Reading Hospital School of Health Sciences
Medical Imaging Program
MI 243 Clinical Seminar IV
2021

Cervical Spine Imaging Protocol

Adult	Pediatric (Under 18)
AP, Open Mouth, RAO, LAO, Lateral	> 2 years old: AP, Lateral, Odontoid
	≤ 2 years old: AP and Lateral

*Pediatric patients with trauma surgeon present: Lateral Only (other views at the discretion of the trauma surgeon)

Additional note: Davis Trauma Series = Routine C-spine plus Flexion and Extension

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Cervical Spine

Routine:	5 views (routinely): Left Lateral, AP Axial, Open Mouth Odontoid, PA Axial Obliques (*Cone down lateral, Swimmer's & Fuch's as needed)*
Projection:	**Left Lateral (Grandy Method)**
Patient Prep:	Remove artifacts from head, neck and mouth, including gown snaps
Technique:	AEC: 85 kVp, center cell, grid Manual: 85 kVp, 8mAs, grid
SID:	72"
Collimation:	8 X 10 or 10 X12 Portrait
Patient Position:	Patient erect as possible with left side against the IR. Place in true lateral position. Center the coronal plane to midline of IR. Adjust the shoulders so they lie in a horizontal plane. Have the patient depress the shoulders as far as possible (sandbags should be given to the patient if not contraindicated). Extend the chin slightly to prevent mandible from superimposing on the cervical spine.
Central Ray:	Direct the central ray perpendicularly so that it is entering C4 (thyroid cartilage).
Marker Placement:	Left marker placed posterior to neck.
Shielding:	Shielding for males and females.
Breathing Instructions:	Suspended expiration.
Purpose/Structures:	All cervical vertebrae and 1/3 of T1 showing cervical bodies and intervertebral disk spaces, articular pillars, and the zygapophyseal joints and spinous processes.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- All seven cervical vertebrae and at least 1/3 of T1 (otherwise a separate radiograph of the cervico-thoracic region is recommended)
- C4 in the center of the radiograph.
- Neck extended so mandibular rami are not overlapping the atlas and axis.
- Superimposed or nearly superimposed rami of the mandible.
- No rotation or tilt of the cervical spine
    - Superimposing zygapophyseal joints and open intervertebral disk spaces
    - Superimposed or nearly superimposed rami of the mandible
    - Spinous processes shown in profile
- Soft tissue and bony trabeculation

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Routine: 5 views (routinely): Left Lateral, AP Axial, Open Mouth Odontoid, PA Axial Obliques
(Cone down lateral, Swimmer's & Fuch's as needed)

Projection: **Cone Down Lateral - RH specific**
Only do if you did not get C7-T1 on regular lateral

Patient Prep: Remove artifacts from head, neck and mouth.

Technique: AEC: 96 kVp, center cell, grid
Manual: 96 kVp, 28mAs, grid

SID: 72"

Collimation: 3-4" wide, length is patient dependent: extend light to top of ear with proper centering.

Patient Position: Pt erect as possible with left side against IR. Place in true lateral Position. Center the coronal plane to midline of IR.
Have the patient depress the shoulders as far as possible (sandbags should be given to the patient if not contraindicated).
Extend the chin slightly to prevent mandible from superimposing on the cervical spine.

Central Ray: Direct the central ray perpendicularly so that it is entering at the thickest part of the shoulders. Top of light field should be at the top of the ear.

Marker Placement: Left marker placed posterior to neck.

Shielding: Shielding for males and females.

Breathing Instructions: Suspended expiration.

Purpose/Structures: C2 to C7-T1 should be visualized.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- Visualization of C2-C7, without rotation from lateral position.
- Visualization of bony structures of C7-T1 and joint space with adequate penetration

Routine: 5 views (routinely): Left Lateral, AP Axial, Open Mouth Odontoid, PA Axial Obliques

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(Cone down lateral, Swimmer's & Fuch's as needed)

Projection: **Swimmer's Lateral (Twining, Pawlow Method)**
Only done if unable to visualize C7-T1 on Cone Down
***Note:** If C7-T1 still unclear after Swimmer's, the ED physician or a radiologist should check the images and may recommend a CT instead of completing the c-spine study.*

Patient Prep: Remove artifacts from head, neck and mouth.

Technique: AEC: 96 kVp, center cell, grid
Manual: 96 kVp, 28mAs, grid

SID: 40"

Collimation: 10 X12 portrait to spine

Patient Position: Place patient with left side against the IR. Place in true lateral position with the mid-sagittal plane parallel to the plane of the IR. Center the mid-coronal plane of the body to the IR. Elevate the arm nearest the IR, flex the elbow, rest the forearm on the patient's head. The humeral head can also be rotated anteriorly (recommended) or posteriorly. can also be rotated anteriorly (recommended) or posteriorly.
Unless contraindicated, depress the patient's shoulder that is farthest from the IR as much as possible, and move that humeral head in the opposite direction of the opposite shoulder (posterior recommended.)

Central Ray: Direct the central ray to the level of C7-T1, located approximately at the level of the vertebral prominence (approximately 2" above the jugular notch)
Tube angle:
- CR perpendicular if the shoulder is well depressed *or*
- CR at a 3-5° caudal angle when the shoulder cannot be well depressed.
- If supine and using erect IR, angle head of litter slightly away from erect IR, since you cannot angle tube caudad on DR erect board because of the grid.

Marker Placement: Left marker placed posterior to neck.

Shielding: Shielding for males and females.

Breathing Instructions: Suspended expiration.

Purpose/Structures: Lateral C5 – approximately T4 visualized through separation of humeral heads.

Evaluation Criteria:
- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.

- Adequate x-ray penetration through the shoulder region demonstrating the lower cervical and upper thoracic vertebra, not appreciably rotated from lateral position.
- Humeral heads minimally superimposed on vertebral column.
- Soft tissue and bony trabecular detail.

Additional Note: Merrill's identifies a breathing technique can be used to blur lung anatomy. Also a compensating filter ay eb beneficial due to the extreme difference between the thin lower neck and the very thick upper thoracic region.

Routine: 5 views (routinely): Left Lateral, AP Axial, Open Mouth Odontoid, PA Axial Obliques
(Cone down lateral, Swimmer's & Fuch's as needed)

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Projection:	**AP Axial**
Patient Prep:	Remove artifacts from head, neck and mouth.
Technique:	AEC: 85 kVp, center cell, grid Manual: 85 kVp, 3.2mAs, grid
SID:	40”
Collimation:	10 X 12 portrait
Patient Position:	Patient erect if possible, AP position. Midsagittal plane centered to IR. Arms down by sides with the shoulders relaxed in transverse plane. Extend the chin so the occlusal plane and base of skull are perpendicular to IR.
Central Ray:	Angle tube 15-20° cephalad to C4 (thyroid cartilage). **(**The top of the IR at about the top of the ear, or 1” above EAM)
Marker:	Right or left marker on appropriate anatomical side.
Shielding:	Shielding for males and females.
Breathing Instructions:	Suspended respiration.
Purpose/Structures:	AP view of cervical spine, from approximately C3- T2 showing interpediculate spaces, superimposed transvers and articular processes, and intervertebral disk spaces.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- Area from superior portion of C3 to T2 and surrounding soft tissue.
- Shadows of the mandible and occiput superimposed over the atlas and most of the axis.
- Open intervertebral disk spaces
- Midsagittal place of head and neck perpendicular to plane of IR, without tilt or rotation.
    - Spinous processes equidistant to the pedicles and aligned with the midline of the cervical bodies.
    - Mandibular angles and mastoid processes equidistant to the vertebrae
- Soft tissue and bony trabecular detail.

Additional Note: Bontrager recommends to angle >20 degrees if significant kyphosis is present.

Routine:	5 views (routinely): Left Lateral, AP Axial, Open Mouth Odontoid, PA Axial Obliques *(Cone down lateral, Swimmer’s & Fuch’s as needed)*

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Projection: **Open Mouth AP (Odontoid)**

Patient Prep: Remove artifacts from head, neck and mouth.

Technique: AEC: 85 kVp, center cell, grid
Manual: 85 kVp, 3.6mAs, grid

SID: 40”

Collimation: Close collimation (5 X 5)

Patient Position: Have console and technique set up before positioning so the patient does not have to hold the position long. Patient erect if possible, AP position. Midsagittal plane centered to IR.
Arms down by sides with the shoulders relaxed down.
Have the patient open the mouth as wide as possible and adjust head so that a line from the lower edge of the upper incisors to the tip of the mastoids (occlusal plane) is perpendicular to the IR. Base of the skull also falls within this plane.

Central Ray: Central ray to center of open mouth and perpendicular to the IR.

Marker: Right or left marker on appropriate anatomical side.

Shielding: Shielding for males and females. _

Breathing Instructions: Suspended respiration.

Purpose/Structures: Ap projection of atlas and axis. The entire dens with associated joint spaces not superimposed by skull anatomy.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- Dens, atlas, axis and articulations between the first and second cervical vertebrae.
- Entire articular surfaces of the atlas and axis (to check for lateral displacement).
- Mouth open wide.
- Superimposed occlusal plane of the upper central incisors and the base of the skull, demonstrating proper neck flexion
    - If the upper incisors are projected over the dens, the neck is flexed too much towards the chest.
    - If the base of skull is projected over the dens, the neck is extended too much.
- Shadow of the tongue not projected over the atlas and axis.
- Mandibular rami equidistant from dens, demonstrating proper head rotation.
- Soft tissue and bony trabecular detail.

Additional Note: Merrill’s recommends that the patient phonates “ah” softly during the exposure to place the tongue in the floor of the mouth so it is not projected on the atlas and axis and prevents movement of the mandible.

Routine: 5 views (routinely): Left Lateral, AP Axial, Open Mouth Odontoid, PA Axial Obliques
(Cone down lateral, Swimmer’s & Fuch’s as needed)

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Projection: **AP Fuchs**
Only done when upper dens not visible on good Odontoid
Should not be done when fracture is present.

Patient Prep: Remove artifacts from head, neck and mouth.

Technique: AEC: 85 kVp, center cell, grid
Manual: 85 kVp, 3.2mAs, grid

SID: 40”

Collimation: Close collimation (5 X 5).

Patient Position: Patient erect if possible, AP position. Midsagittal plane centered to IR.
Have patient extend the chin until the tip of the chin and the EAM are in line and perpendicular to the IR (mentomeatal line). Mastoid process also falls within this line.

Central Ray: Perpendicular and enters just inferior to the tip of the chin.
***** *See additional notes.*

Marker Placement: Right or left marker on appropriate anatomical side.

Shielding: Shielding for males and females.

Breathing Instructions: Suspended respiration.

Purpose/Structures: Entire dens viewed within the foramen magnum.

Evaluation Criteria:
- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- Entire dens within the foramen magnum.
- No rotation of the head or neck, demonstrated by symmetry of the mandible, cranium, and vertebrae.
- Soft tissue and bony trabecular detail.

Additional Fuchs Notes:
- May use a cephalad tube angle if the patient unable to extend chin enough for proper position. Angle will be parallel with the patient’s mentomeatal line in the extended position.

Routine: 5 views (routinely): Left Lateral, AP Axial, Open Mouth Odontoid, PA Axial Obliques
(Cone down lateral, Swimmer’s & Fuch’s as needed)

Projection: **Both PA Axial Obliques (RAO & LAO)**

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Patient Prep: Remove artifacts from head, neck and mouth, including gown snaps.

Technique: AEC: 85 kVp, center cell, grid
Manual: 85 kVp, 10mAs, grid

SID: 40”

Collimation: 8 X 10 or 10 X 12 portrait

Patient Position: Patient erect if possible, arms down by their sides. If able, have patient hold sandbags in both hands to depress shoulders.
Turn patient PA, then rotate patient (chair) so their body forms a 45° angle with the IR. Keep their head positioned with the Midsagittal plane of the body at 45°. Extend (jut) chin slightly and center the spine to the IR.

Central Ray: Tube angled 15-20° caudad. To allow for the caudal angulation of the central ray, center the IR at the level of C5 (1” caudal to the most prominent point of the thyroid cartilage.) The central ray should be going through the level of C4.

Marker Placement: Mark the side against the IR with appropriate anatomical marker. Marker is placed posterior to neck.

Shielding: Shielding for males and females.

Breathing Instructions: Suspended respiration.

Purpose/Structures: Foramina ***closest*** to the IR are demonstrated, opened, from C2-C7, T1. Opened disk spaces.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- All seven cervical and the first thoracic vertebrae.
- Appropriate 45-degree rotation of body and neck
    - Open intervertebral foramina closest to the IR, from C2-3 to C7-T1
    - Uniform size and contour of the foramina
- Appropriately elevated chin
    - Mandible not overlapping the atlas and axis
    - Occipital bone not overlapping the atlas and axis
- Open intervertebral disk spaces
- Soft tissue and bony trabecular detail.

Additional Oblique Notes: If unable to sit patient erect for both obliques, these can be done supine (RPO & LPO). Angle the tube 15 degrees cephalad and mark the side against the IR anterior to the neck.

RH Department of Radiology Guidelines
Cervical Spine Charging

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Views Obtained	**Correct Charge**
Any 1 view including X-table Lateral (w or w/o collar)	XR Cervical Spine 1 VW
2 or 3 Views (any combination)	XR Cervical Spine 2 or 3 Views
Flexion and Extension Only	XR Cervical Spine Flex Ext Only
AP, Lateral, Odontoid	XR Cervical Spine AP Lateral Odontoid
4 or 5 views (any combination)	XR Cervical Spine 4 or 5 Views
6 or more views	XR Cervical Spine 6 or more Views
Routine Cervical Spine + Flex Ex	XR Cervical Spine w Flex Ext VWS

Charging Update Effective 2/14/17

*In the event we need to perform a FUCHS view to obtain better visualization of the odontoid, we will be counting this as a separate view and we will be charging for it *

For EPIC orders- if the order is for a XR Cervical Spine with specific views and you have taken additional views (ie Fuchs), this charge must be changed and the order sent back as co-sign required.

For Transcribed orders- we must obtain a new written order if the order specifically states the number of views and we have now acquired a Fuchs. If the written order simply states XR Cervical Spine- *you may proceed to charge appropriately*.

Pediatric Cervical Spine Views
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Pediatrics are considered patients under the age of 18

Pediatric trauma patients with trauma surgeon present: Lateral only (other views at discretion of trauma surgeon)

> 2 years old: AP, Lat, Odontoid

≤ 2 years old: AP and Lat

Regarding c-spine obliques on pediatric patients: No obliques unless requested by ordering physician. If they are requested, clarify order with Radiologist before obtaining.

Special Views for Cervical Spine

Projection: **Cross Table Lateral (Trauma)**
If collar must remain on, perform this projection first before other projections.

CT may also be performed first.
The attending physician or radiologist MUST review this image to rule out fracture or dislocation before removing collar or performing other projections.

Patient Prep: Remove artifacts from head, neck and mouth, including gown snaps, if able to safely with collar on.

Technique: AEC: 85 kVp, center cell, grid
Manual: 85 kVp, 8mAs, grid

SID: 72”

Collimation: 10 X 12 portrait to anatomy

Patient Position: Patient supine with **NO** head or neck manipulation.
Center the coronal plane that passes through the mastoid tips to midline of IR. Have the patient relax the shoulders as much as possible.
NOTE : Traction on arms will help depress shoulders but should only be performed by physician.

Central Ray: Direct the central ray perpendicularly so that it is entering C4 (thyroid cartilage).

Marker Placement: Left marker, placed anterior to the spine.
Annotate “x-table” and “with collar” if done with collar on

Shielding: Shielding for males and females.

Breathing Instructions: Suspended expiration.

Purpose/Structures: All cervical vertebrae and 1/3 of T1 in the lateral view. Demonstrates height and alignment of vertebral bodies, intervertebral disk spaces, as well as zygapophyseal joints.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- All seven cervical vertebrae and at least 1/3 of T1 (otherwise a separate radiograph of the cervico-thoracic region (cone down and/or swimmers) is recommended)
- C4 in the center of the radiograph.
- Superimposed or nearly superimposed rami of the mandible.
- No rotation or tilt of the cervical spine
    - Superimposing zygapophyseal joints and open intervertebral disk spaces
    - Superimposed or nearly superimposed rami of the mandible
    - Spinous processes shown in profile

Projection: **Cross Table Lateral CONEDOWN (Trauma)**
Only do if you did not get C7-T1 on regular cross table lateral

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Patient Prep: Remove artifacts from head, neck and mouth, including gown snaps, if able to safely with collar on.

Technique: AEC: 96 kVp, center cell, grid
Manual: 96 kVp, 28mAs, grid

SID: 72”

Collimation: 3-4” wide – length is patient dependent: light extended to top of ear with proper centering; portrait to anatomy

Patient Position: Patient supine with **NO** head or neck manipulation.
Center the mid coronal plane to horizontal centering line on IR. (slightly posterior to middle of collar). Have the patient relax the shoulders as much as possible.
NOTE : Traction on arms will help depress shoulders but should only be performed by physician.

Central Ray: Direct the central ray perpendicularly so that it is entering the thichest part of the shoulders. Light at superior patient should be at top of ear.

Marker Placement: Left marker, placed anterior to the spine.
Annotate “x-table” and “with collar” if done with collar on

Shielding: Shielding for males and females.

Breathing Instructions: Suspended expiration.

Purpose/Structures: C2-C7 should be visualized, C7-T1 properly penetrated.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- Visualization of C2-T1, not appreciably rotated from lateral position.
- Visualization of bony structures of C7-T1 and joint space with adequate penetration

Projection: **Cross Table Lateral SWIMMER’S (Trauma)**
Only do if you did not get C7-T1 on conedown.

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Note: IF C7-T1 is still unclear after swimmer's, the ED physician or a radiologist should check the images and may recommend a CT instead of completing the cspine study.
Do not attempt if patient has shoulder pain or injury

Patient Prep: Remove artifacts from head, neck and mouth, including gown snaps, if able to safely with collar on.

Technique: AEC: 96 kVp, center cell, grid
Manual: 96 kVp, 28mAs, grid

SID: 40" (56-60" detent is acceptable if 40 cannot fit due to angling of the litter)

Collimation: 12x10 portrait to spine

Patient Position: Patient supine with **NO** head or neck manipulation.
Center the mid coronal plane to horizontal centering line on IR. (slightly posterior to middle of collar). Elevate the arm nearest the IR. Keep arm nearest the tube down by their side. Have the patient reach up with the elevated arm and down towards their toes with the opposite arm as best as possible.

Central Ray: Direct the central ray perpendicularly to level of C7-T1 located approximately 2" above the jugular notch.) Since pt will not be able to anteriorly and posteriorly separate shoulders angle should be included.

- If using a free detector, angle the tube 3-5 degrees caudal (parallel with portrait grid strips)
- If supine and using wall unit, angle head of litter slightly away from IR since you can not angle the tube caudad towards the patient's feet on the erect DR board because of the grid.

Marker Placement: Left marker, placed anterior to the spine.
Annotate "x-table" and "with collar" if done with collar on

Shielding: Shielding for males and females.

Breathing Instructions: Suspended expiration.

Purpose/Structures: Lateral C5-approximately T4 visualized with separation of humeral heads.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- Adequate xray penetration through shoulder region demonstrating lower cervical and upper thoracic vertebra, not appreciably rotated from lateral position.

Projection: **Lateral Flexion and Extension (Should NOT be attempted unless fracture has been ruled out)**

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Patient Prep: Remove artifacts from head, neck and mouth.

Technique: AEC: 85 kVp, center cell, grid
Manual: 85 kVp, 8mAs, grid

SID: 72”

Collimation: 10 X 12 portrait

Patient Position: Patient erect as possible with left side against the IR. Place in true lateral position. Center the coronal plane to midline of IR.
Have the patient depress the shoulders as far as possible (sandbags should be given to the patient if not contraindicated).
Flexion – Ask patient to drop head forward as much as possible and draw chin as close to chest as possible.. Body of mandible will be almost vertical.
Extension – Ask the patient to elevate chin as much as possible. Body of mandible will be almost horizontal.

Central Ray: Direct the central ray perpendicularly so that it is entering C4 (thyroid cartilage).

Marker Placement: Left marker, placed anterior to the spine.
Annotate “flexion” and “extension” as appropriate

Shielding: Shielding for males and females.

Breathing Instructions: Suspended expiration.

Purpose/Structures: Demonstrate the normal anteroposterior movement or absence of movement resulting from trauma or disease (motility of cervical spine, disks and zygapophyseal joints). Rule put whiplash injuries. Also done post spinal fusion.

Evaluation Criteria:

- Evidence of proper collimation and side marker placed clear of anatomy of interest
- All seven vertebrae in true lateral position
    - No rotation or tilt of the cervical spine
        - Superimposed zygapophyseal joints and open intervertebral disk spaces
        - Superimposed or nearly superimposed rami of the mandible
        - Spinous processes shown in profile
- Bony trabecular detail and surrounding soft tissues

- Hyperflexion and hyperextension identification markers correctly used for each respective projection
- Hyperflexion
    - Body of mandible almost vertical in normal patient
    - All seven spinous processes in profile, elevated and widely separated
- Hyperextension
    - Body of mandible almost horizontal in normal patient
    - All seven spinous processes in profile, depressed and closely spaced

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Projection: **Both AP Axial Obliques (RPO & LPO)**

Patient Prep: Remove artifacts from head, neck and mouth.

Technique: AEC: 85 kVp, center cell, grid
Manual: 85 kVp, 10mAs, grid

SID: 40”

Collimation: 8 X 10 or 10 X 12 portrait

Patient Position: Patient erect if possible, arms down by their sides. If able, have patient hold sandbags in both hands to depress shoulders.
Turn patient AP, then rotate patient (chair) so their body forms a 45° angle with the IR. Keep their head positioned with the MSP of the body at 45°. Extend (jut) chin slightly and center the spine to the IR.

Central Ray: Tube angled 15-20° **cephalad.** Center IR to 3rd cervical body (1” superior ro most prominent point of thyroid cartilage) to compensate for cephalic angulation of central ray.

Marker Placement: Mark the side against the IR with appropriate anatomical marker. Marker is placed anterior to neck.

Shielding: Shielding for males and females.

Breathing Instructions: Suspended respiration.

Purpose/Structures: Foramina **farthest** from IR are demonstrated, opened, from C2-C7, T1. Opened disk spaces.

Evaluation Criteria:

- Evidence of proper collimation and presence of side marker placed clear of anatomy of interest.
- All seven cervical and the first thoracic vertebrae.
- Appropriate 45-degree rotation of body and neck
    - Open intervertebral foramina furthest from the IR, from C2-3 to C7-T1
    - Uniform size and contour of the foramina
- Appropriately elevated chin
    - Mandible not overlapping the atlas and axis
    - Occipital bone not overlapping the atlas and axis
- Open intervertebral disk spaces
- Soft tissue and bony trabecular detail.

Additional Oblique Notes:

- If unable to sit patient erect for both obliques, these can be done supine (RPO & LPO).

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Trauma Axial Oblique C-Spine

- Do not use grid
  - Double angle will cause grid cut off
- IR gently placed under supine and immobilized patient
- IR centered to the mastoid process opposite the tube at the level of C4
  - Approximately 3” lateral to the MSP

Central Ray

- 45 degrees lateromedially
- 15-20 degrees cephalad
- Enters slightly lateral to MSP at the level of C4

- 40” SID
- Mark side opposite from tube

Evaluation criteria

- Image will look distorted
- Dislocations and subluxations shown
- Should see C1-T1
- Opens up the intervertebral disc spaces and intervertebral foramina on side opposite of the CR entrance point

- When CR enters the right side, the left foramina and disk space are demonstrated

- When CR enters the left side, the right disk spaces and foramina are demonstrated