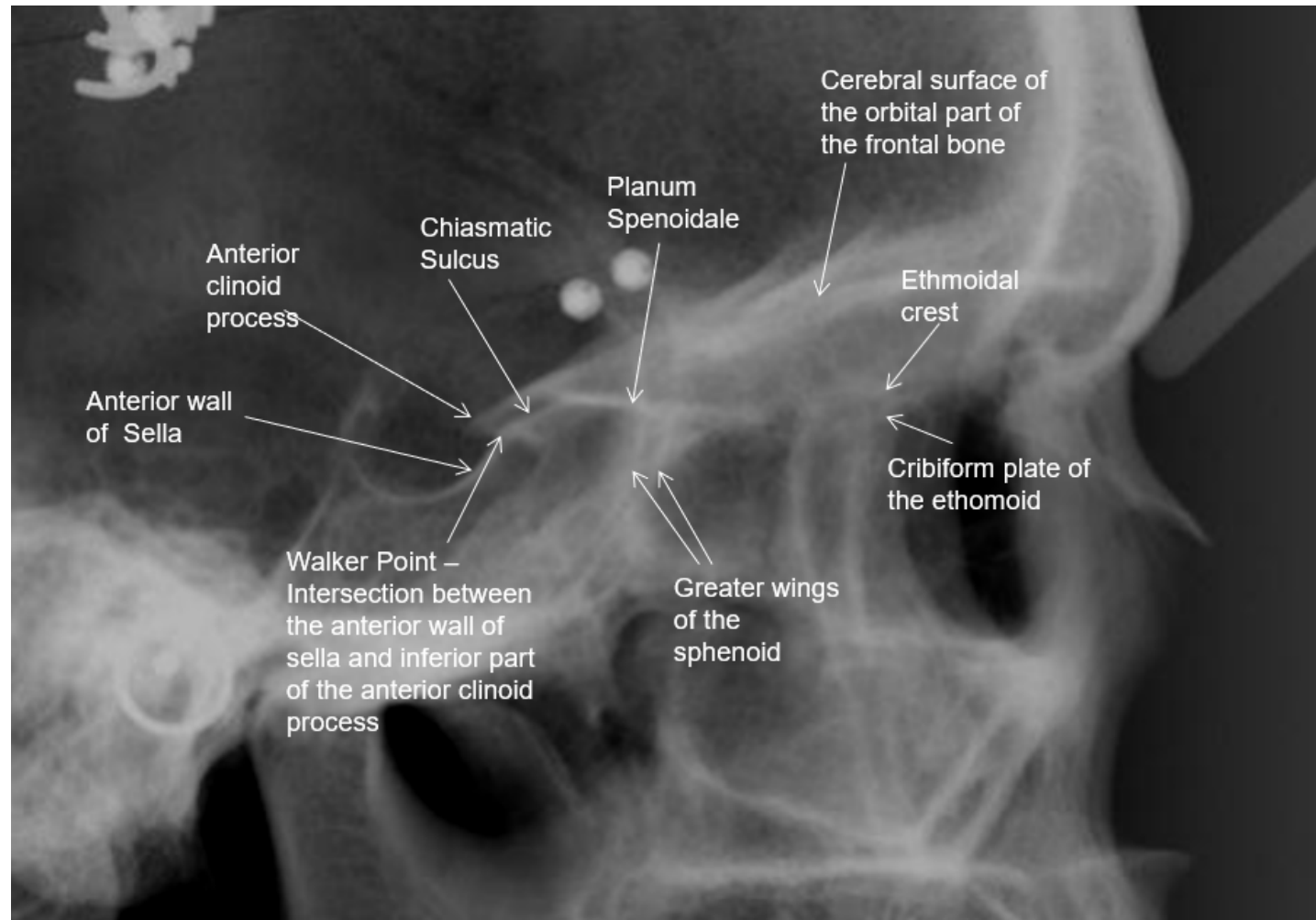
- 
- Constructed Gonion is used for mandibular plane.
 - Measurements given in an exam are specific to the scenario patient.
 - Examinees should be familiar with cephalometric measurement norms, standard deviations, and ethnic variations.



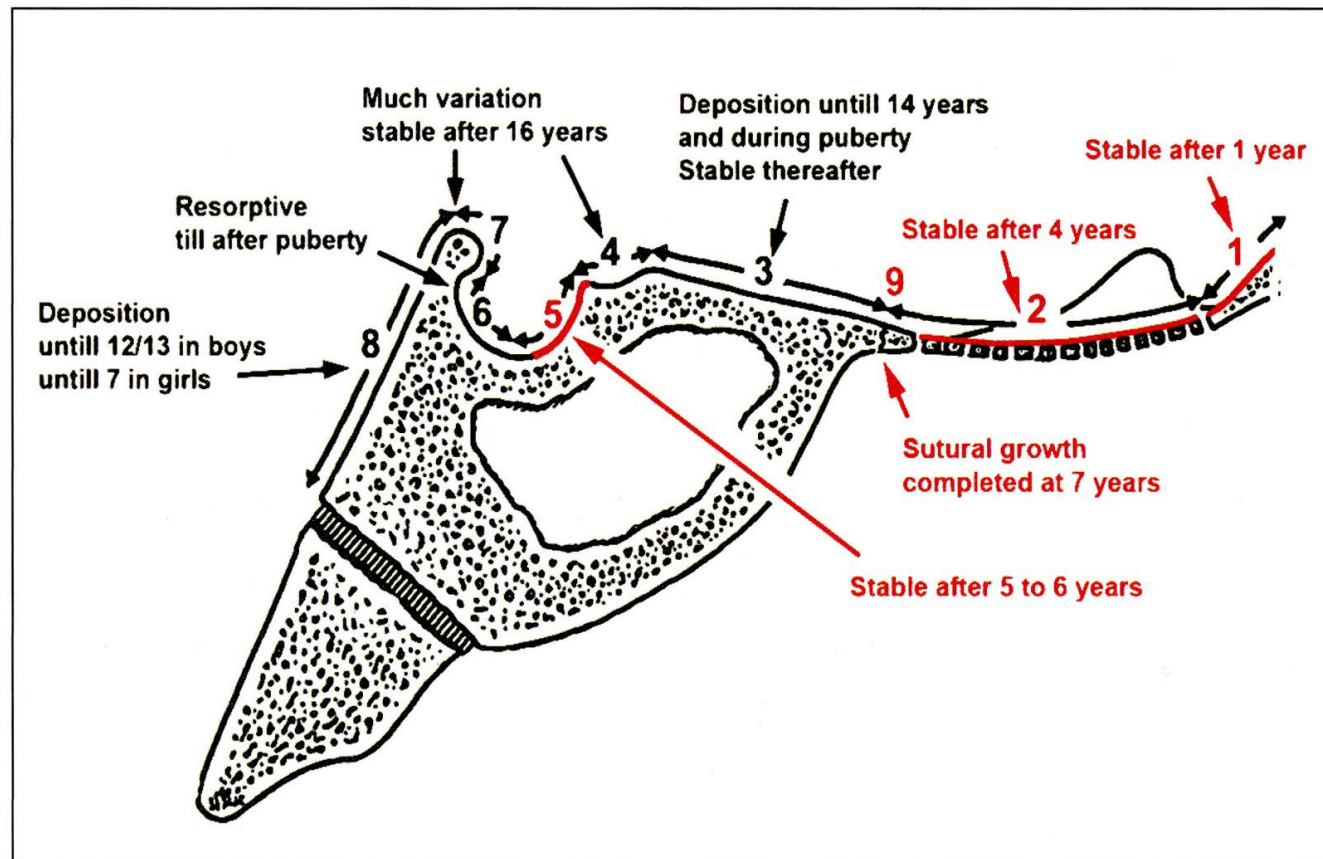
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Superimposition Review

Cranial Base Anatomy



Evidence for Stability of these Anatomical Structures



Maxillary Regional Superimposition

- **Vertical changes:**
 - Maxillary growth in height occurs at its processes.
 - Apposition of bone at the floor of the orbits.
 - Resorption of bone at the nasal floor and apposition on the palatal surfaces.
- **Sagittal changes:**
 - Anterior surface of the zygomatic processes was relatively stable.

Maxillary Regional Superimposition

The ABO has used the literature to arrive at the suggested technique with the use of the appropriate anatomical structures.

Let's review those anatomical structures.



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Maxillary Regional Superimposition

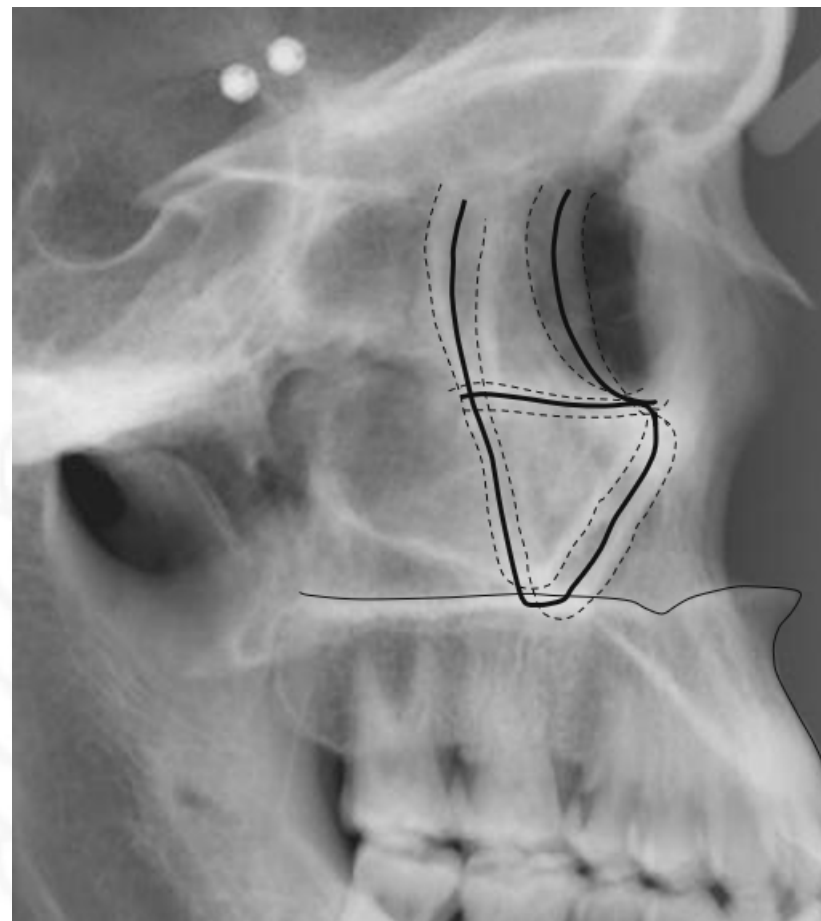
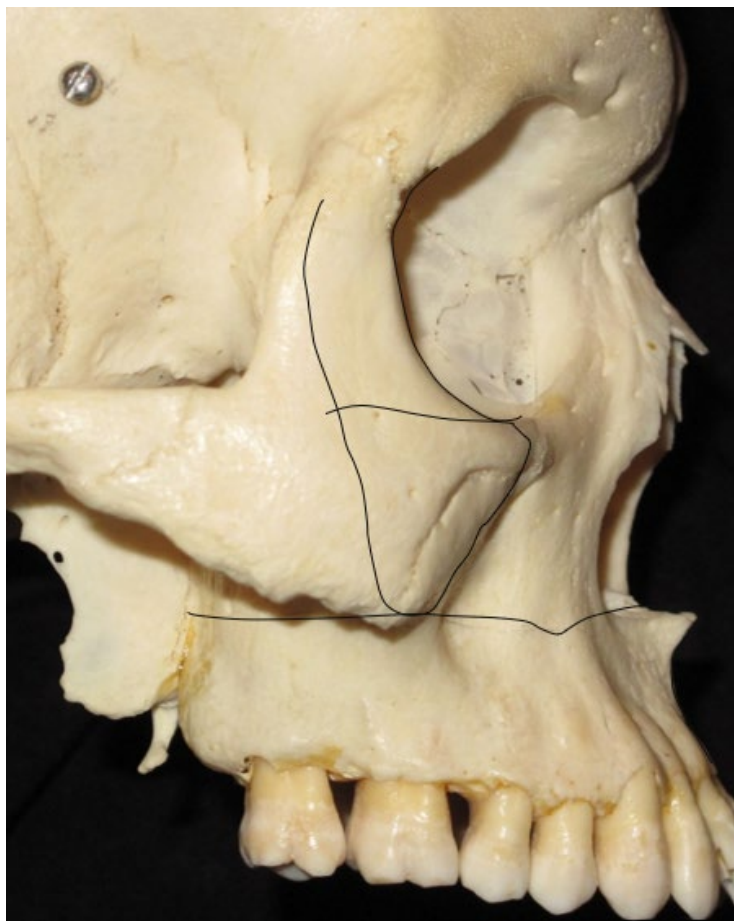
- Both the right and left (or carefully split the two) zygomatic processes (ant. & post. Legs).
- Superior surface of both orbital floors (or carefully split).
- Superior surface of the palatal floor.



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Maxillary Superimposition



Mandibular Regional Superimposition

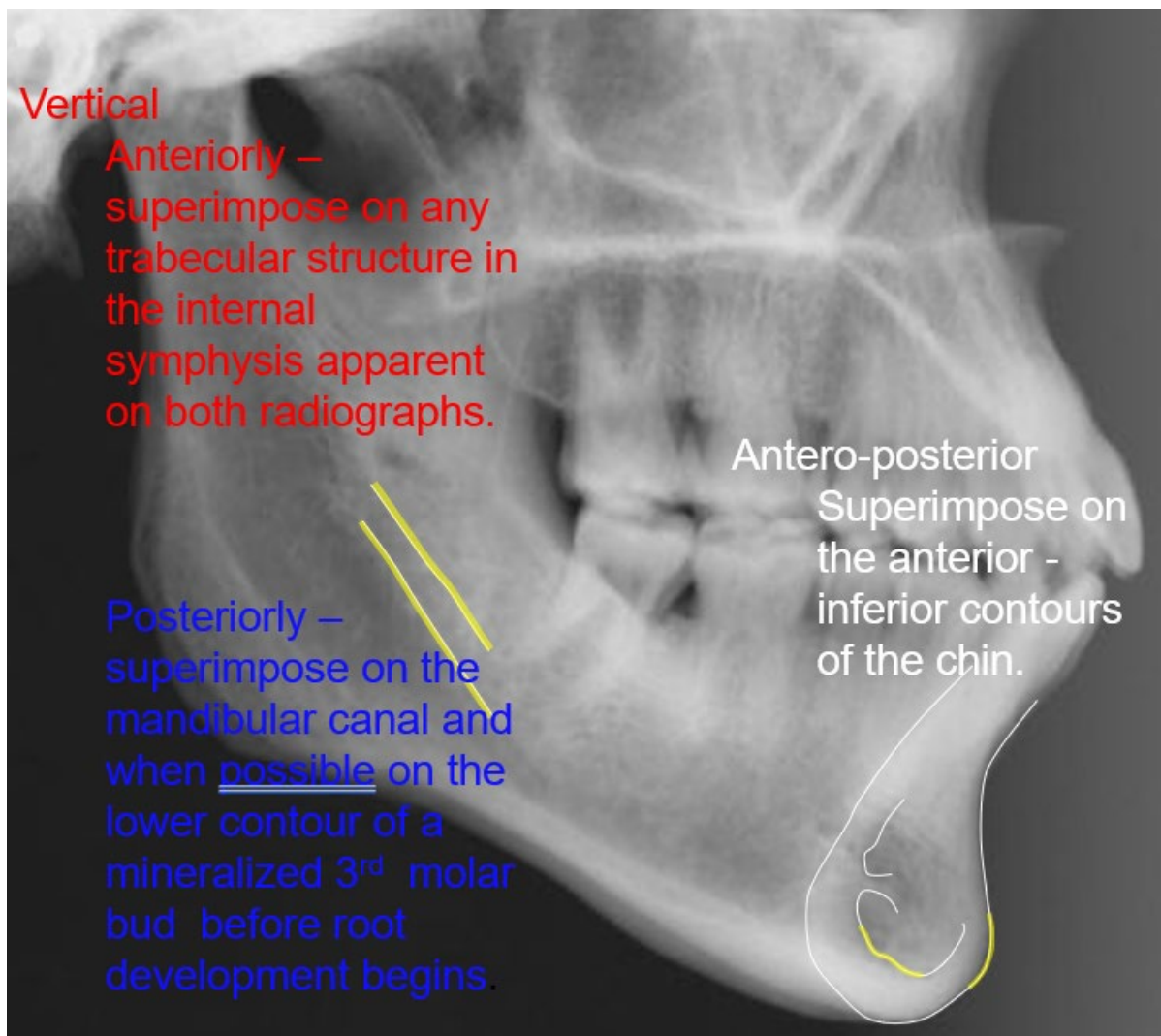
Anatomical Structures used for the Superimposition

1. The most anterior (inferior) portion of the symphysis.
2. The inferior, internal cortical plate of the symphyseal cross-section.
3. The inferior alveolar nerve canal.
4. When present, the inferior aspect of the 3rd molar tooth bud before root development.



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Mandibular Superimposition Reference



Tracing the Cranial Base

Trace across
neck of the
condyle to basion



Adjust

Enhance ☐ 50

Radius ☐ 16

Invert ☒

Brightness ☐ 0

Contrast ☐ 0

Saturation ☐ 0

Exposure ☐ 0

Gamma ☐ 41

Hue ☐

Revert

Transparency ☐

Then up the
clivus to...
the dorsum
sellae



Adjust Image



Transparency



Edit Privacy

00:33.99

posterior clinoid to
posterior, inferior &
anterior sella to...



Adjust

Enhance ☐ 50

Radius ☐ 16

Invert ☒

Brightness ☐ 0

Contrast ☐ 0

Saturation ☐ 0

Exposure ☐ 0

Gamma ☐ 41

Hue ☐

Revert

Transparency ☐

jugum
sphenoidale
to...



Adjust Image



Transparency



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00:45.47

jugum
sphenoidale
to...

the sphenoidal plane



Adjust Image



Transparency



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00:45.47

Cribiform
plate of the
ethmoid to...

Adjust

Enhance ☐ 50

Radius 16

Invert ☒

Brightness 0

Contrast 0

Saturation 0

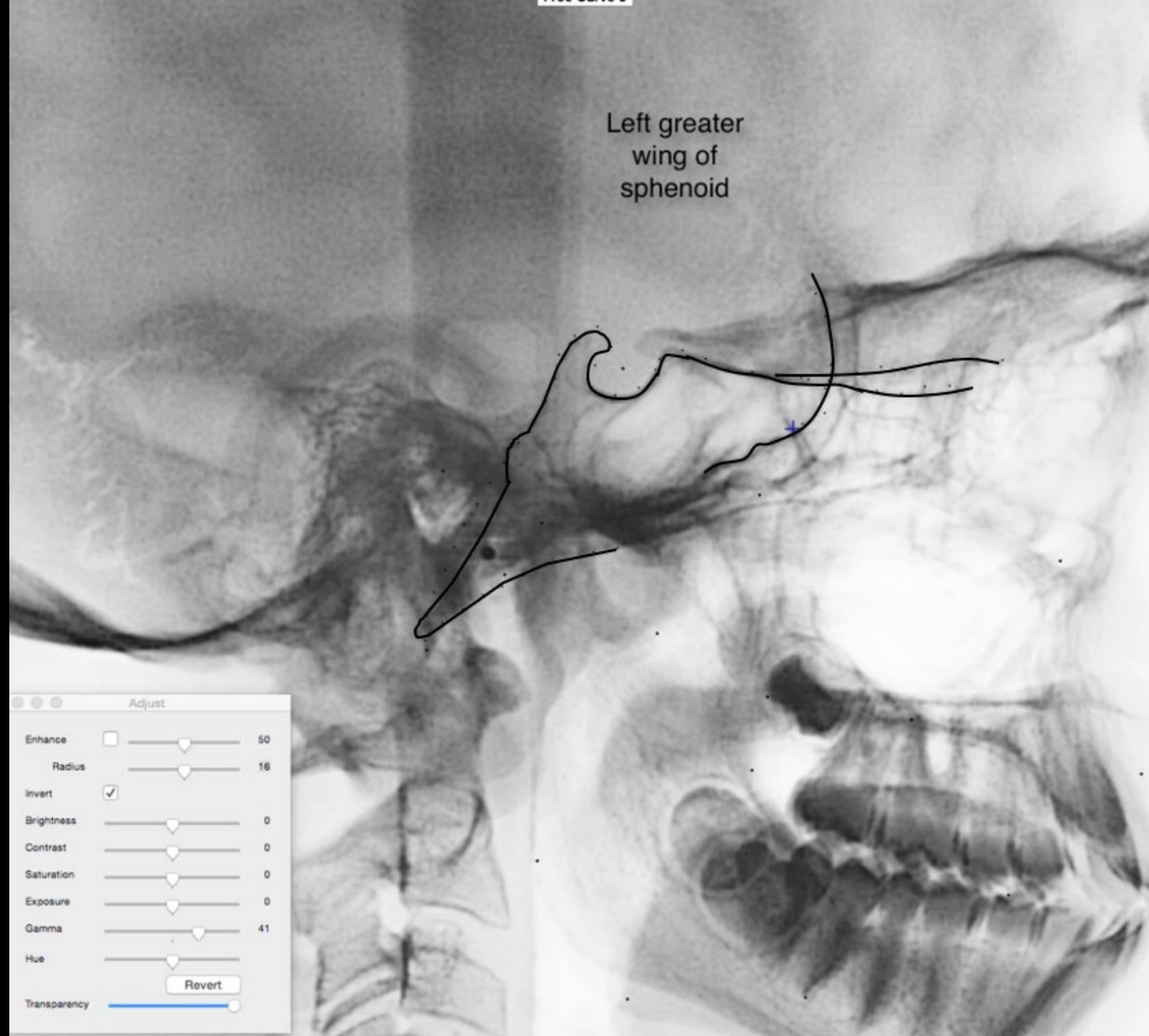
Exposure 0

Gamma 41

Hue

Revert

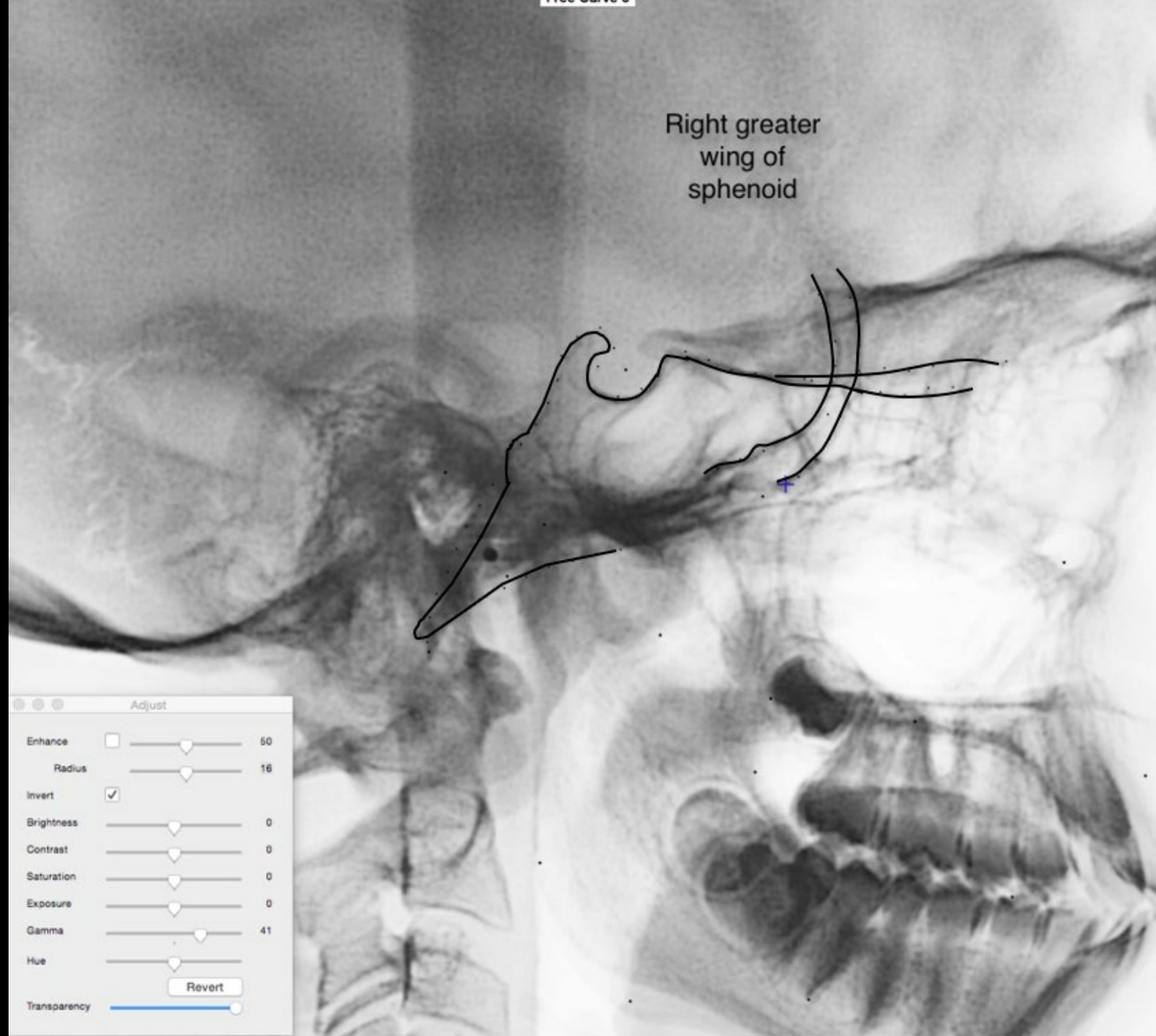
Transparency





Free Curve

Right greater
wing of
sphenoid



Adjust

Enhance	☐		50
Radius			16
Invert	☒		
Brightness			0
Contrast			0
Saturation			0
Exposure			0
Gamma			41
Hue			
Revert			
Transparency			



Free Curve

Anterior clinoid ->
floor of anterior
cranial fossa

Adjust

Enhance ☐ 50

Radius 16

Invert ☒

Brightness 0

Contrast 0

Saturation 0

Exposure 0

Gamma 41

Hue

Revert

Transparency



Adjust Image

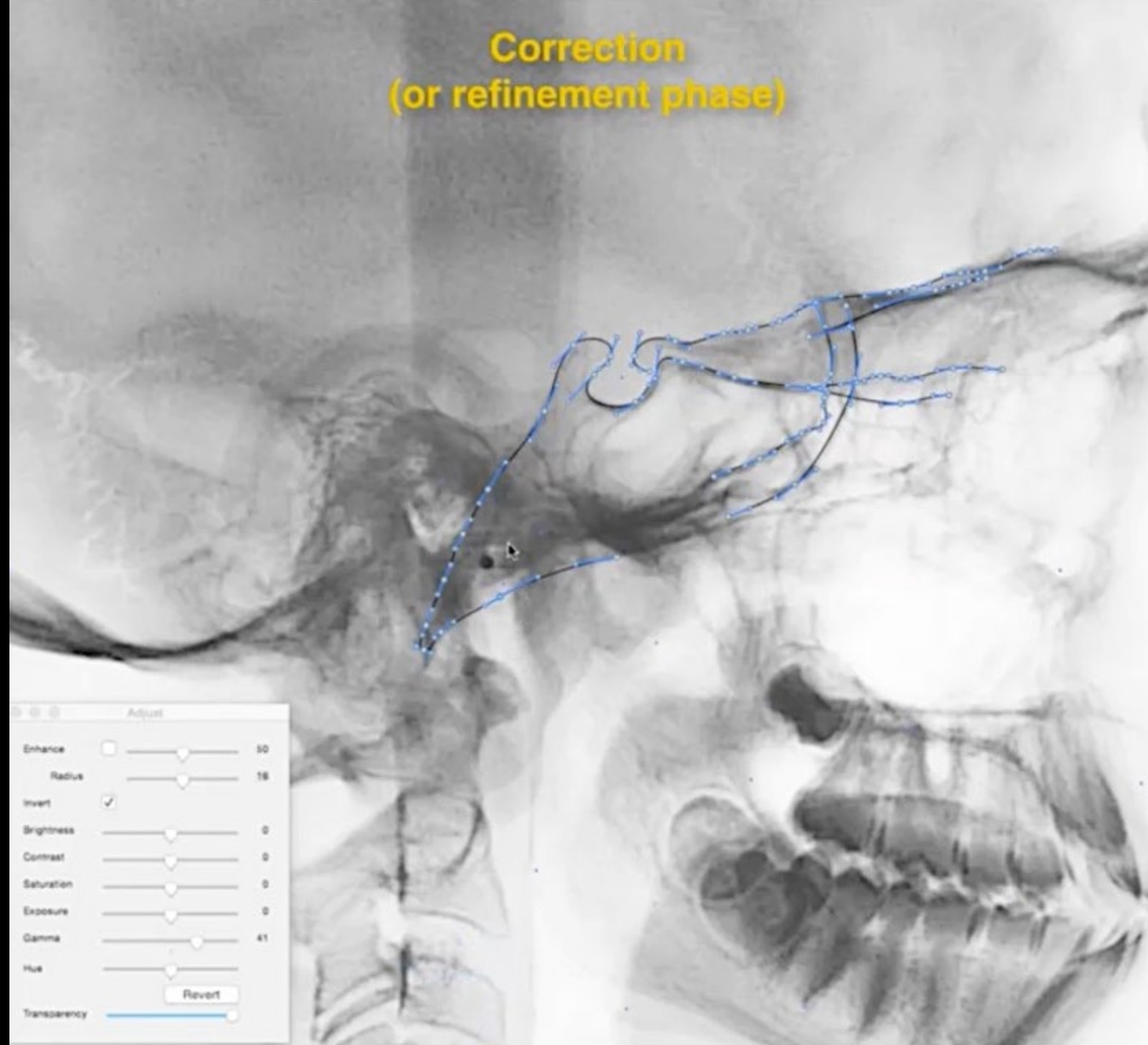


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Correction (or refinement phase)





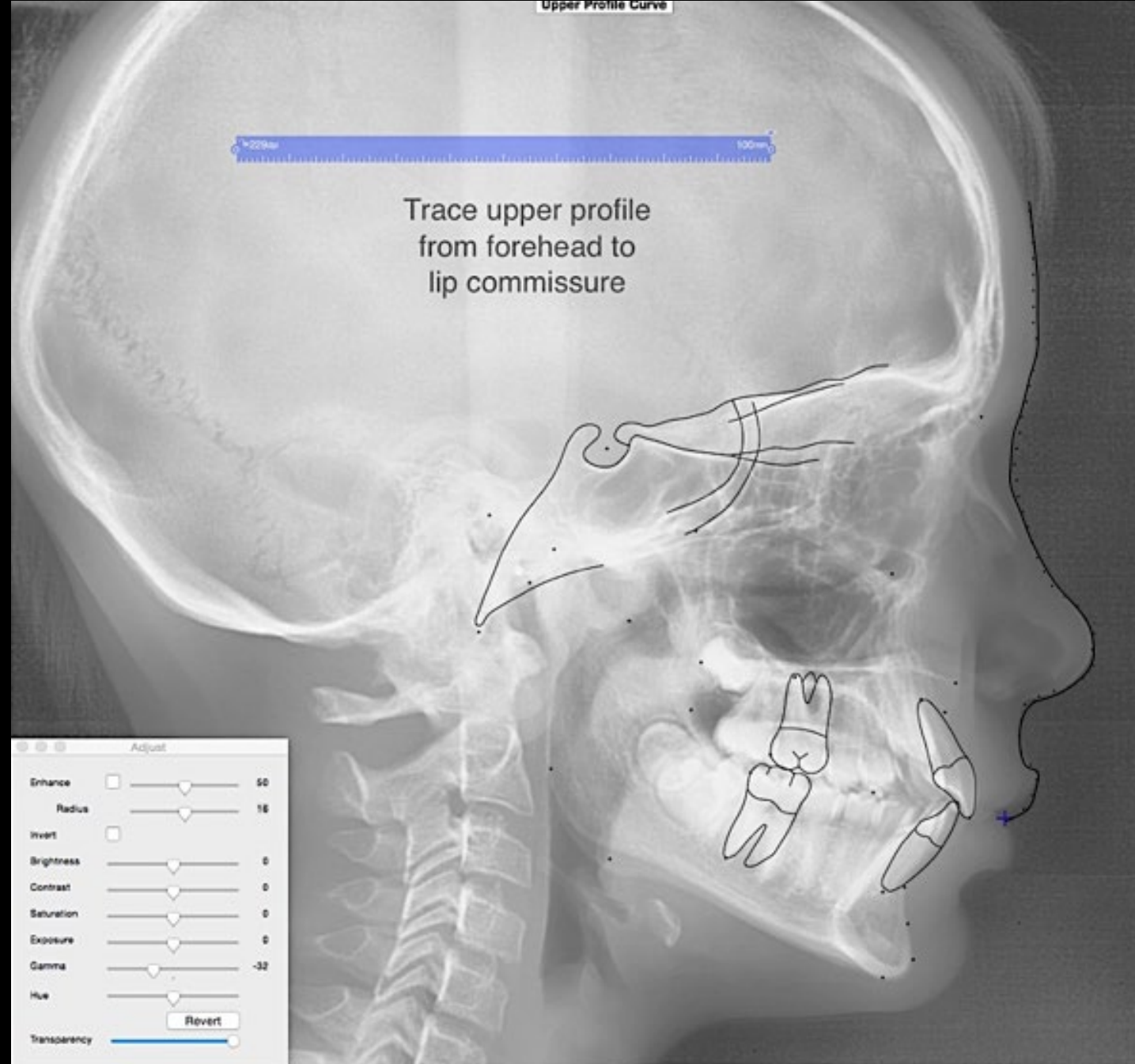
Tracing the:

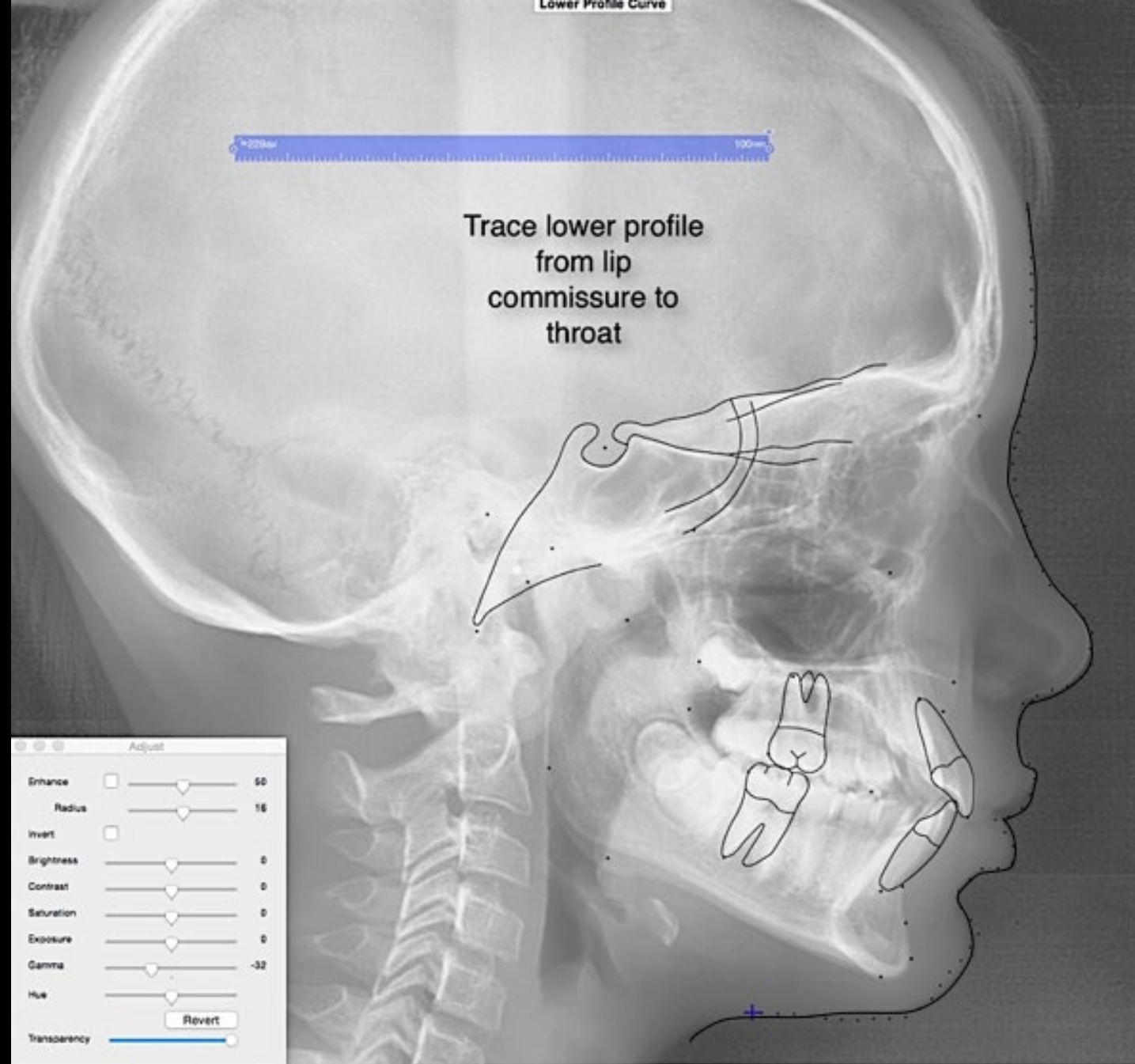
- Upper Profile
- Lower Profile
- Mandible
- Maxilla
- Key Ridges



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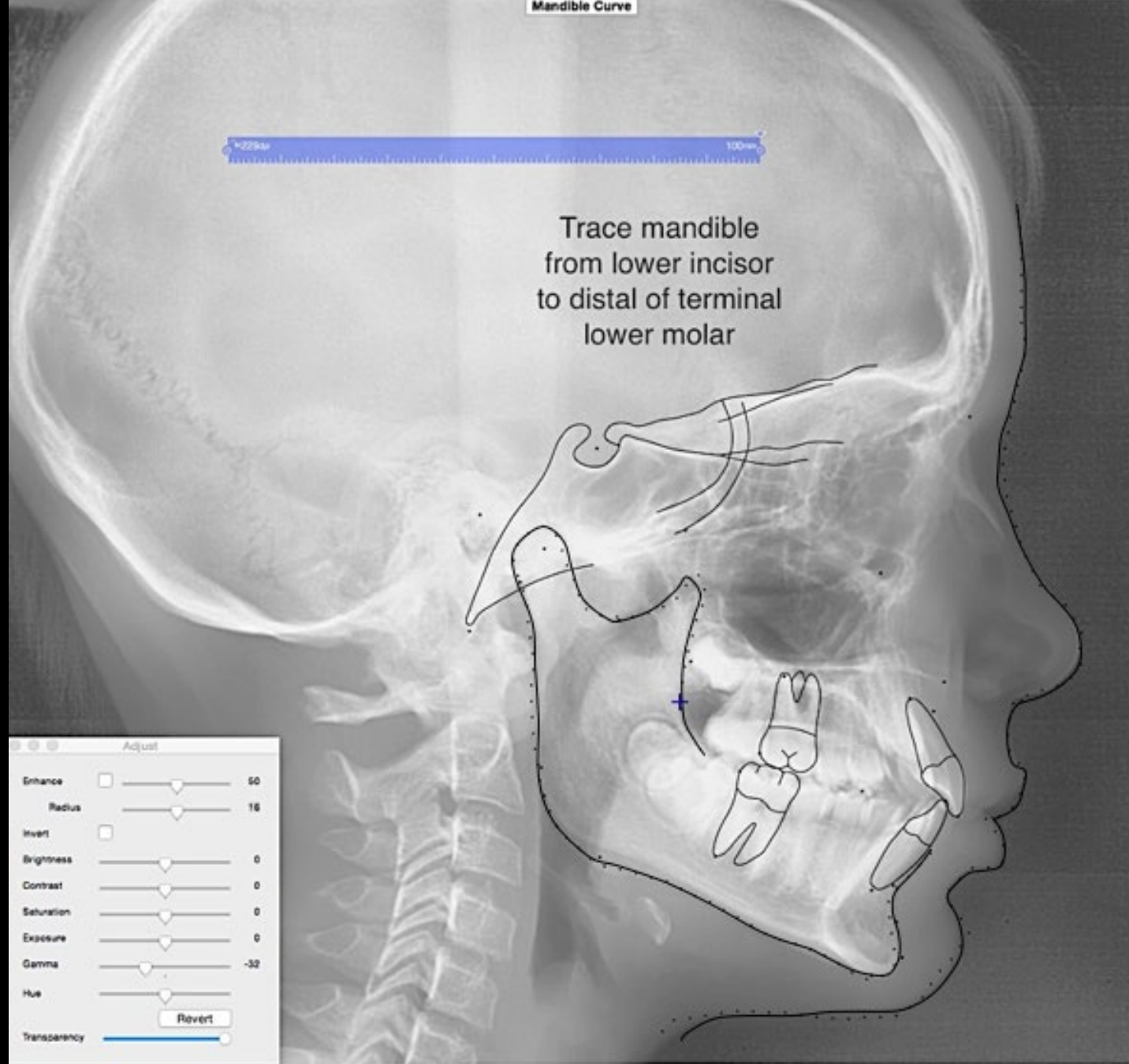


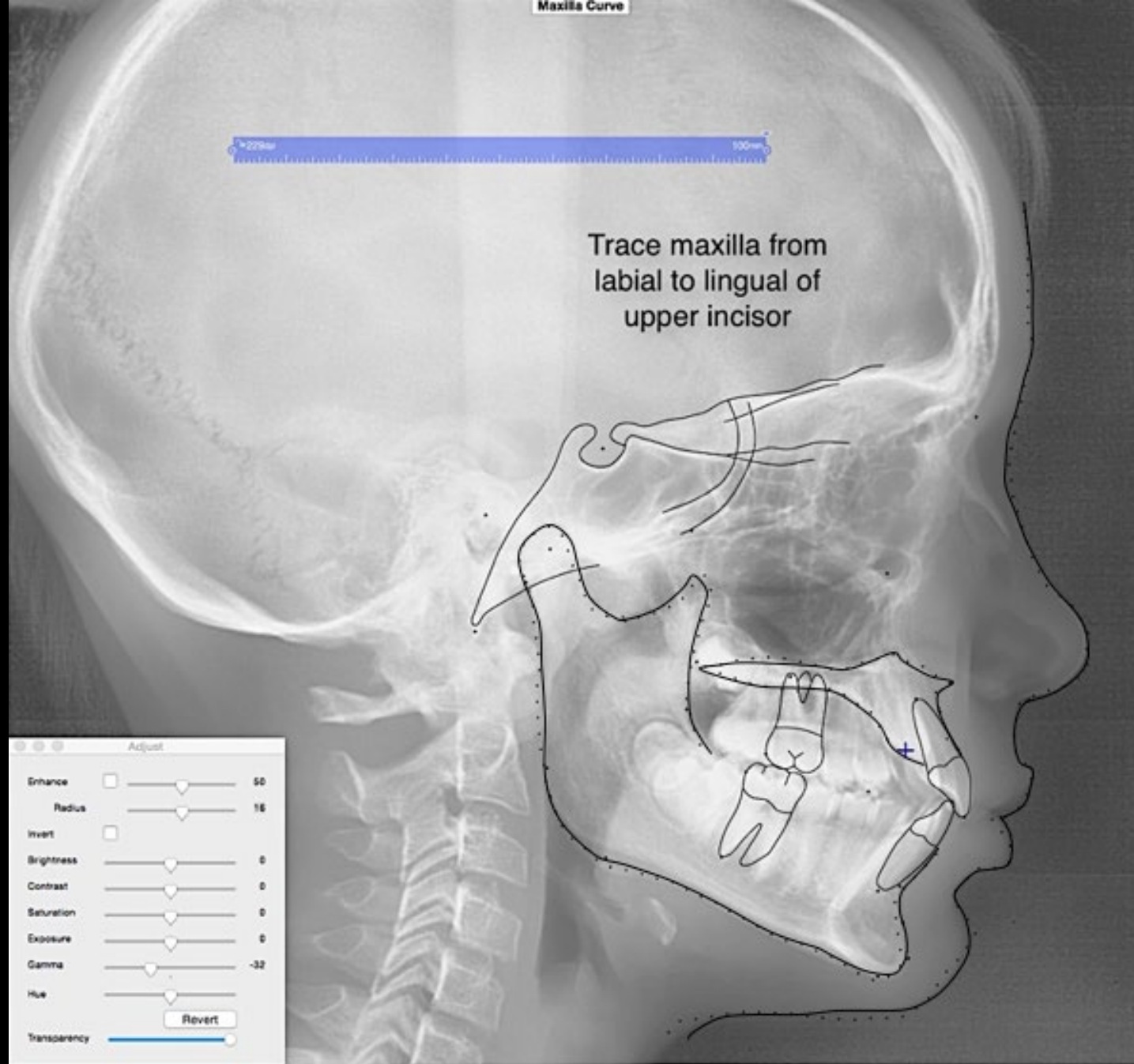
Trace lower profile
from lip
commissure to
throat

Adjust

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Radius		<input type="range"/>	16
Invert	☐		
Brightness		<input type="range"/>	0
Contrast		<input type="range"/>	0
Saturation		<input type="range"/>	0
Exposure		<input type="range"/>	0
Gamma		<input type="range"/>	-32
Hue		<input type="range"/>	
<button>Revert</button>			
Transparency		<input type="range"/>	







Adjust

Enhance	☐		50
Radius	☐		16
Invert	☐		
Brightness			0
Contrast			0
Saturation			0
Exposure			0
Gamma			-32
Hue			
Revert			
Transparency			



Outer Symphysis



Trace outer
symphysis

Adjust

Enhance	☐		50
Radius			16
Invert	☐		
Brightness			0
Contrast			0
Saturation			0
Exposure			0
Gamma			-32
Hue			
<button>Revert</button>			
Transparency			



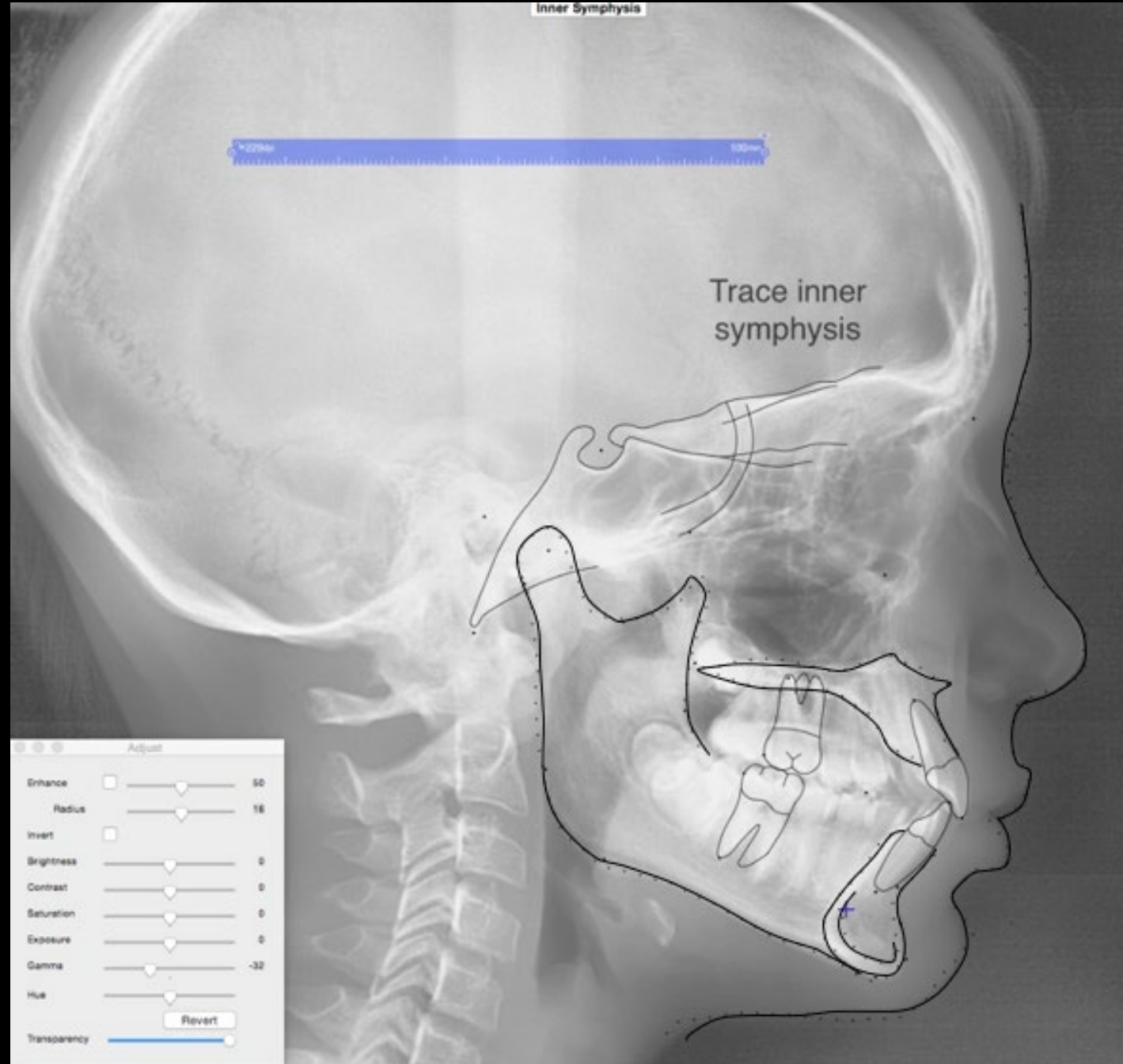
Adjust Image



Transparency



Edit Privacy Mask



Adjust

Enhance	☐		50
Radius			18
Invert	☐		
Brightness			0
Contrast			0
Saturation			0
Exposure			0
Gamma			-32
Hue			
Revert			
Transparency			



Adjust Image



Transparency



Edit Privacy Mask



Nerve Canal Lower



Trace upper
and lower
nerve canals

Adjust

Enhance	☐	<input type="range"/>	50
Radius		<input type="range"/>	16
Invert	☐		
Brightness		<input type="range"/>	0
Contrast		<input type="range"/>	0
Saturation		<input type="range"/>	0
Exposure		<input type="range"/>	0
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Transparency		<input type="range"/>	



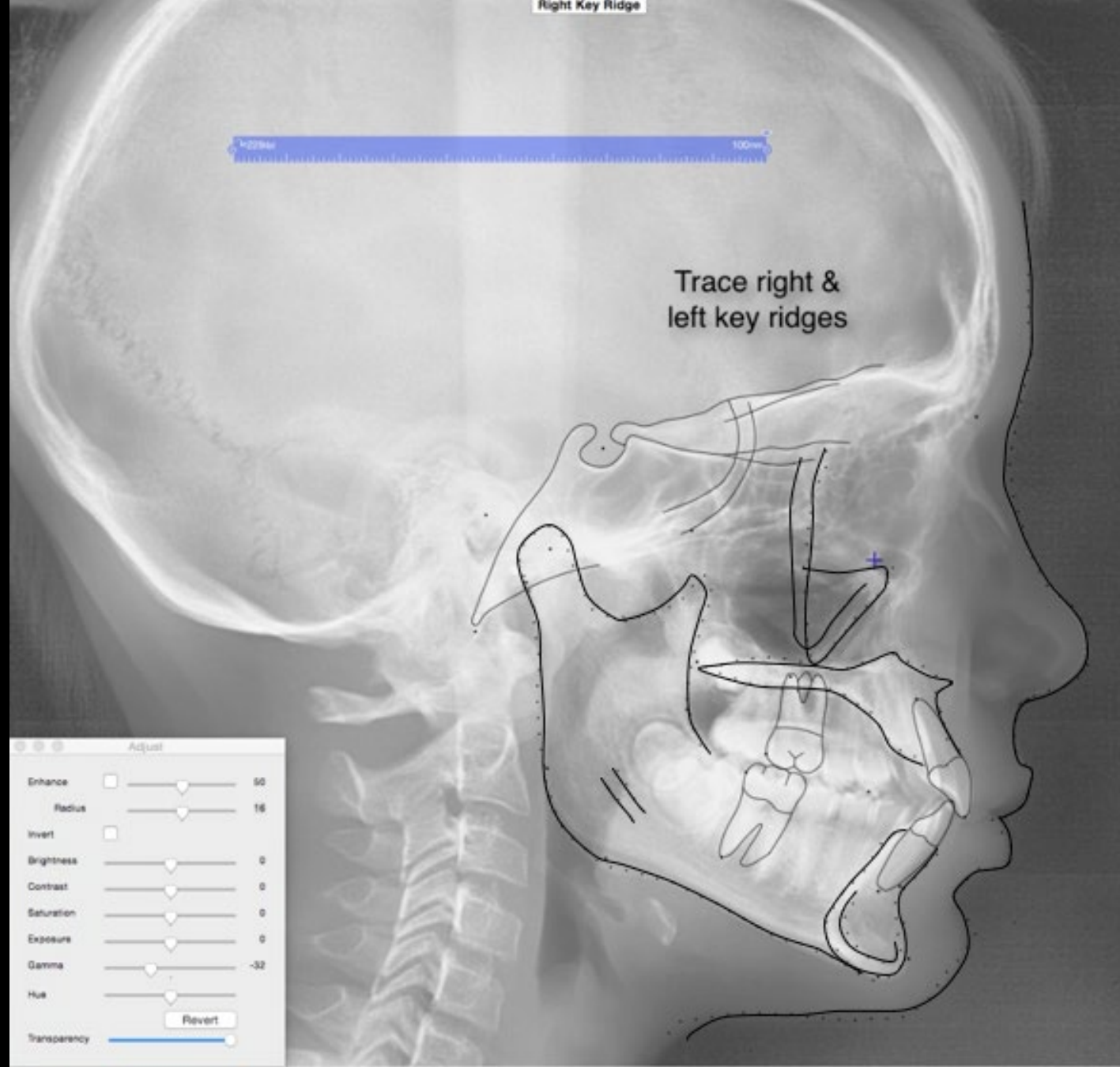
Adjust image



Transparency



Edit Privacy Mask



Adjust Image



Transparency



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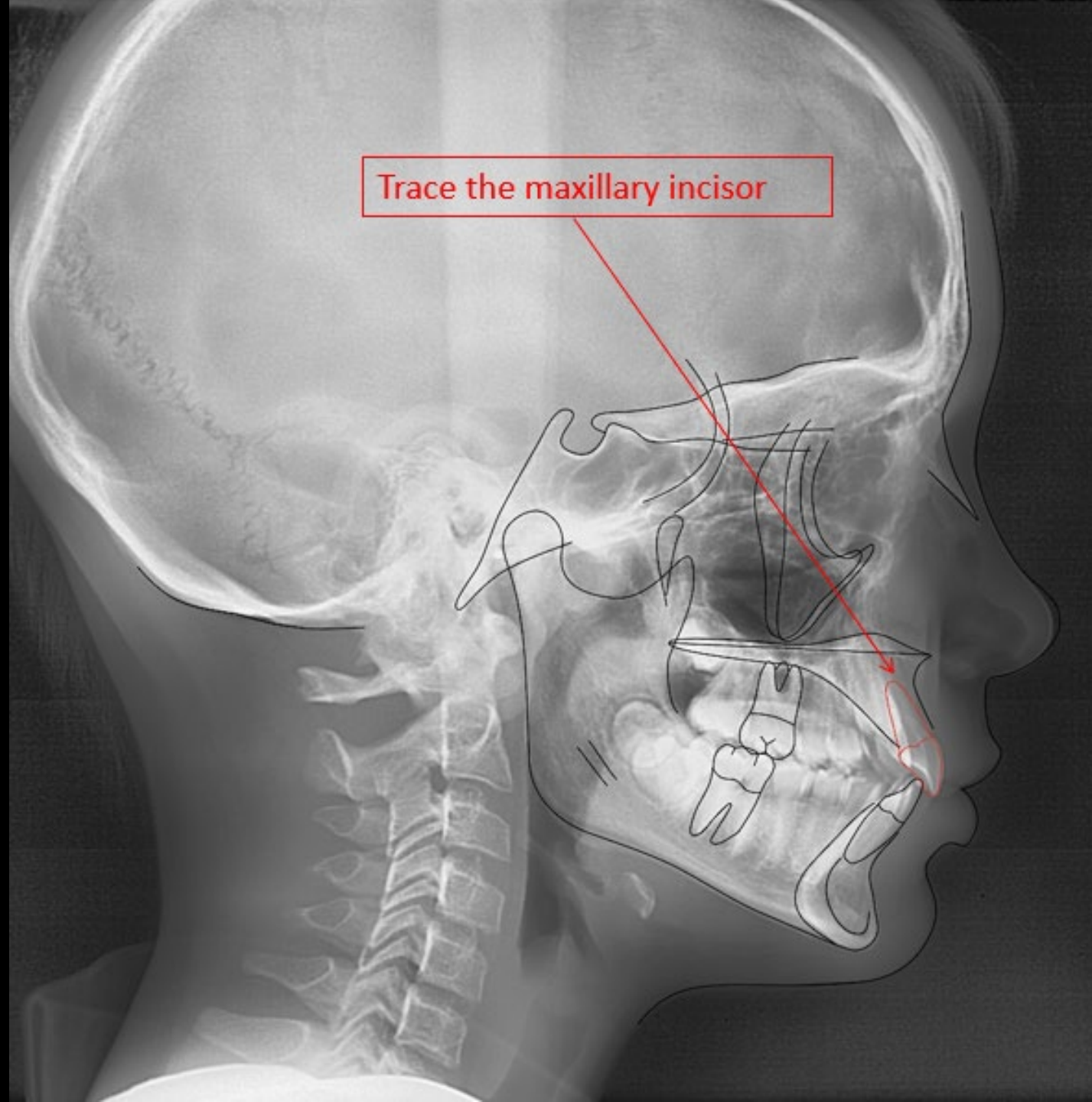


Tracing the:

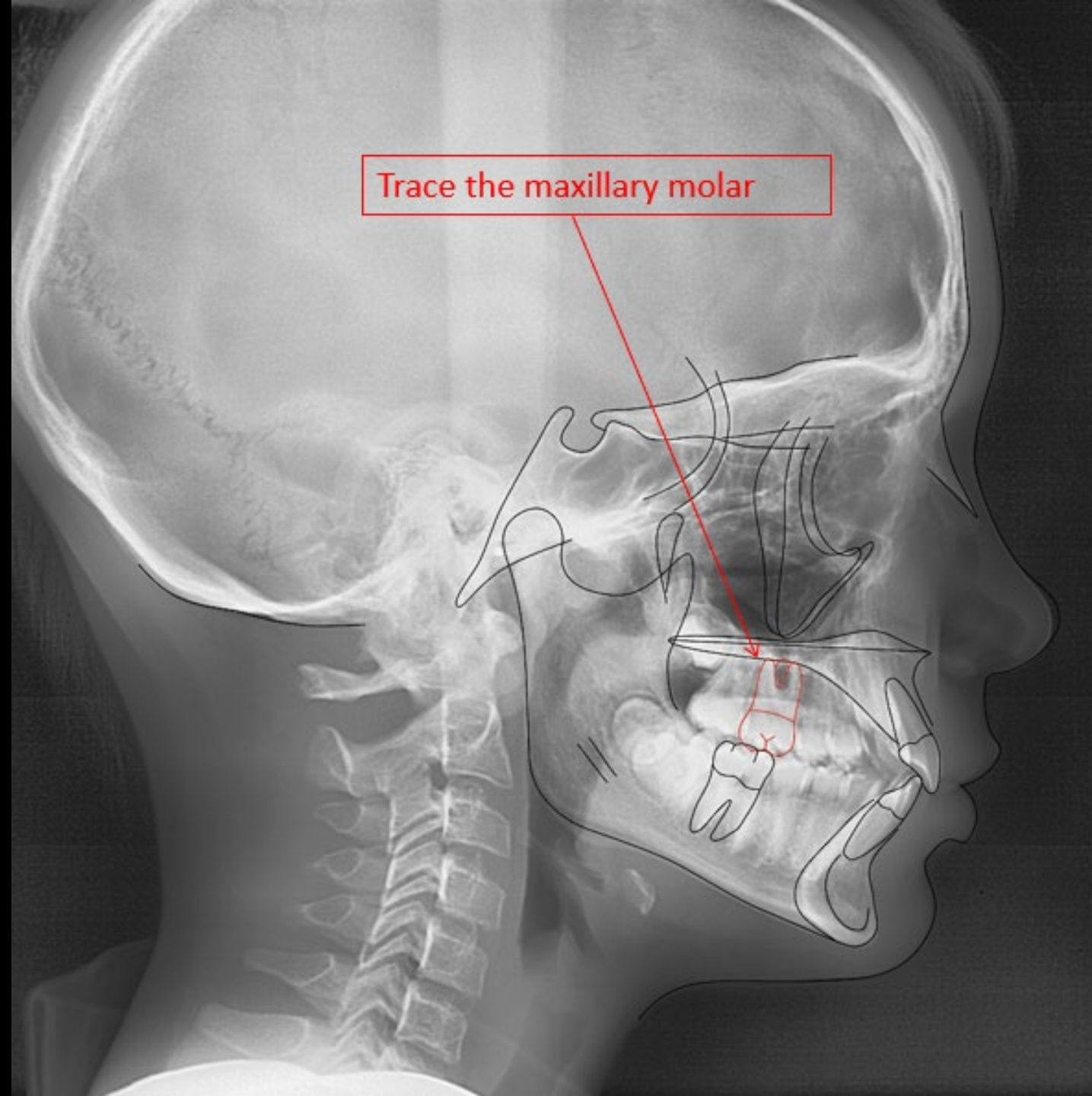
- Maxillary and Mandibular Incisors
- Maxillary and Mandibular Molars
- Frontal Bone
- Nasal Bone
- Occipital Bone



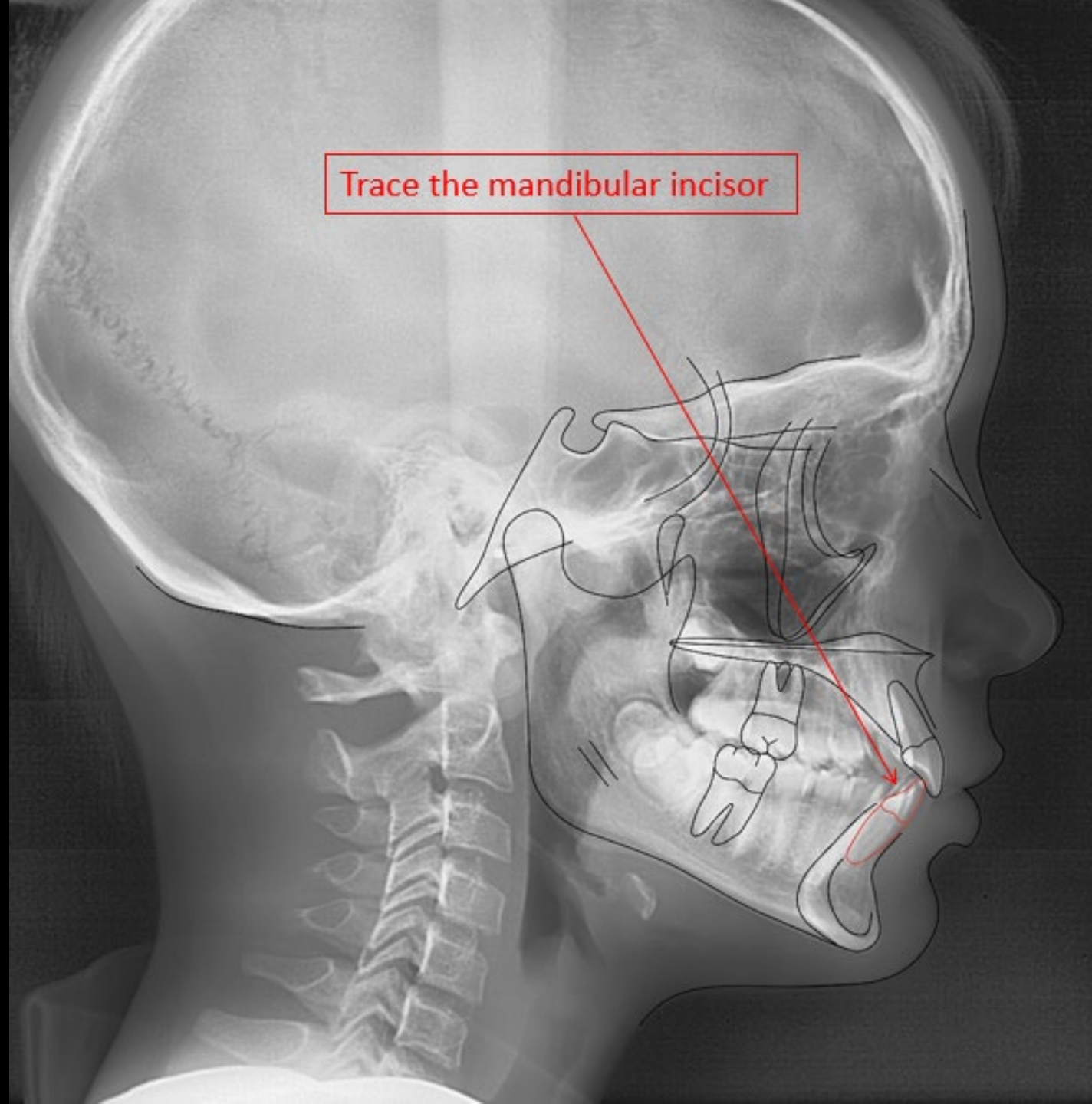
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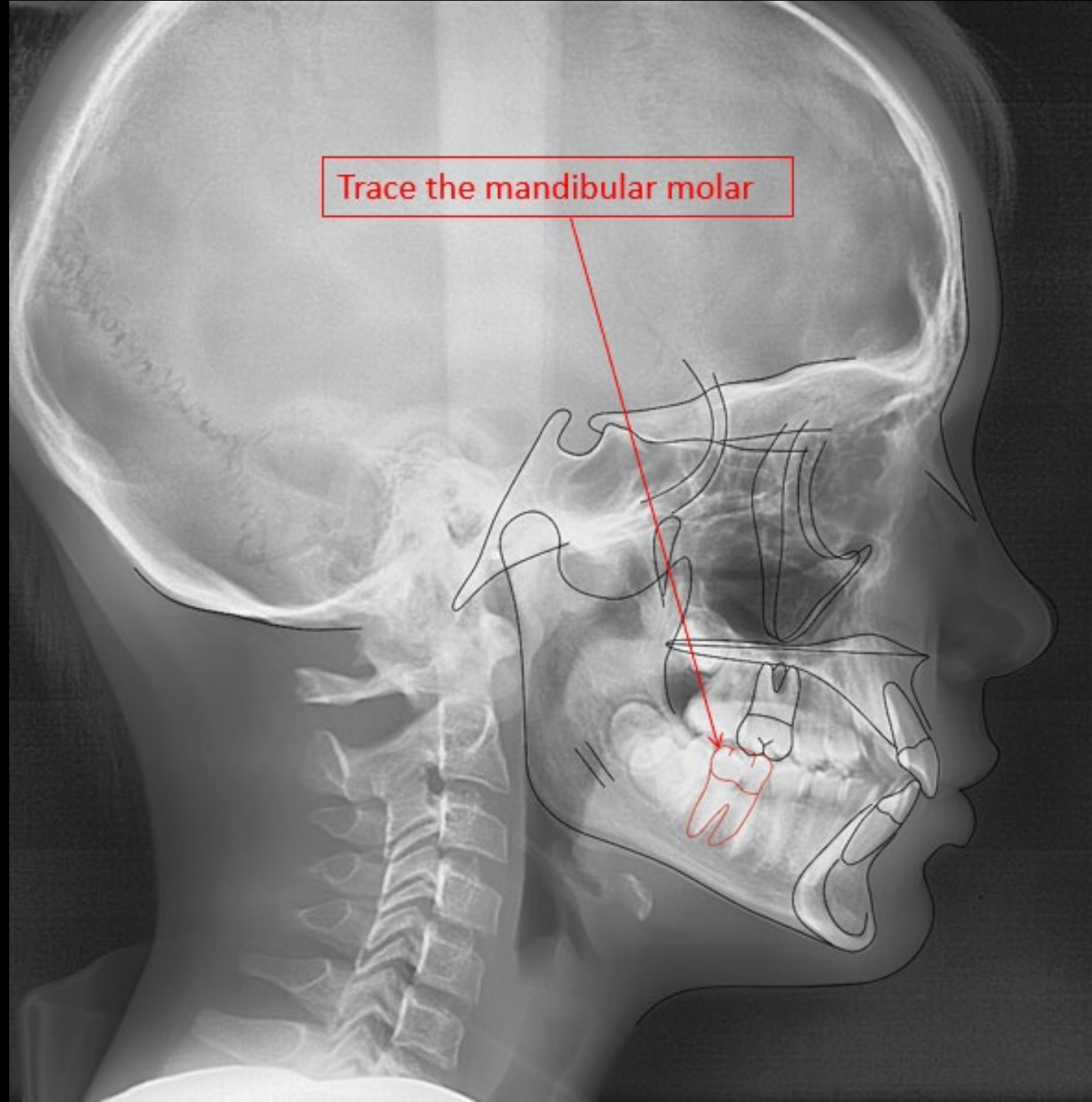
Trace the maxillary incisor

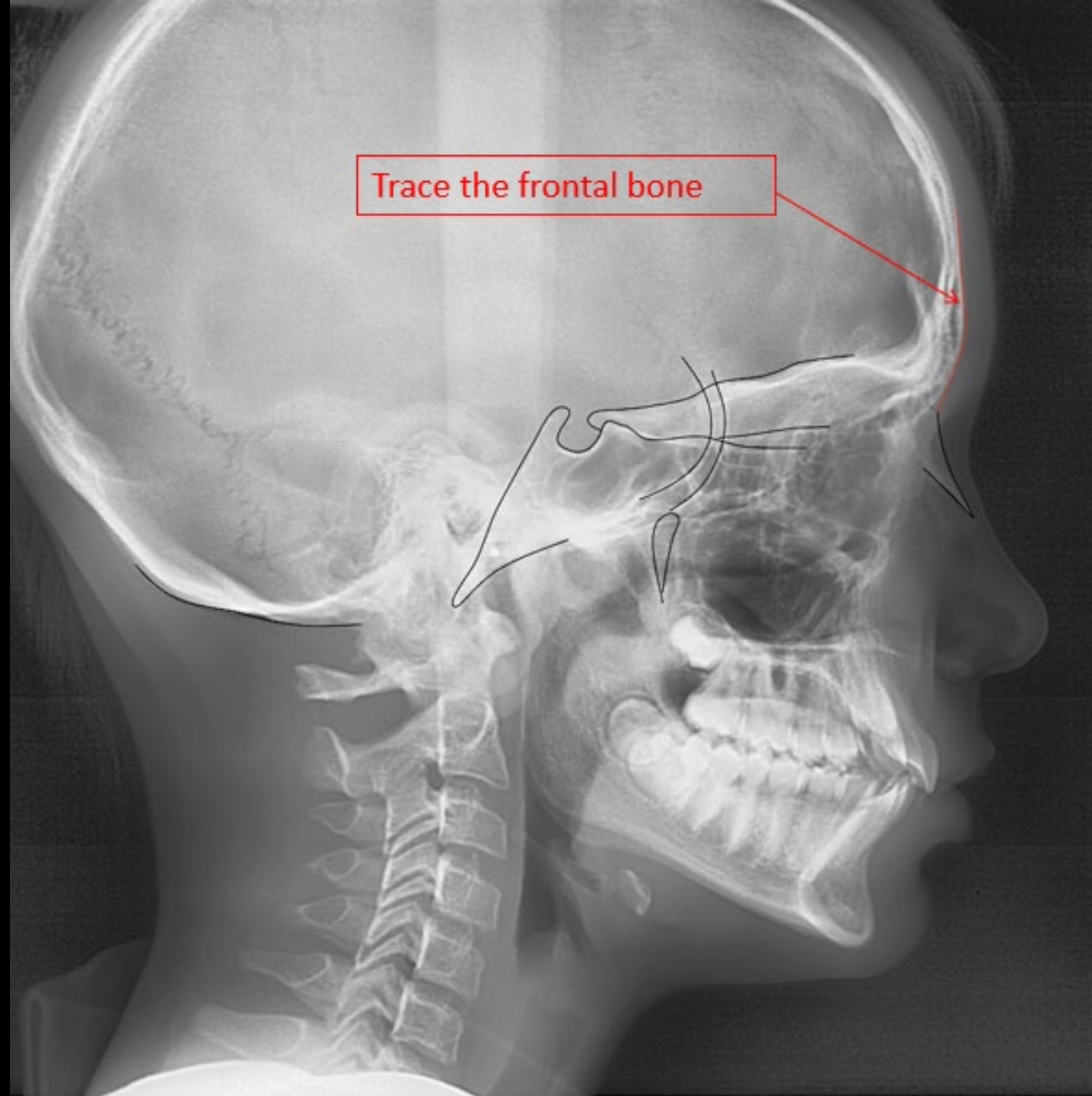


Trace the maxillary molar

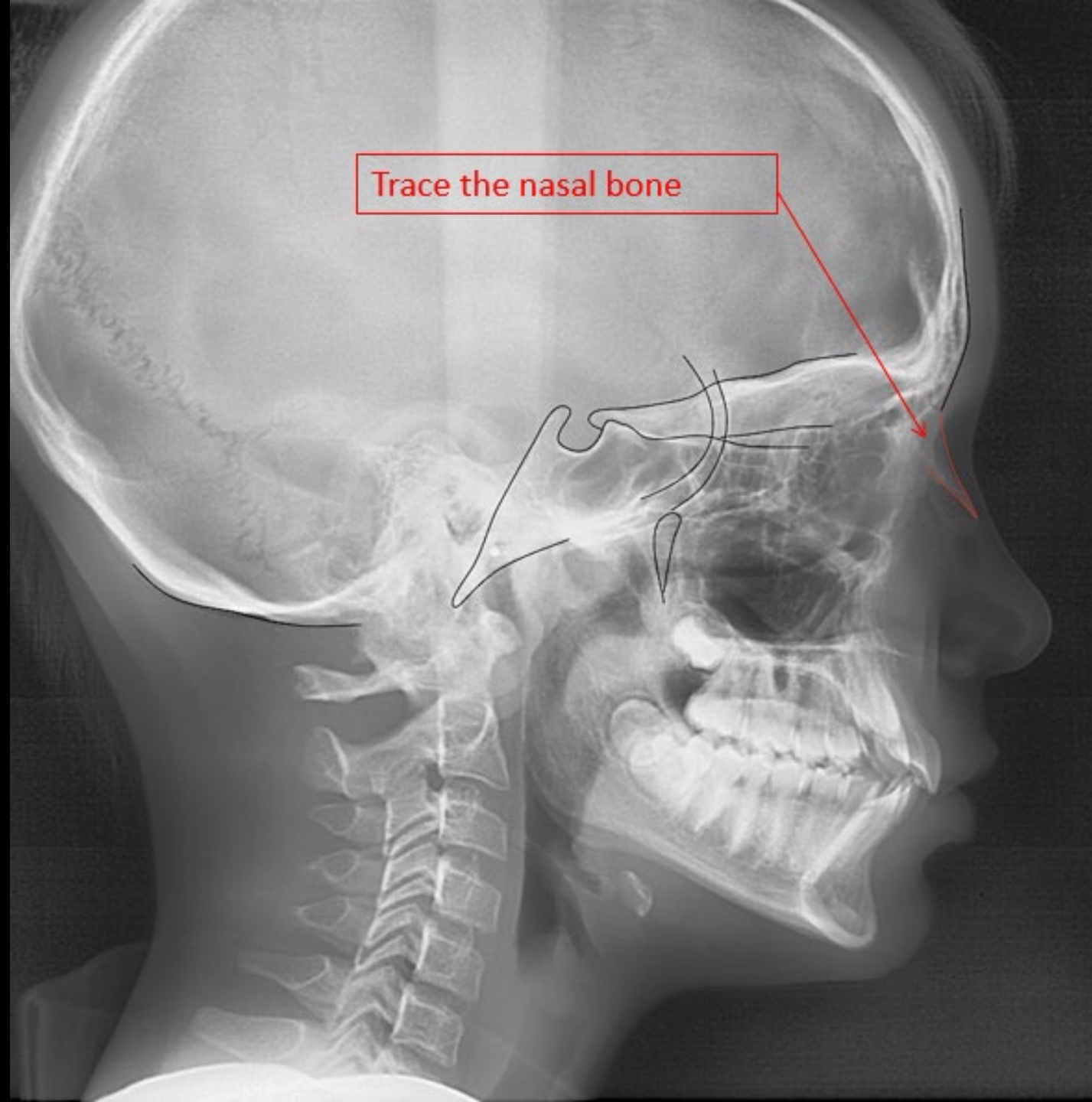


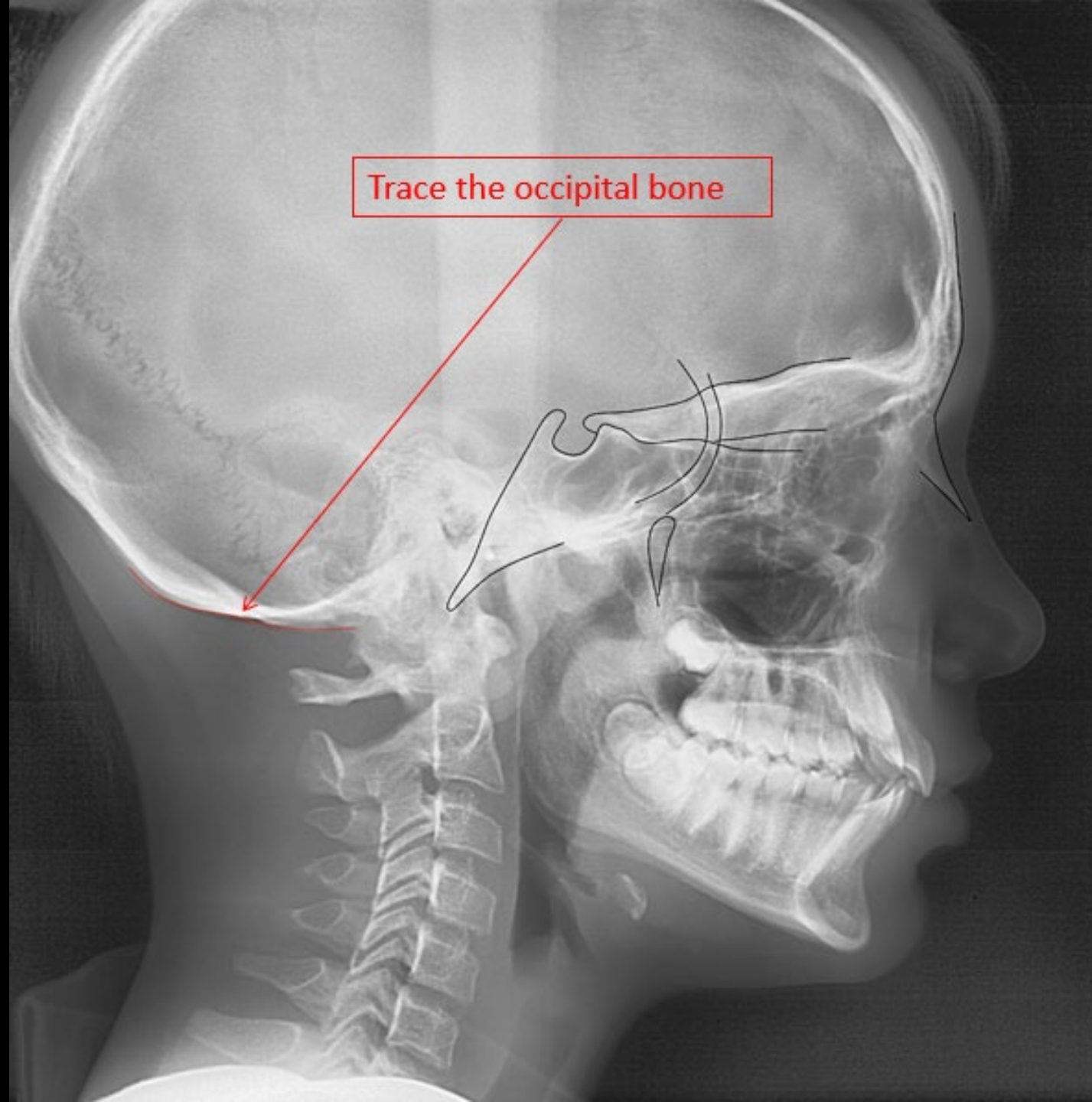
Trace the mandibular incisor





Trace the frontal bone





Tips & Tricks When Tracing with a Computer Program

- Adjust the line width of the computer-generated lines to 0.1mm (or 0.2mm at most).
- Trace the image line with greatest contrast.
- Best to trace the superior surfaces of sella.
- Best to trace the superior surfaces of:
 - Jugum sphenoidale
 - Cribiform plate of the ethmoid bone
 - Ethmoidal crest



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Tips & Tricks When Tracing with a Computer Program

- Be consistent in what and where you trace between cephs.
- Use gamma control for more accurate location of bone margins & profile.
- Have the 2nd or 3rd cephs available to help visualize each anatomical structure.



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Tips & Tricks When Tracing with a Computer Program

- Make sure the tooth templates are all the same size ***within an individual tracing and also between different tracings***, i.e.:
 - Don't have a small incisor and/or molar template for pretreatment and large ones for posttreatment or vice-versa.
 - Don't have a very small incisor and a very large molar or vice-versa within the same tracing.
 - If you can choose a tooth template size, use images from the best ceph for each template.

Tips & Tricks When Tracing with a Computer Program

- Learn the quickest way to make the tracing lines show or be hidden; toggle between the two frequently when correcting (“refining”).
- Learn the quickest way to zoom in and out, and use it frequently.
- Use the point of the cursor to place on an anatomical area, and then hide or show your tracing to see if it is accurately placed.
- Have 1st tracing on the ceph and in view when tracing the 2nd ceph.
- **DO NOT ACCEPT THE PRE-TRACED, PROGRAM GENERATED ANATOMICAL LINES AS ACCURATE; REFINE THESE AS NEEDED TO MEET THE ACCURACY REQUIREMENT.**



Superimpositions

Superimposition Videos are on the ABO
Website



Superimpositions are Done in the Following Order

- Overall craniofacial superimposition
- Maxillary regional superimposition
- Mandibular regional superimposition

How do you Superimpose Tracings?

For the cranial base superimposition, you need structures that do not change or grow over time. This allows you to assess the total changes, both tooth movements in the maxilla and mandible and the displacement of teeth due to jaw growth.

To determine the effect of growth, the orthodontist must subtract the tooth movements found in the maxillary and mandibular superimpositions from the total change found in the cranial base superimposition.



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Cranial Base Superimposition

1. Anterior wall of sella turcica below the anterior clinoid processes
2. Planum sphenoidal
3. Greater wings of the sphenoid
4. Cribiform plate
5. Ethmoidal crests
6. Cerebral surfaces of the orbital part of the frontal bone



Maxillary Regional Superimposition

- Reposition the Composite tracing so the Initial Maxillary Regional tracing is over the Maxillary area of the Final tracing.
- For the A-P orientation, place the anterior surface of the Zygomatic Arch tracings over one another.

Maxillary Regional Superimposition

- Reposition the Composite tracing so the Initial Maxillary Regional tracing is over the Maxillary area of the Final tracing.
- For the A-P orientation, place the anterior surface of the Zygomatic Arch tracings over one another.
- In the vertical plane, move the Initial tracing up & down so the inferior border

Maxillary Regional Superimposition

- The Final tracing of the floor of the nose/palatal plane should be slightly inferior to the tracing of the initial floor of the nose/palatal plane.



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Maxillary Regional Superimposition

- The Final tracing of the floor of the nose/palatal plane should be slightly inferior to the tracing of the initial floor of the nose/palatal plane.
- The orbital floor of the Final tracing should show vertical apposition in the ratio of 3/5 compared to 2/5 for resorption at the floor of the nose.



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Mandibular Regional Superimposition

- Reposition the Composite tracing so the Initial Mandibular Regional tracing is over the mandibular area of the Final tracing.

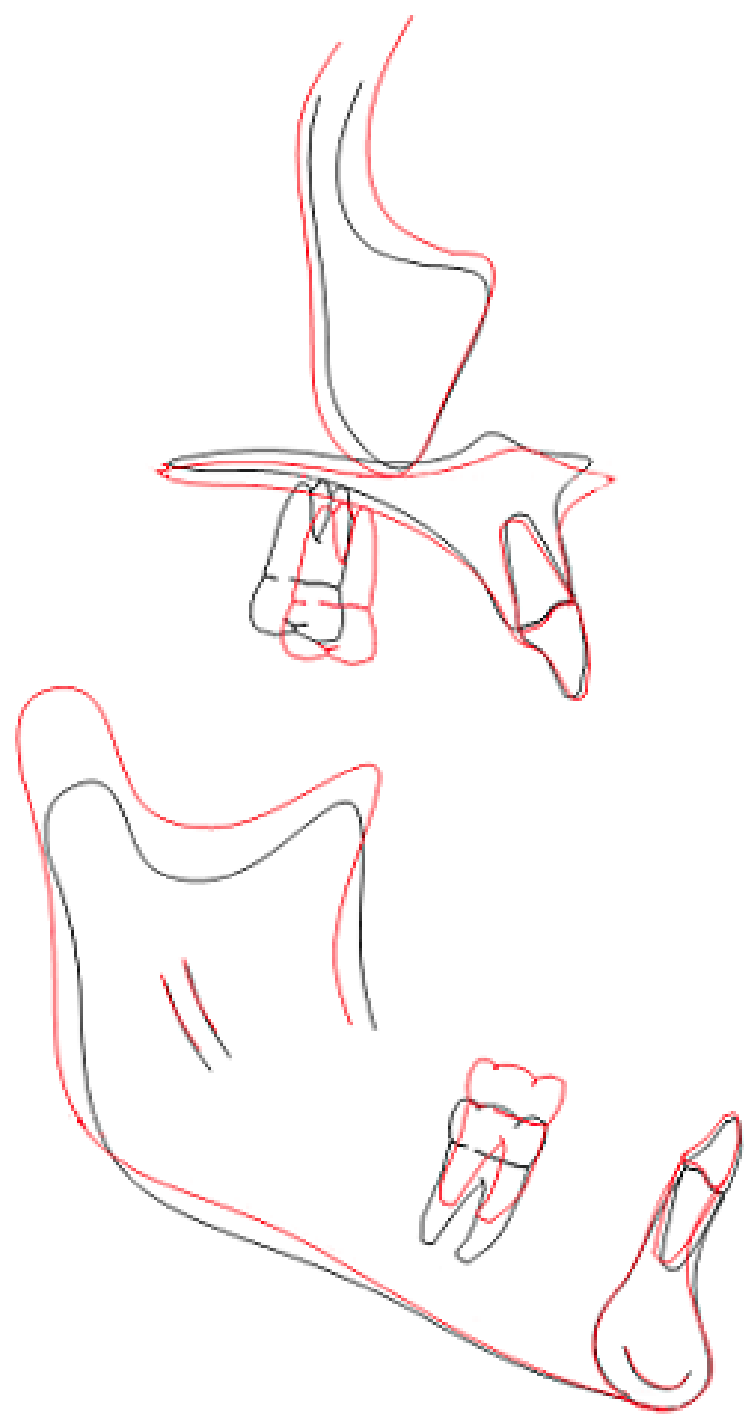
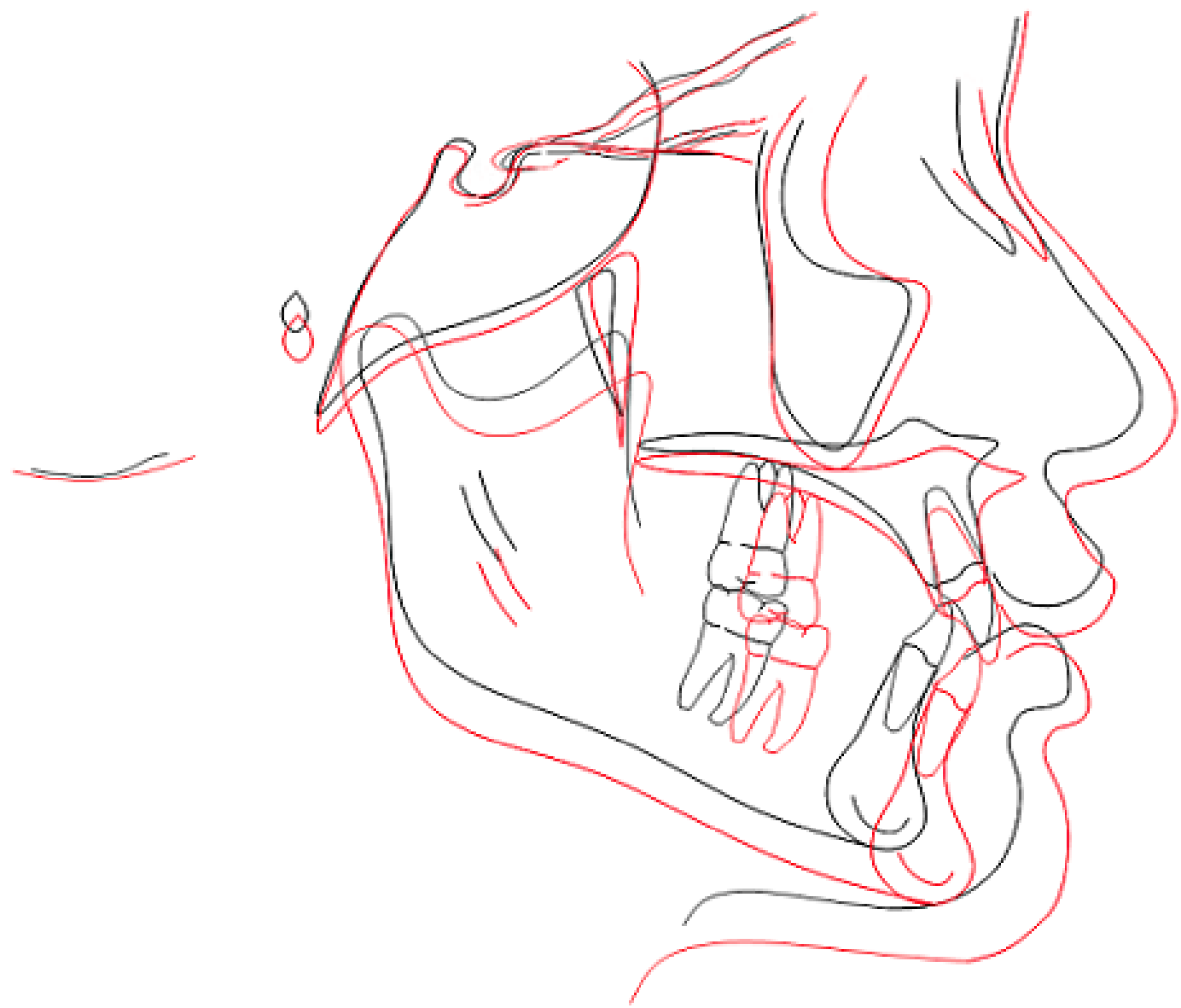


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Mandibular Regional Superimposition

- Reposition the Composite tracing so the Initial Mandibular Regional tracing is over the mandibular area of the Final tracing.
- Use the internal x-sectional features of the symphysis and the inferior alveolar nerve canal tracing. Go back and forth between the 2 areas until the best superimposition of each is obtained.



Common Cephalometric Errors

- Image quality
- Accuracy of tracing
- Not following ABO guidelines
- Head positioning
- Software constraints



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A-2 Head Position





A-2 Head Position

- Significant errors occurs in the position of landmarks lateral to the sagittal plane by varying the head position.
- Damon DH. A Clinical Study of Extraoral High pull Traction to the Maxilla Utilizing a Heavy Force: A Cephalometric Analysis of Dentofacial Changes. (Thesis.) Seattle: University of Washington, 1970.
- Masumoto GT. An Analysis of the Use of the Metallic Implant Method in Superimpositioning of the Maxilla. (Thesis.) Seattle: University of Washington, 1970.

A-2 Head Position

- Patients can rotate their heads as much as 3° and tip their heads 5° even though positioned firmly in the cephalostat.
- Julius RB. A Serial Cephalometric Study of the Metallic Implant Technique and Methods of Maxillary and Mandibular Superimposition. (Thesis.) Seattle: University of Washington. 1971.

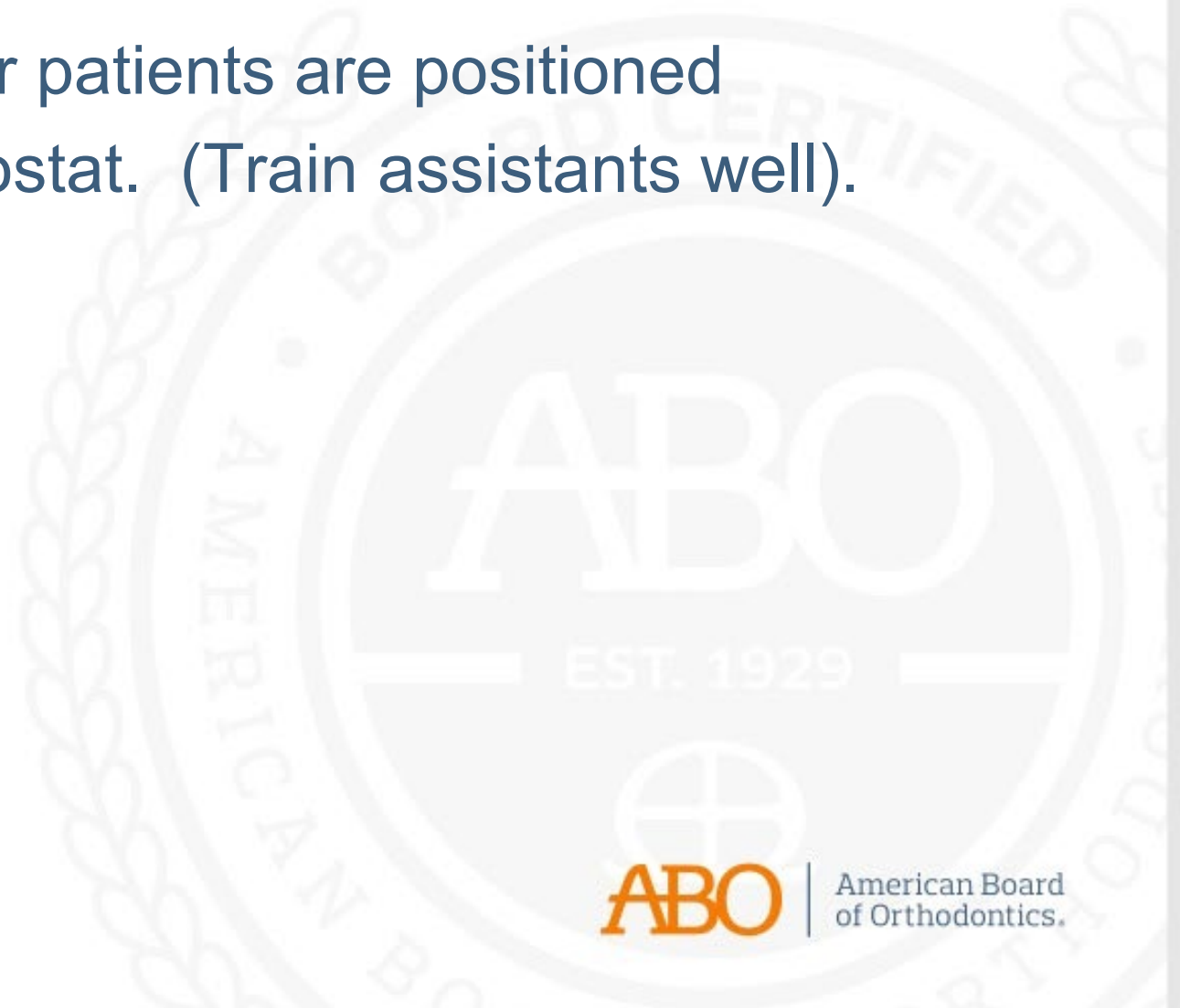
A-2 Head Position

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- Julius RB. A Serial Cephalometric Study of the Metallic Implant Technique and Methods of Maxillary and Mandibular Superimposition. (Thesis.) Seattle: University of Washington. 1971.
- These head position problems introduce the potential for error in the superimposition tracings.



A-2 Head Position

- Therefore, make sure your patients are positioned consistently in the cephalostat. (Train assistants well).



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A-2 Head Position

- Therefore, make sure your patients are positioned consistently in the cephalostat. (Train assistants well).
- With CBCT originated 2D lateral cephalograms, make sure that you attempt to position the head on the screen and obtain the best sagittal cut as you can. You have to exercise good judgement in the orientation of the image.

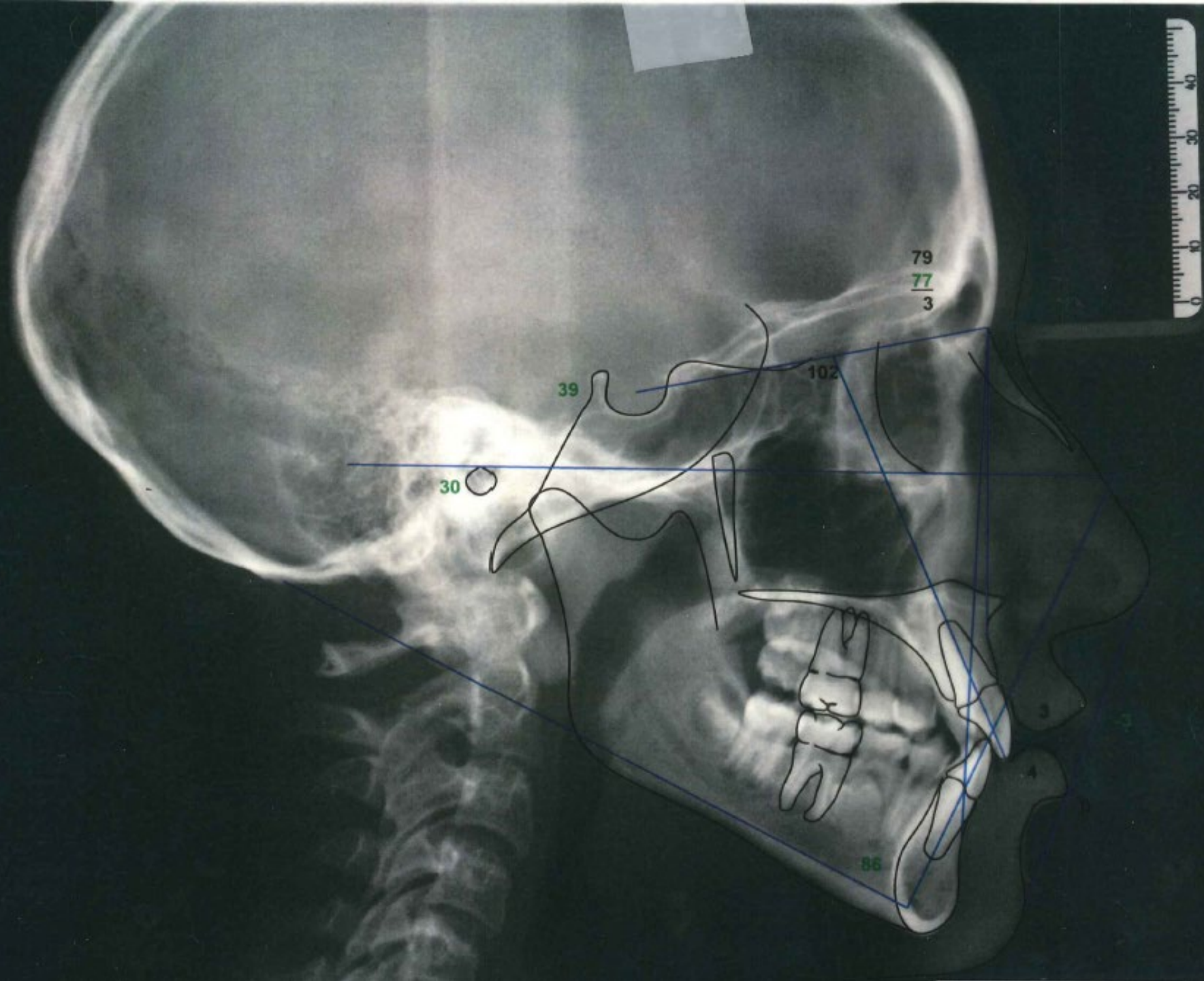


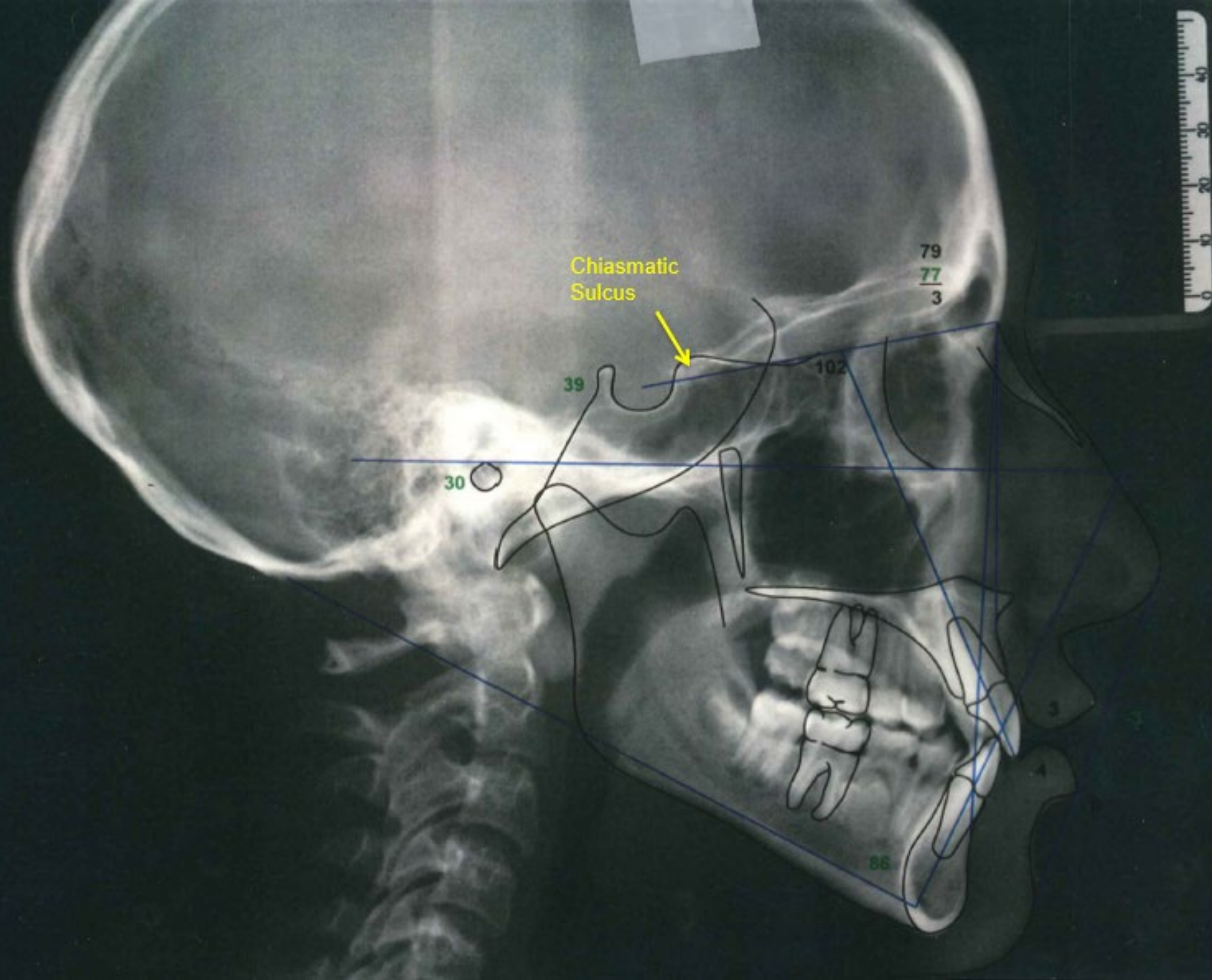
Typical Tracing Errors and Omissions

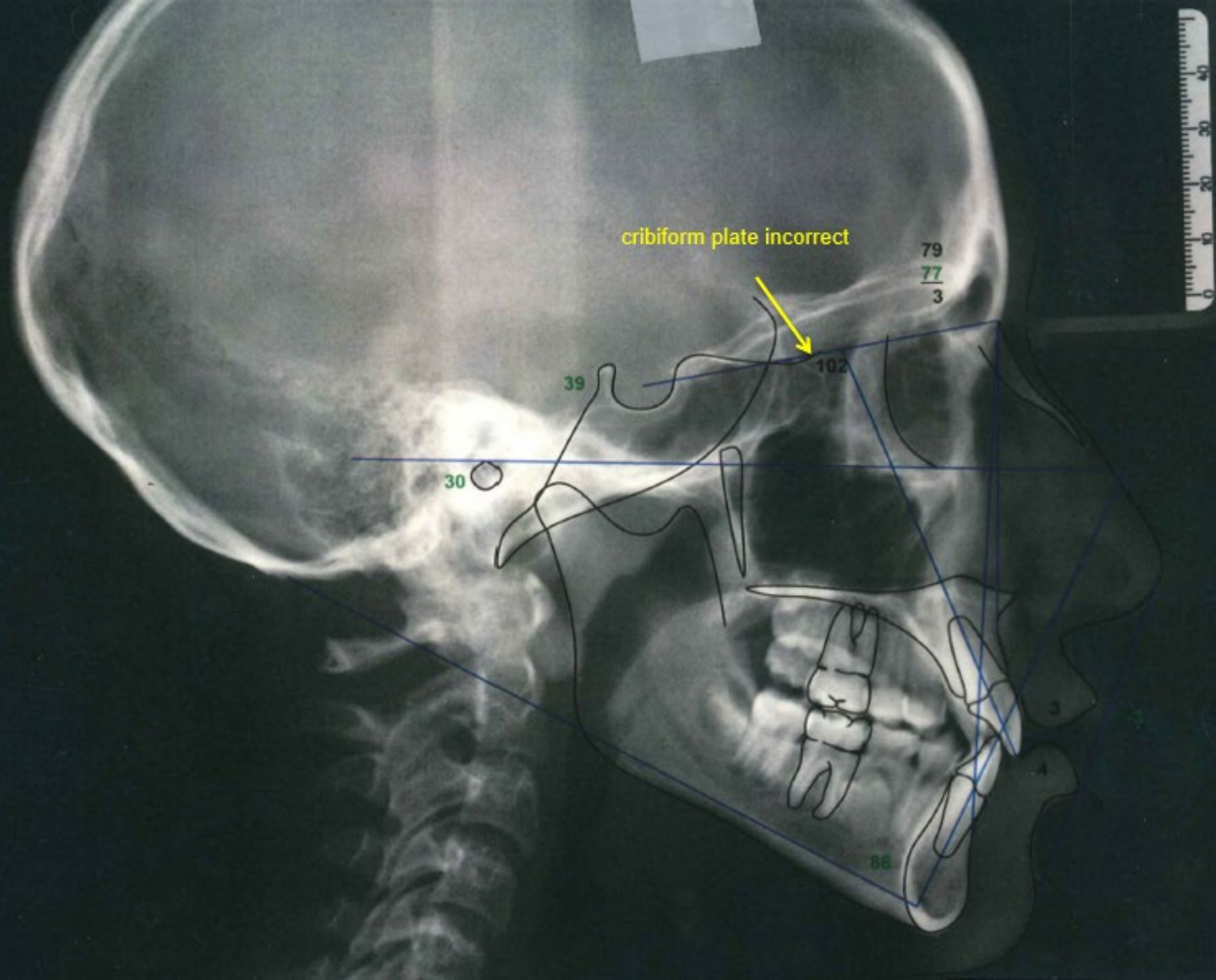
How many can you identify on the following tracing?

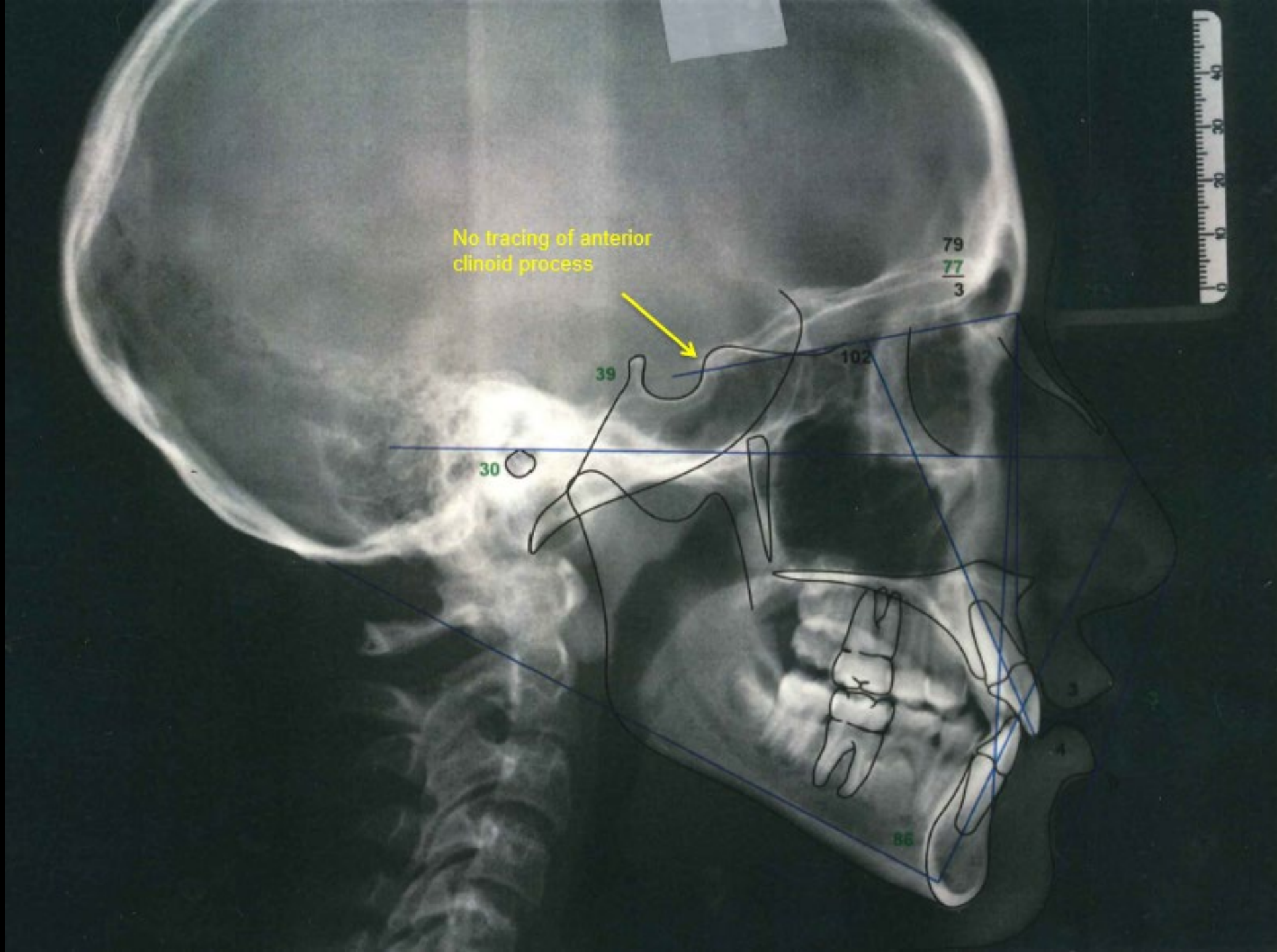


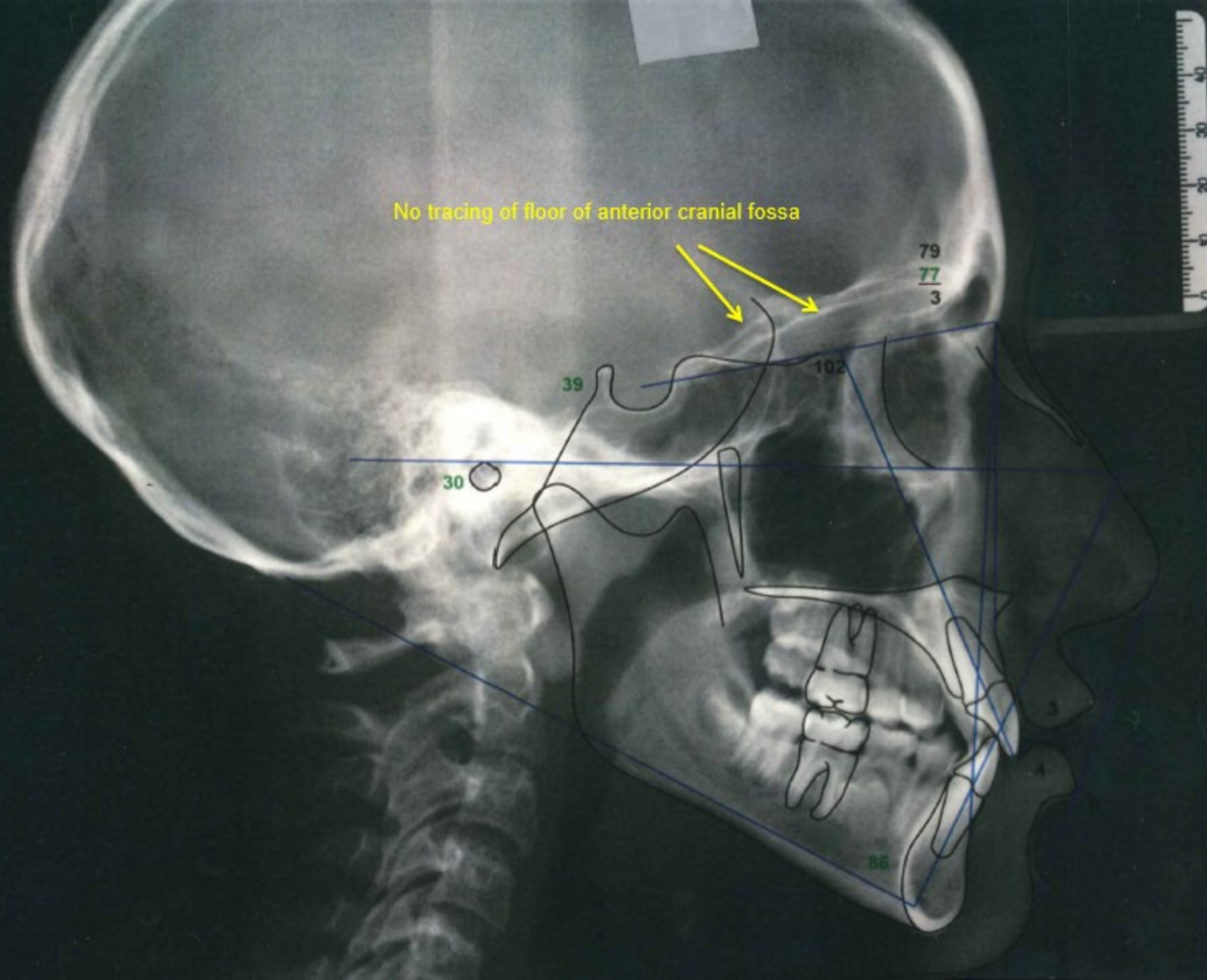
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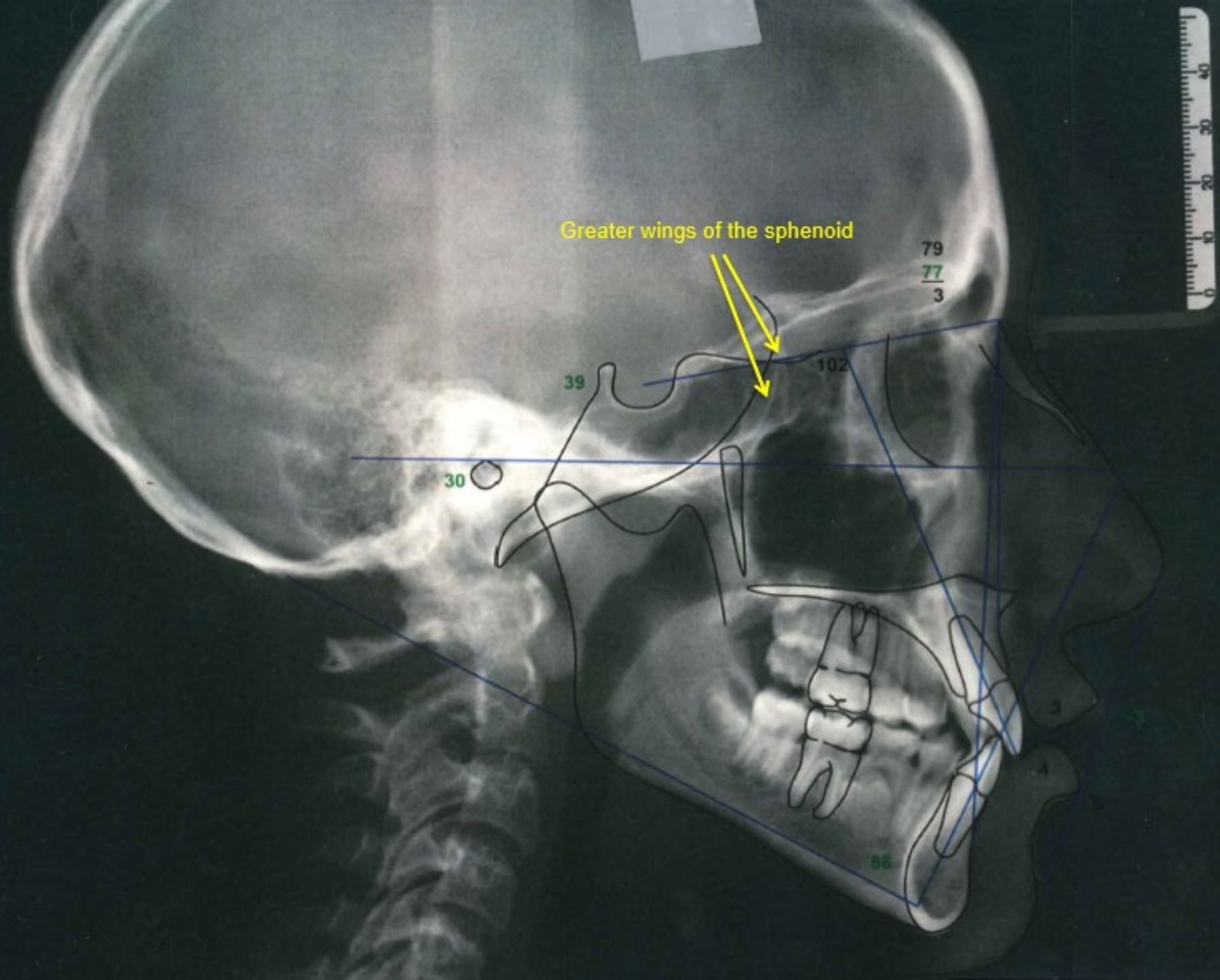


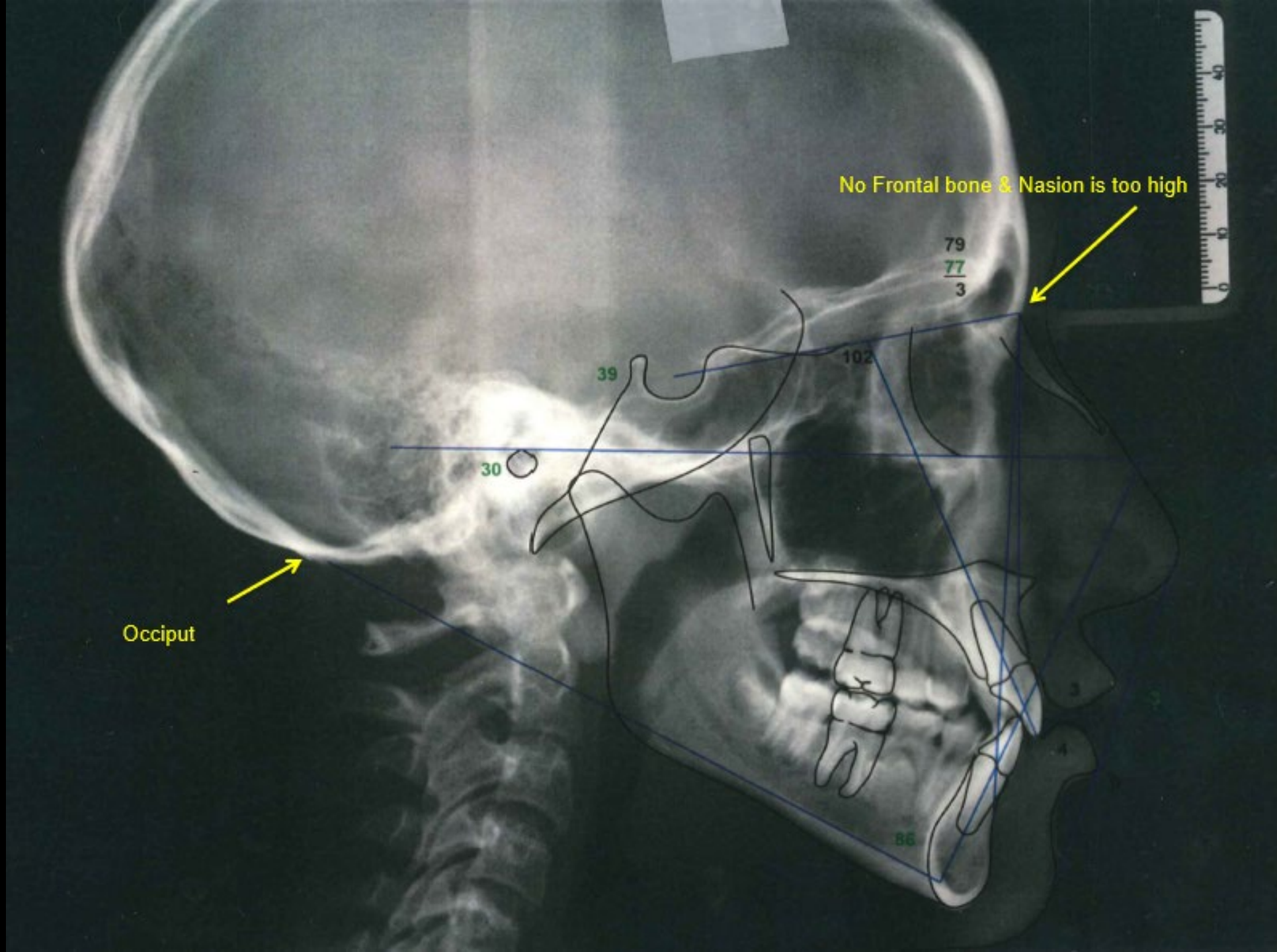


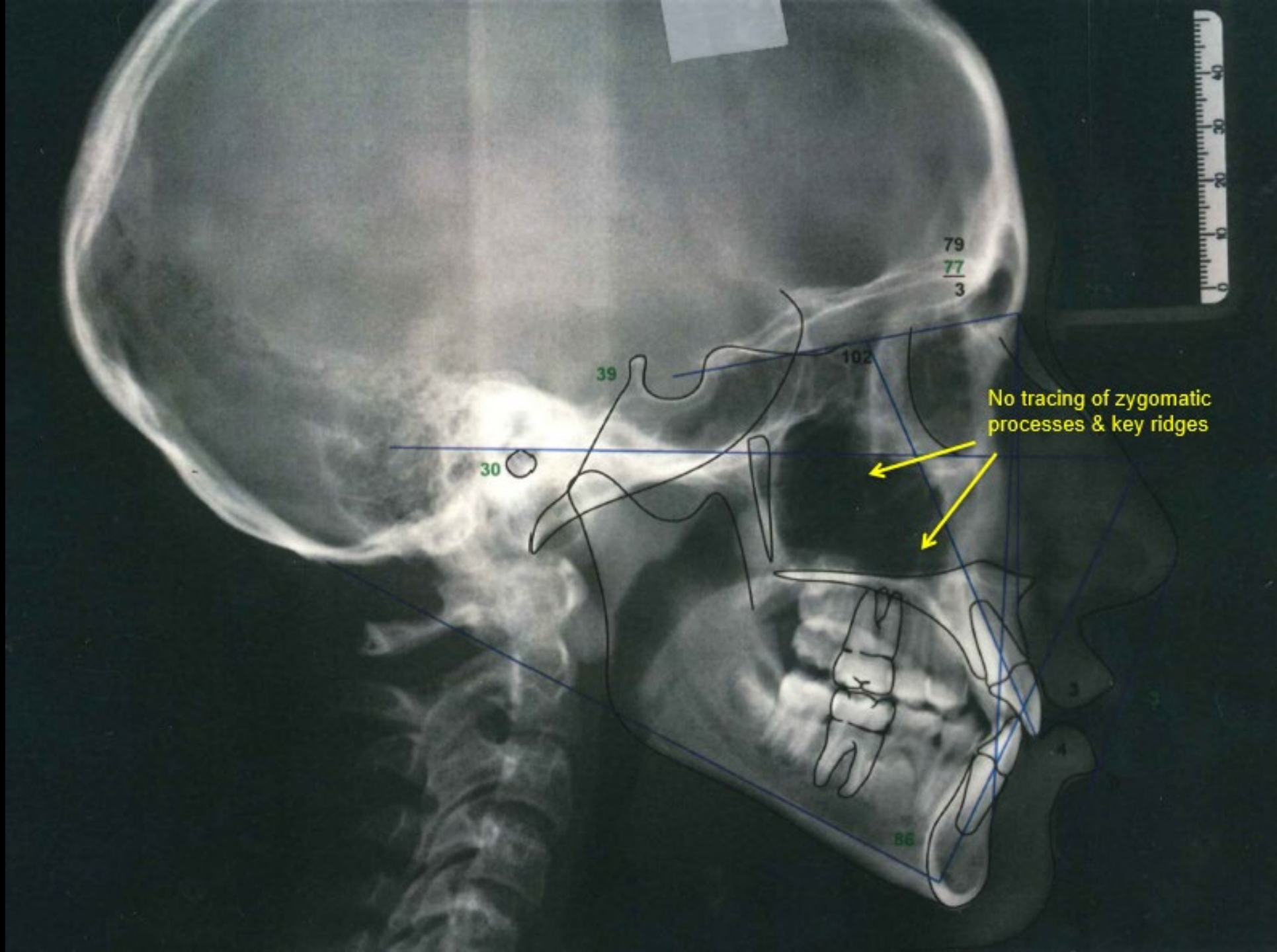


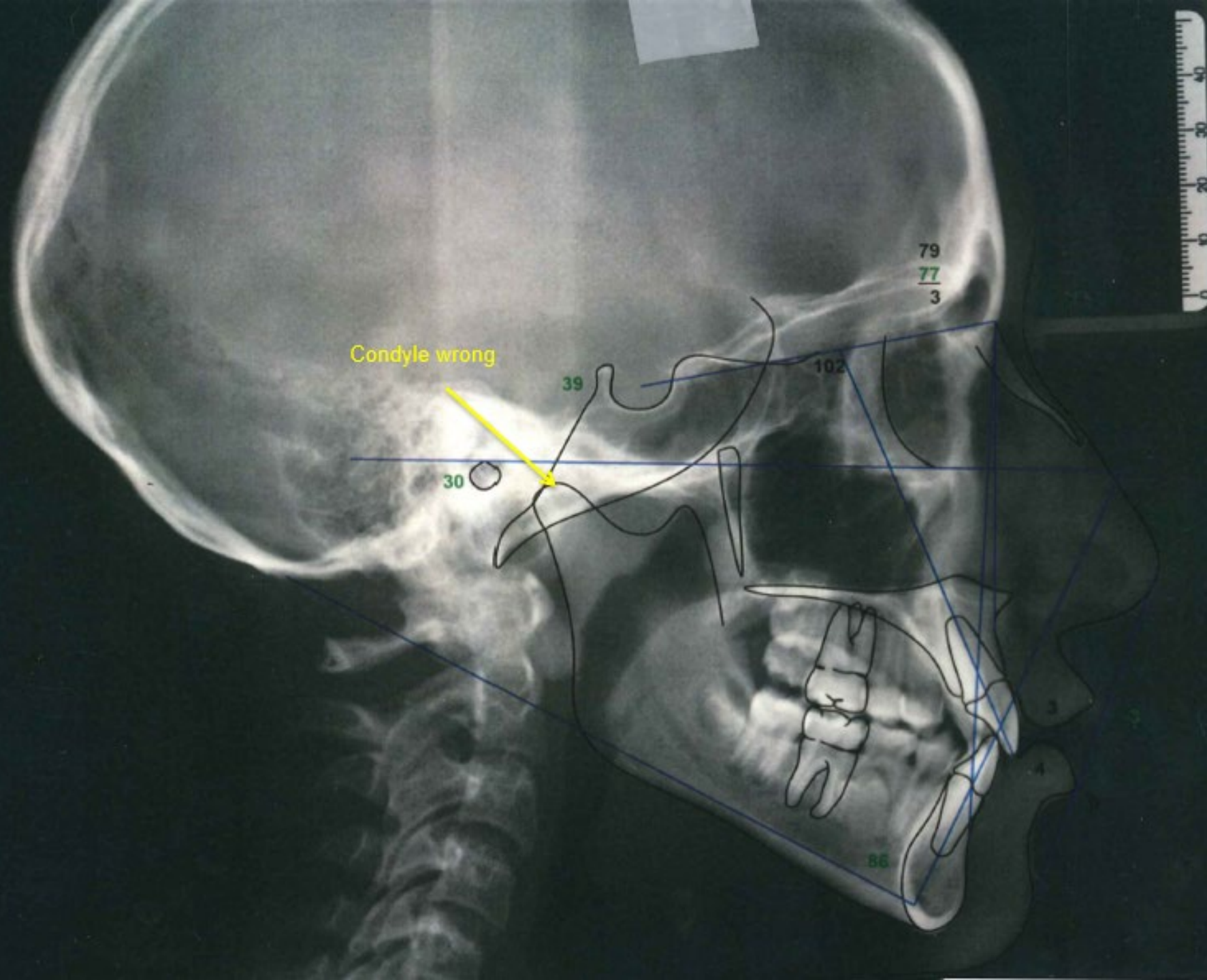


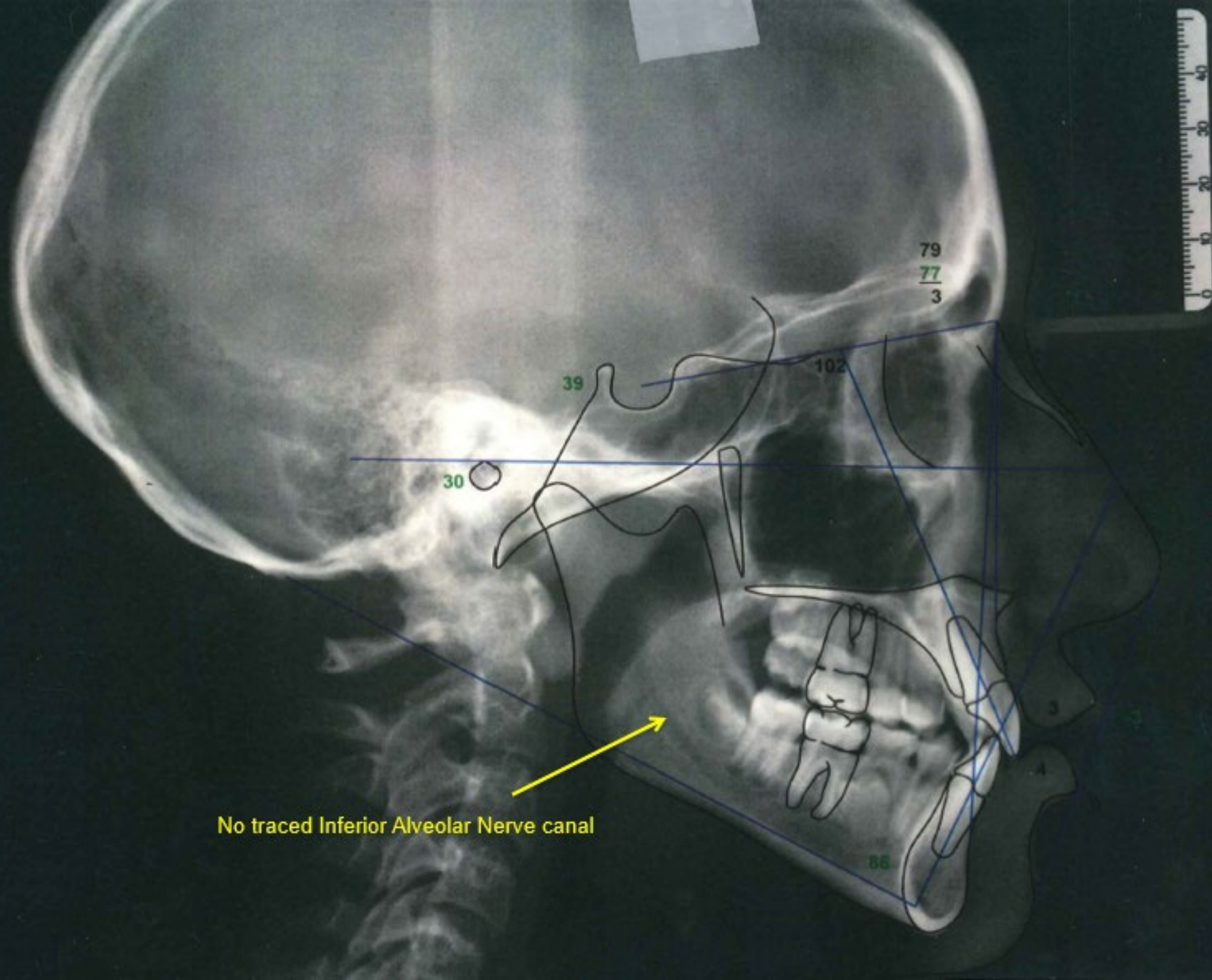




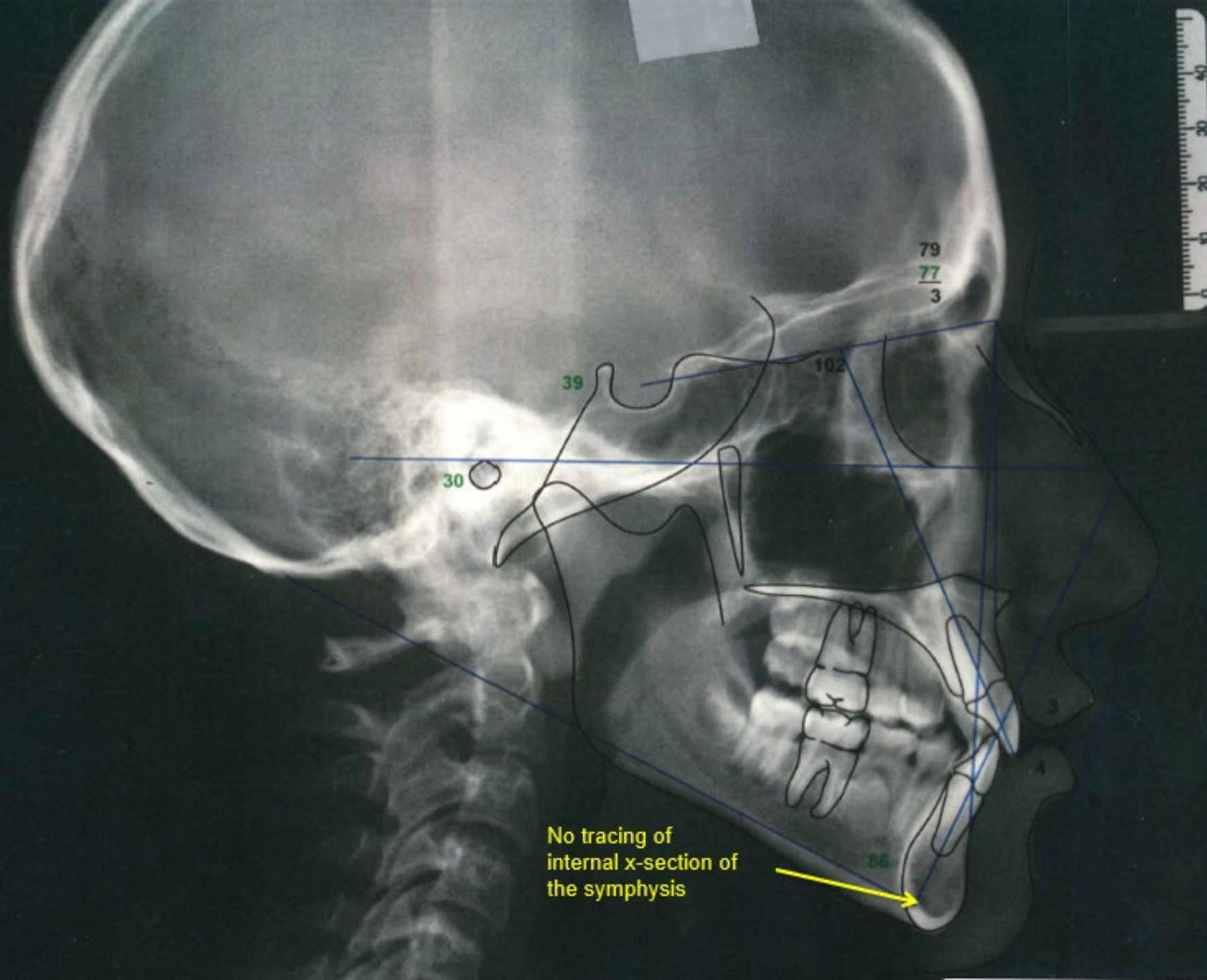


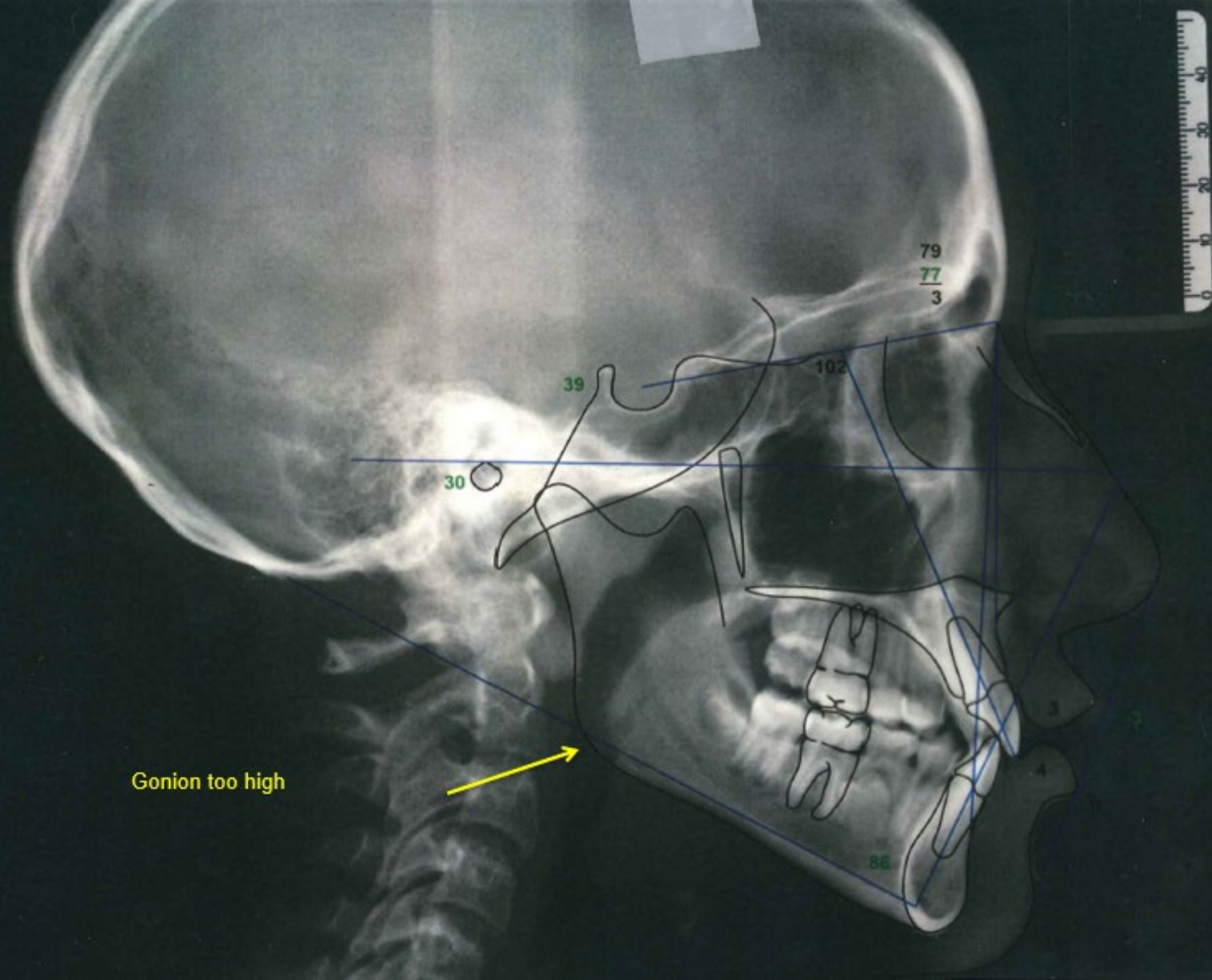


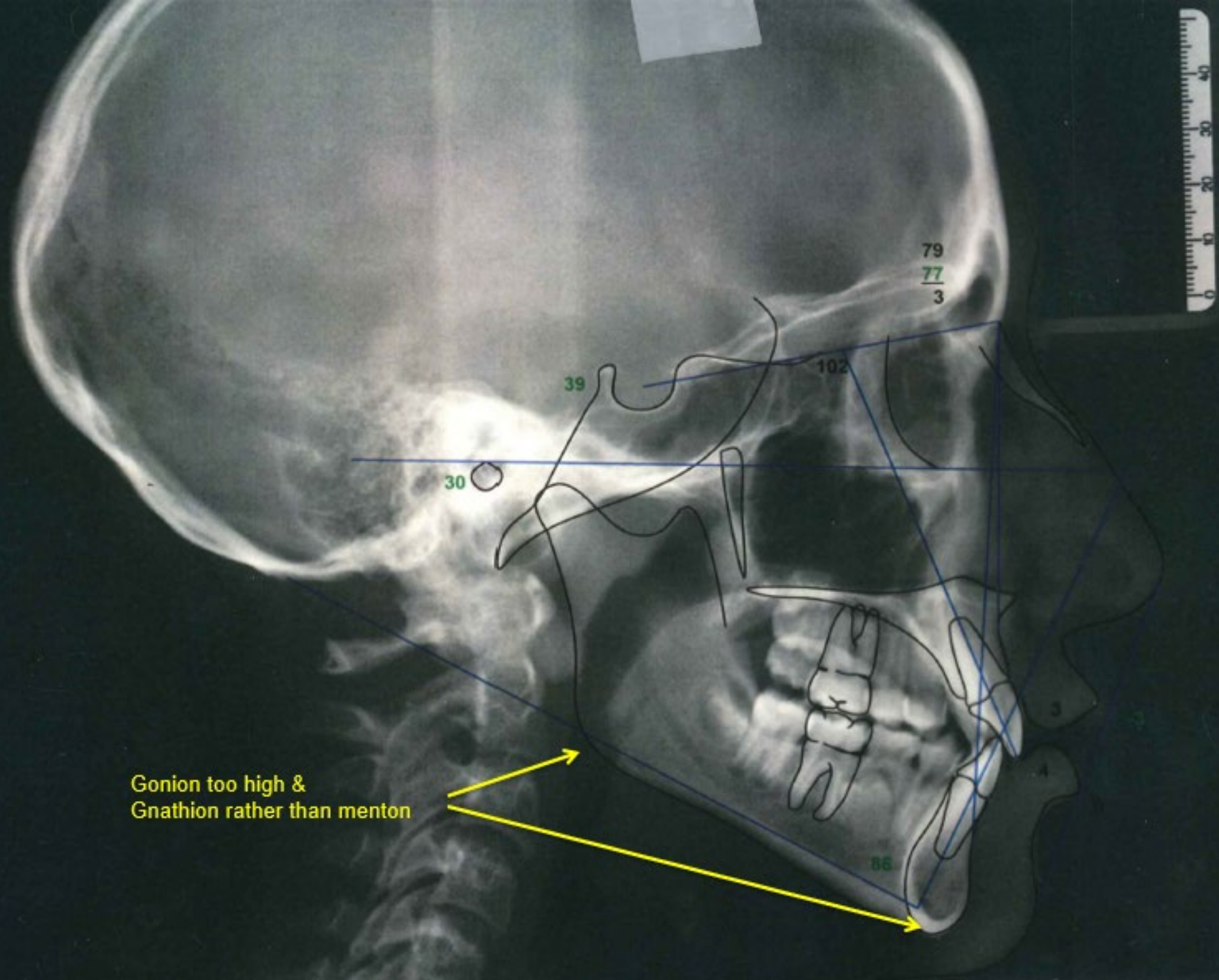


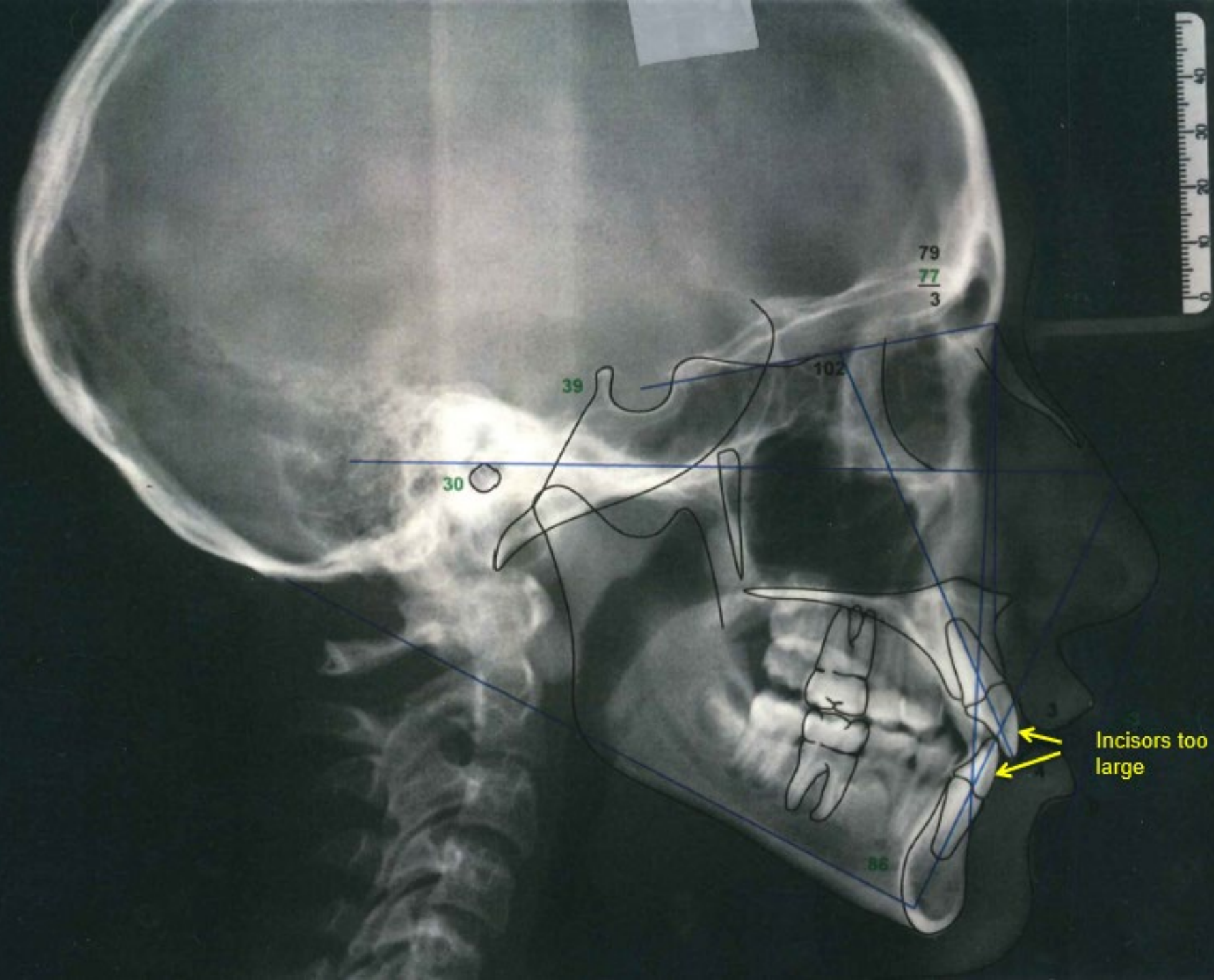


No traced Inferior Alveolar Nerve canal











Causes of Inaccuracy of Tracings

- Incorrect Landmark identification and inaccurate tracing of the “true” anatomical structures.
- Not tracing the minimal needed anatomical structures.
- Virtual tracings from computer software may not accurately reflect the TRUE anatomy.
- Consistent tracing of the same anatomic surfaces between initial and final cephs.



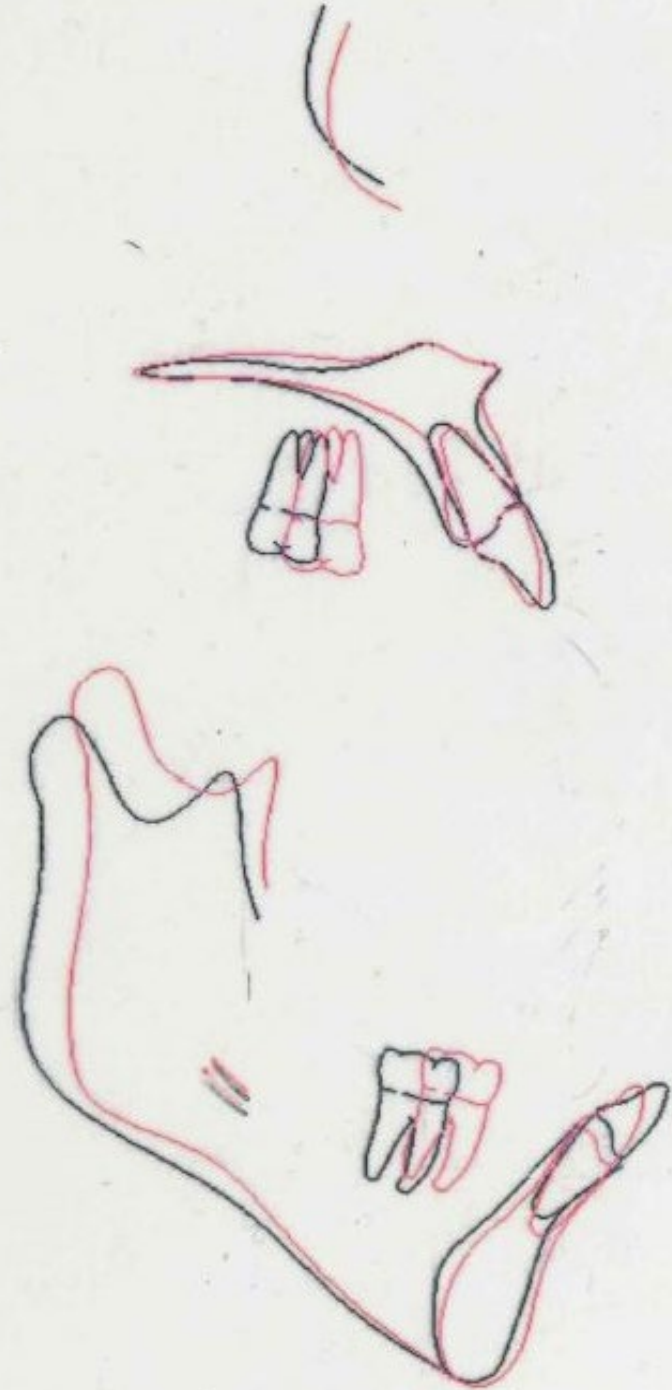
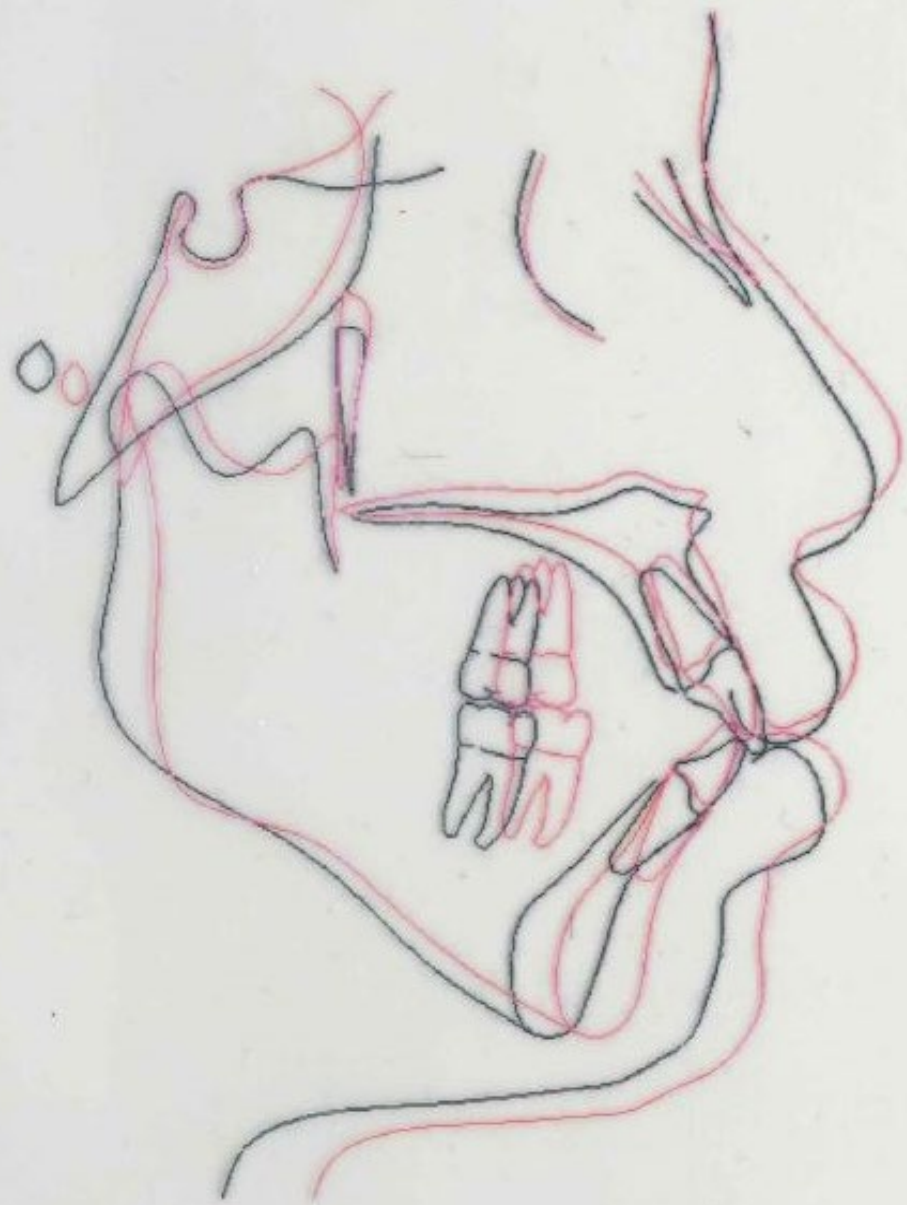
C. NOT Following ABO Instructions

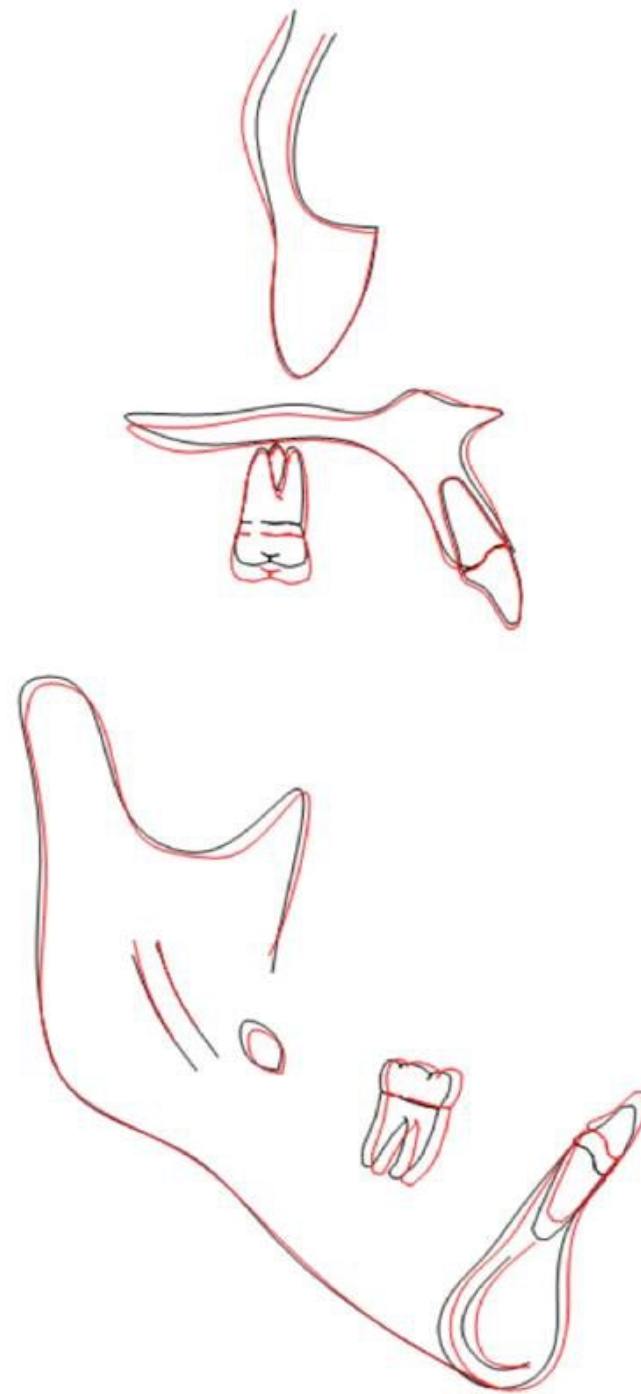
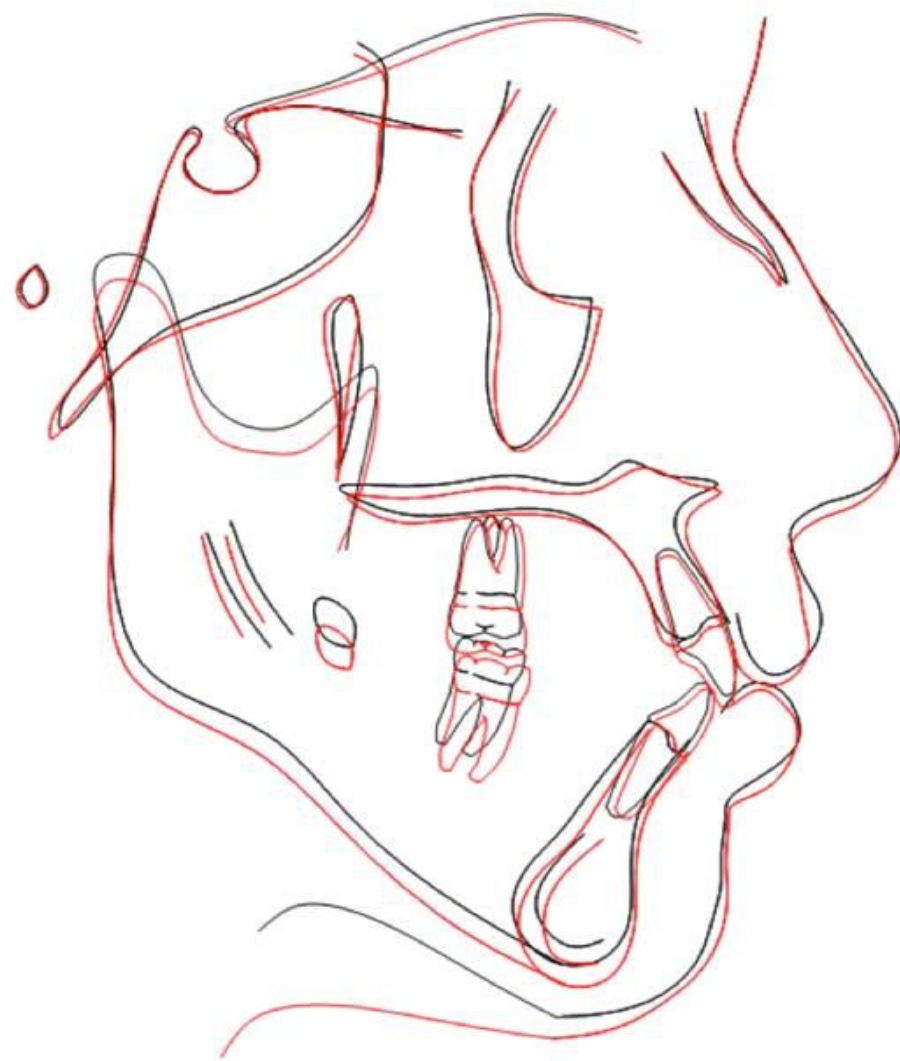
- C-1 Thoroughly understand the ABO instructions for tracing and superimposition of the tracings. Therefore, read and re-read carefully.



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Examples of Incorrect Superimpositions





A Systematic Method of Serial Cephalometric Assessment

- 
- A system for evaluating treatment and growth is needed to assess affects of the skeletal, dental, and facial changes facilitates precision and thoroughness.



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- 
- Serial cephalograms monitor growth and treatment change over time.
 - Think in three planes of space:
 - Horizontal
 - Vertical
 - Transverse



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Areas of evaluation:

- Skeletal
- Dental
- Facial
- Growth affects
- Treatment affects



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Three views:

- Overall superimposition
- Maxillary superimposition
- Mandibular superimposition



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Overall Superimposition

- Direction of growth: Maxilla and mandible
- Amount of growth: Maxilla and mandible
- Change in planes: Palatal, occlusal, and mandibular
- Soft tissue change: Nose, lips, chin
- Incisors relative to facial plane



Maxillary Superimposition

- Incisal change: Vertical tip, torque, bodily change
- Molar change: Vertical, tip, torque, bodily change
- Occlusal plane change: Clockwise or counterclockwise rotation
- Morphology change



Mandibular Superimposition

- Incisor change: Vertical, tip, torque, bodily change
- Molar change: Vertical, tip, torque, bodily change
- Occlusal plane: Clockwise or counterclockwise rotation
- Morphology change: Hard tissue, profile
- Growth: Measured at Articulare

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- Dr. Robert Little and Dr. Michael Fey: Cephalometric Superimposition
- Buschang PH, Roldan SI, Tadlock LP: Guidelines for Assessing the Growth and Development of Orthodontic Patients. Seminars in Orthodontics 23(4): 321-335, December 2017.
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