Review of Positioning Standards for the Skull and Facial Bones

Stephen Weber, R.T.(R)
Objectives

• The participant (you) will learn the nuances of skull and facial bones radiography

• To gain a better understanding of the criteria for proper radiographic appearances of skull and facial bones radiography

• To review common positioning errors and how to correct them
Skull Anatomy
Skull Morphology: Mesocephalic
Skull Morphology: Brachycephalic

BRACHYCEPHALIC SKULL

Petrosus pyramid

54°

SUPERIOR ASPECT

[Image of a dog looking up at a treat]
Skull Morphology: Dolichocephalic
Skull Topography:

- Supraorbital Groove
- Superciliary Ridge (Arch)
- Supra and Infraorbital Margin
- Inner and Outer Canthus
Skull Topography:

- Vertex
- Occiput
- Inion
- Glabella
- Nasion
- Acanthion
- Gonion
- Mental Point
Skull Topography:

- Auricle
- Tragus
- TEA
- EAM
Skull Baselines:

- GML
- OML
- IOML
- AML
- MML
Skull Baselines:

- **GML**: Glabellomeatal Line
- **OML**: Orbitalmeatal Line
  - There is an **8 degree** difference between the GML and the OML
- **IOML**: Infraorbitomeatal Line
  - AKA Reid’s Base Line
  - There is a **7 degree** difference between the OML and the IOML
Skull Baselines:

- AML: Acanthiomeatal Line
- MML: Mentomeatal Line
  - There is a 53 degree difference between the OML and the MML
- Interpupillary Line
Cranial Bones (8):

- Calvarium or Skull Cap
  Frontal
  Two Parietals
  Occipital
- Floor of the Cranium
  Two Temporals
  Sphenoid
  Ethmoid
Facial Bones (14):

- Two Maxillae
- Two Zygomas
- Two Lacrimals
- Two Nasal Bones
- Two Inferior Nasal Conchae
- Two Palatine Bones
- Vomer
- Mandible
Base of Orbits (14):

- Cranial Bones
  - Frontal
  - Sphenoid
  - Ethmoid

- Facial Bones
  - Maxilla
  - Zygoma
  - Lacrimal
  - Palatine
Bony Nasal Septum:

- Consists of the perpendicular plate of the ethmoid and the vomer
Paranasal Sinuses:

- Maxillary (2)
  - AKA antra of highmore
- Frontal (usually 2)
  - Become aerated at age 6
- Ethmoid (consists of many air cells within the labyrinth)
- Sphenoid (1 or 2)
- All sinuses become aerated at age 17 or 18
Paranasal Sinuses:

- Frontal sinususes
- Ethmoid air cells
- Sphenoidal sinususes
- Maxillary sinususes

Ethmoidal air cells:
- Posterior
- Middle
- Anterior

ANTERIOR ASPECT

LATERAL ASPECT
Positioning Considerations
Positioning Considerations:

• May be done upright or recumbent
  – Upright allows patient to be positioned quickly
  – Upright visualizes existing air/fluid levels within the cranial or sinus cavities

• Ensure patient comfort

• Hygiene
  – Disinfect table/bucky surface before and after use

• Exposure factors
  – Medium kV 75-85
  – Minimum SID is 40”
"UMMM... CAN I GET A THYROID SHIELD?"
Radiation Protection:

• Best techniques for minimizing radiation exposure
  – Use good collimation practices
  – Minimize repeats

• Gonadal shielding is *not* always needed
  – No detectable exposure to gonadal area during skull radiography
  – However, lead shields may be used to reassure the patient
Causes of Positioning Errors:

• Human body is expected to be symmetric bilaterally... This is not always true
  – Ears, Nose, and Jaw are often asymmetric

• Use patient’s eyes as opposed to their nose as a positioning landmark
Correct Positioning:

- Bony parts such as mastoid tips and orbital margins are safer landmarks to use.
- Look at the various facial features and palpate anatomic landmarks for accurate positioning.
Positioning Errors:

The do \textit{NOT's} of palpating your patient during positioning...
Positioning:

A more appropriate means to palpating and positioning your patient for their exam.
5 Common Positioning Errors:

• Rotation
  – Almost *always* results in a retake

• Tilt

• Excessive Flexion

• Excessive Extension

• Incorrect CR angle
Skull: No Rotation or Tilt
Skull: Rotation
Skull: Tilt
Skull: Rotation vs. Tilt

None  Rotation  Tilt
Pediatric Applications:

when babies get x-rays...

....it's not funny
Pediatrics Applications:

• Communication
  – Clear explanation of the procedure
  – Obtain trust and cooperation of the patient and guardian

• Immobilization
  – Use of positioning immobilization devices reduces the need of patient being held
  – Guardian can hold, provide them with shielding
Pediatric Immobilization Devices:

- Soft & Comfortable Head Positioning Strap
- Toddler Arm Positioning Straps
- Waist Securing Safety Strap
- No-kick Safety Leg Straps
Skull Radiography
Routine Skull Positioning

- Routine Skull Positions:
  1. PA
  2. AP Axial (Towne)
  3. Both Laterals
  4. Submentovertex (SMV) or Full Basal
### PA Skull:

<table>
<thead>
<tr>
<th><strong>SID</strong></th>
<th>40”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IR Size</strong></td>
<td>24 x 30 cm Lengthwise</td>
</tr>
<tr>
<td><strong>Tube Angle</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>CR</strong></td>
<td>Center to Glabella</td>
</tr>
<tr>
<td><strong>Collimation</strong></td>
<td>Collimate on four sides</td>
</tr>
<tr>
<td><strong>Positioning</strong></td>
<td>Place patient’s forehead and nose against IR with OML and MSP perpendicular to IR</td>
</tr>
<tr>
<td><strong>Breathing</strong></td>
<td>Suspend</td>
</tr>
<tr>
<td><strong>Additional Comments</strong></td>
<td>The patient’s arms and hands are by their head for support if done on the table. Can also be done AP. Mark correct side.</td>
</tr>
</tbody>
</table>
PA Skull:
PA Skull:

- **Positioning Accuracy:**
- Distance from outer canthus and lateral margin of skull must be equal on both sides
- Petrous Ridges must fill the orbits
PA Skull positioning:

• Angle central ray so it forms a perpendicular angle with the OML

• If petrous ridges are below the supra orbital rim:
  – The chin is too high
  – Will appear like a PA Axial (Caldwell) view

• If petrous ridges are above the supra orbital rim:
  – The chin is too low
  – Will appear like an AP Axial (Towne) view
### AP Axial (Towne) Skull:

<table>
<thead>
<tr>
<th>SID</th>
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<tbody>
<tr>
<td>IR Size</td>
<td>24 x 30 cm Lengthwise</td>
</tr>
<tr>
<td>Tube Angle</td>
<td><strong>30 degrees caudal to OML</strong></td>
</tr>
<tr>
<td>CR</td>
<td>Center 2.5” above Glabella</td>
</tr>
<tr>
<td>Collimation</td>
<td>Collimate on four sides</td>
</tr>
<tr>
<td>Positioning</td>
<td>Have patient tuck chin to place OML and MSP perpendicular to IR</td>
</tr>
<tr>
<td>Breathing</td>
<td>Suspend</td>
</tr>
<tr>
<td>Additional Comments</td>
<td>Place a small sponge behind patients head to help tuck chin. Angle 37 degrees if IOML is perpendicular to IR</td>
</tr>
</tbody>
</table>
AP Axial (Towne) Skull:

- **Positioning Accuracy:**
  - Petrous Ridges must be symmetrical
  - The dorsum sellae must be found within the foramen magnum
# Lateral Skull:

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>IR Size</td>
<td>24 x 30 cm Crosswise</td>
</tr>
<tr>
<td>Tube Angle</td>
<td>None</td>
</tr>
<tr>
<td>CR</td>
<td>Center 2” above the EAM</td>
</tr>
<tr>
<td>Collimation</td>
<td>Collimate on four sides</td>
</tr>
<tr>
<td>Positioning</td>
<td>Oblique pt. &amp; place affected side against IR in a <strong>true lateral position</strong>. Interpupillary line is perpendicular to IR. MSP is parallel to IR. IOML is perpendicular to edge of IR</td>
</tr>
<tr>
<td>Breathing</td>
<td>Suspend</td>
</tr>
<tr>
<td>Additional Comments</td>
<td>Use sponge under chin or head to prevent tilt</td>
</tr>
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</table>
Lateral Skull:
Positioning Accuracy:
- Orbital Plates must be superimposed
- Angles of the mandible must be superimposed
Submentovertex (SMV) or Full Basal:

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</tr>
<tr>
<td>Tube Angle</td>
<td>None</td>
</tr>
<tr>
<td>CR</td>
<td>CR will be perpendicular to IOML and enter midway between the gonia</td>
</tr>
<tr>
<td>Collimation</td>
<td>Collimate on four sides</td>
</tr>
<tr>
<td>Positioning/Planes &amp; Baselines</td>
<td>Pt. raises chin to place IOML parallel and MSP perpendicular to IR</td>
</tr>
<tr>
<td>Breathing</td>
<td>Suspend</td>
</tr>
<tr>
<td>Additional Comments</td>
<td>Base of the cranium, petrous pyramids, mandible, zygomatic arches, and sphenoid sinuses all best demonstrated</td>
</tr>
</tbody>
</table>
Submentovertex (SMV) or Full Basal:
Submentovertex (SMV) or Full Basal:
Submentovertex (SMV) or Full Basal:
Submentovertex (SMV) or Full Basal:

Positioning Accuracy:
- Mandible must be symmetrical
- Condyles of the mandible must be anterior to the petrous ridges
Optional Skull Positions:

1. PA Axial (Caldwell)
2. PA Axial (Haas) aka Reverse Towne’s
## PA Axial (Caldwell) Skull:

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<tbody>
<tr>
<td>IR Size</td>
<td>24 x 30 cm Lengthwise</td>
</tr>
<tr>
<td>Tube Angle</td>
<td>15 degrees caudal</td>
</tr>
<tr>
<td>CR</td>
<td>Center at the nasion</td>
</tr>
<tr>
<td>Collimation</td>
<td>Collimate on four sides</td>
</tr>
<tr>
<td>Positioning</td>
<td>Place patient’s forehead and nose against IR with OML and MSP perpendicular to IR</td>
</tr>
<tr>
<td>Breathing</td>
<td>Suspend</td>
</tr>
<tr>
<td>Additional Comments</td>
<td>Mark correct side</td>
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</table>
PA Axial (Caldwell) Skull:
Positioning Accuracy:
- Petrous Ridges must fill the lower 1/3 of the orbits
- Distance from outer canthus and lateral margin of skull must be equal on both sides
## PA Axial (Haas) Skull:

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<td>IR Size</td>
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</tr>
<tr>
<td>Tube Angle</td>
<td>25 degrees Cephalic to OML</td>
</tr>
<tr>
<td>CR</td>
<td>Center 1.5” below inion (between EAM)</td>
</tr>
<tr>
<td>Collimation</td>
<td>Collimate on four sides</td>
</tr>
<tr>
<td>Positioning</td>
<td>PA: Have patient tuck chin to place OML and MSP perpendicular to IR</td>
</tr>
<tr>
<td>Breathing</td>
<td>Suspend</td>
</tr>
<tr>
<td>Additional Comments</td>
<td>Angle 37 degrees if IOML is perpendicular to IR</td>
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Positioning Accuracy:
- Petrous Ridges must be symmetrical
- The dorsum sellae must be found within the foramen magnum
Facial Bones Radiography
Routine Facial Bones Positioning:

- Routine Facial Bones Positions:
  1. Parietoacanthial or Waters
  2. PA Axial or Caldwell
  3. Lateral of the Affected Side
  4. Submentovertex (SMV) or Full Basal

* Best if done upright
### Parietoacanthial or Waters:

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<td>None</td>
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<tr>
<td><strong>CR</strong></td>
<td>Exiting the acanthion</td>
</tr>
<tr>
<td><strong>Collimation</strong></td>
<td>Collimate on four sides</td>
</tr>
<tr>
<td><strong>Positioning/Planes &amp; Baselines</strong></td>
<td>Have patient raise chin and place against IR, MML and MSP are perpendicular to IR, OML forms a 37 degree angle to bucky</td>
</tr>
<tr>
<td><strong>Breathing</strong></td>
<td>Suspend</td>
</tr>
<tr>
<td><strong>Additional Comments</strong></td>
<td>Best demonstrates orbits, zygomas, and maxillae.</td>
</tr>
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</table>
Parietoacanthalial or Waters:
Parietoacanthial or Waters:

Positioning Accuracy:
- Petrous Ridges must be below the maxillary sinuses
- Distance from outer canthus and lateral margin of skull must be equal on both sides
Parietoacanthial or Waters:

Chin is raised too high

Chin is not raised high enough
### PA Axial (Caldwell) Facial Bones:

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Positioning Accuracy:
- Petrous Ridges must fill the lower 1/3 of the orbits
- Distance from outer canthus and lateral margin of skull must be equal on both sides

PA Axial (Caldwell) Facial Bones:
Petrous Ridges Troubleshooting:

• Positioning Accuracy for PA Axial (Caldwell):
  • Petrous Ridges must fill the lower 1/3 of the orbits
    – If the Petrous Ridges are in the upper portion either
      a) raise the chin or b) increase the CR angle
    – If the Petrous Ridges are inferior to the orbital rims either a) lower the chin or b) decrease the CR angle
Petrous Ridges Troubleshooting:

• The Petrous Ridges move with the back of the head in the PA position
  – Raising the chin moves the Petrous Ridges down
  – Lowering the chin moves the Petrous Ridges up

• The central ray moves the orbits
  – Increasing the CR angle moves the orbits down
  – Decreasing the CR angle moves the orbits up
## Lateral Facial Bones:

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<td>CR</td>
<td>Center to the malar bone</td>
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<td>Collimation</td>
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<td>Positioning/Planes &amp; Baselines</td>
<td>Oblique pt. &amp; place affected side against IR in a true lateral position. Interpupillary line is perpendicular to IR. MSP is parallel to IR. IOML is perpendicular to edge of IR</td>
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Lateral Facial Bones:
Lateral Facial Bones:
Lateral Facial Bones:

- **Positioning Accuracy:**
- Orbital Plates must be superimposed
- Angles of the mandible must be superimposed
Lateral Facial Bones:

- **Positioning Accuracy:**
- **Detecting Tilt:**
  - Orbital roofs
  - EAM
  - Lesser wings of sphenoid
- **Detecting Rotation:**
  - Mandibular rami
  - EAM
  - Greater wings of sphenoid
Modified Parietoacanthial (Modified Water’s):

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<td>None</td>
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<tr>
<td>CR</td>
<td>Exiting the acanthion</td>
</tr>
<tr>
<td>Collimation</td>
<td>Collimate on four sides</td>
</tr>
<tr>
<td>Positioning /Planes &amp; Baselines</td>
<td>Have patient place chin and nose against IR, <strong>MML is not perpendicular to IR</strong>, OML forms a 55 degree angle to bucky</td>
</tr>
<tr>
<td>Breathing</td>
<td>Suspend</td>
</tr>
<tr>
<td>Additional Comments</td>
<td>Best demonstrates floor of the orbits, and used to r/o a blow-out fracture of orbit</td>
</tr>
</tbody>
</table>
Modified Parietoacanthial (Modified Water’s):

**Positioning Accuracy:**
- Petrous Ridges are projected into the maxillary sinuses
- Distance from outer canthus and lateral margin of skull must be equal on both sides
Modified Parietoacanthial (Modified Water’s):

- Orbital fracture (blowout) and neoplastic/inflammatory processes are shown
- Foreign bodies in eye may be demonstrated in this position
Additional Studies
VP Shunt Radiography

- Ventriculo-Peritoneal Shunt
- Thin tube placed inside the brain’s ventricle and tunneled underneath the skin to the peritoneum
- Reduces pressure of Cerebral Spinal Fluid in the brain
- Drains to the abdominal area
- Series of overlapping radiographs taken to image the entire VP Shunt
VP Shunt Radiography
The Codman Hakim Shunt

• Programmable ventricular shunt valve system used to treat hydrocephalus

• It is necessary to radiographically check ventricular shunt valves following MR studies
  — Shunt valve has susceptibility to MR fields

• X-Ray film taken in relation to the valve and not to the patient’s anatomy
Shunt Valve Radiography:
Shunt Valve Radiography:

**Correct**
- Radiopaque Marker
- Central Marker
- Valve "x"
- Implanted Valve
- Cam Position Indicator
- Radiograph Plate

**Incorrect**
- Radiopaque Marker
- Central Marker
- Valve "x"
In Closing…

• Reviewed the nuances of skull and facial bones radiography
• Analyzed the criteria for proper radiographic appearance of the skull and facial bones
• Discussed common positioning errors and methods on how to correct them
• Now you can apply this knowledge towards your clinical setting
Demonstrate Confidence…

The ER just order Skull and Facial Bones X-Rays…

…and your co-workers let you know they got your back
Expectations:

How the patient encounter should go:

*VS.* What’s really about to go down...
The X-Ray Technologist:

What my family thinks I do
What ER patients thinks I do
What nurses thinks I do
What entire hospital sees me do
What X-Ray students think I do
What I really do