

Thoracic and Cervical Spine Imaging: A Blunt Investigation of MVC Trauma

Ryan Ellis, MS4

5/30/19

DII RAD 4001 elective

(Assistance provided by Dr. Catherine Carney, M.D.)

History

21 M

Presented to MHH ER as Trauma
Level 1 post MVC – 0300 5/27/19

- Fell asleep at the wheel, ran off road
where the vehicle rolled multiple times,
found hours later.

+ LOC, + Airbags, +SB, prolonged extrication

History

21 M

HR 72, BP 82/118, RR 18, SpO2 98% on 2LNC

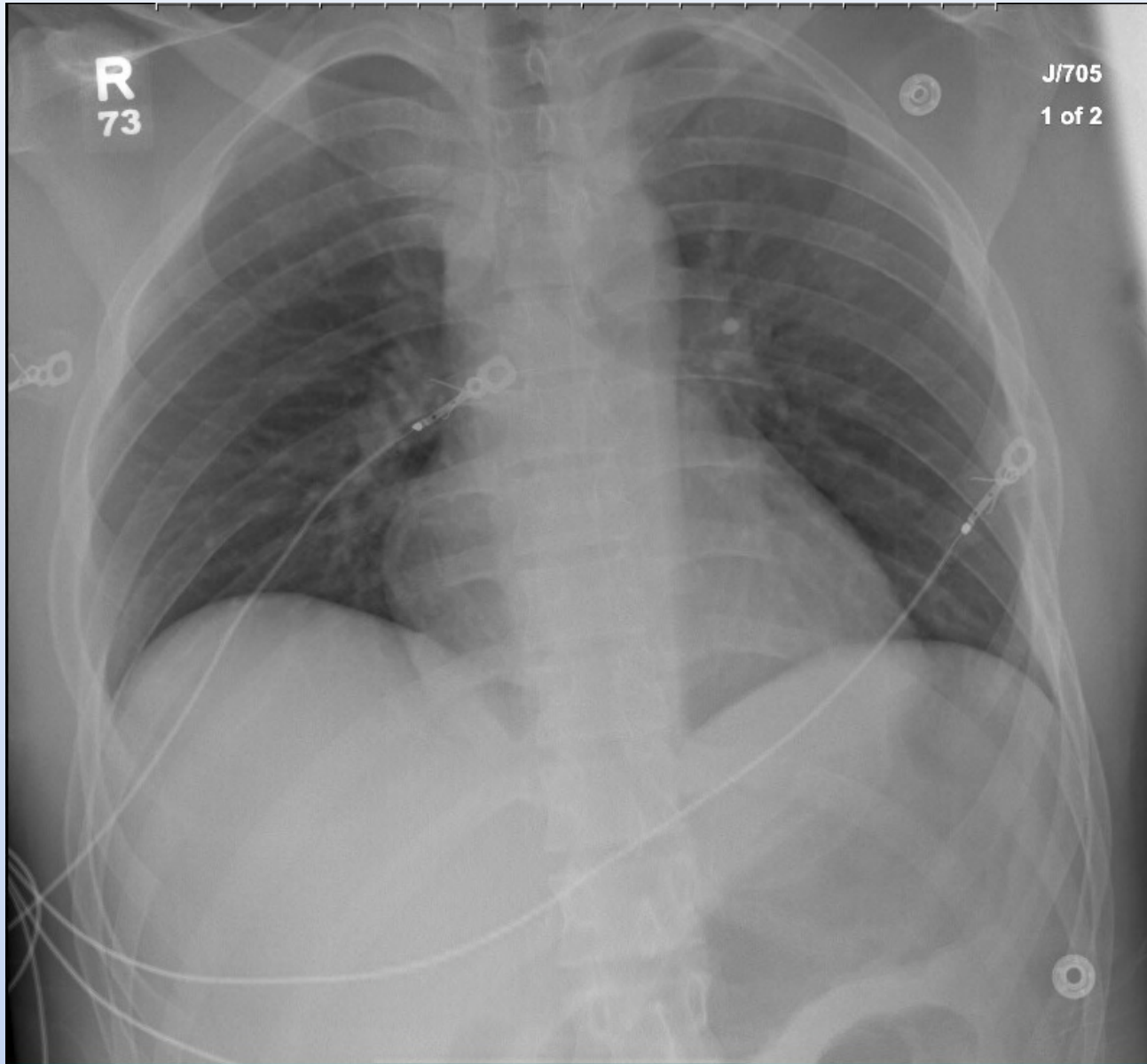
Patient noted to be insensate below T4 with paralysis of BLE, tenderness over cervical and upper thoracic spinous processes

No previous medical or surgical history.

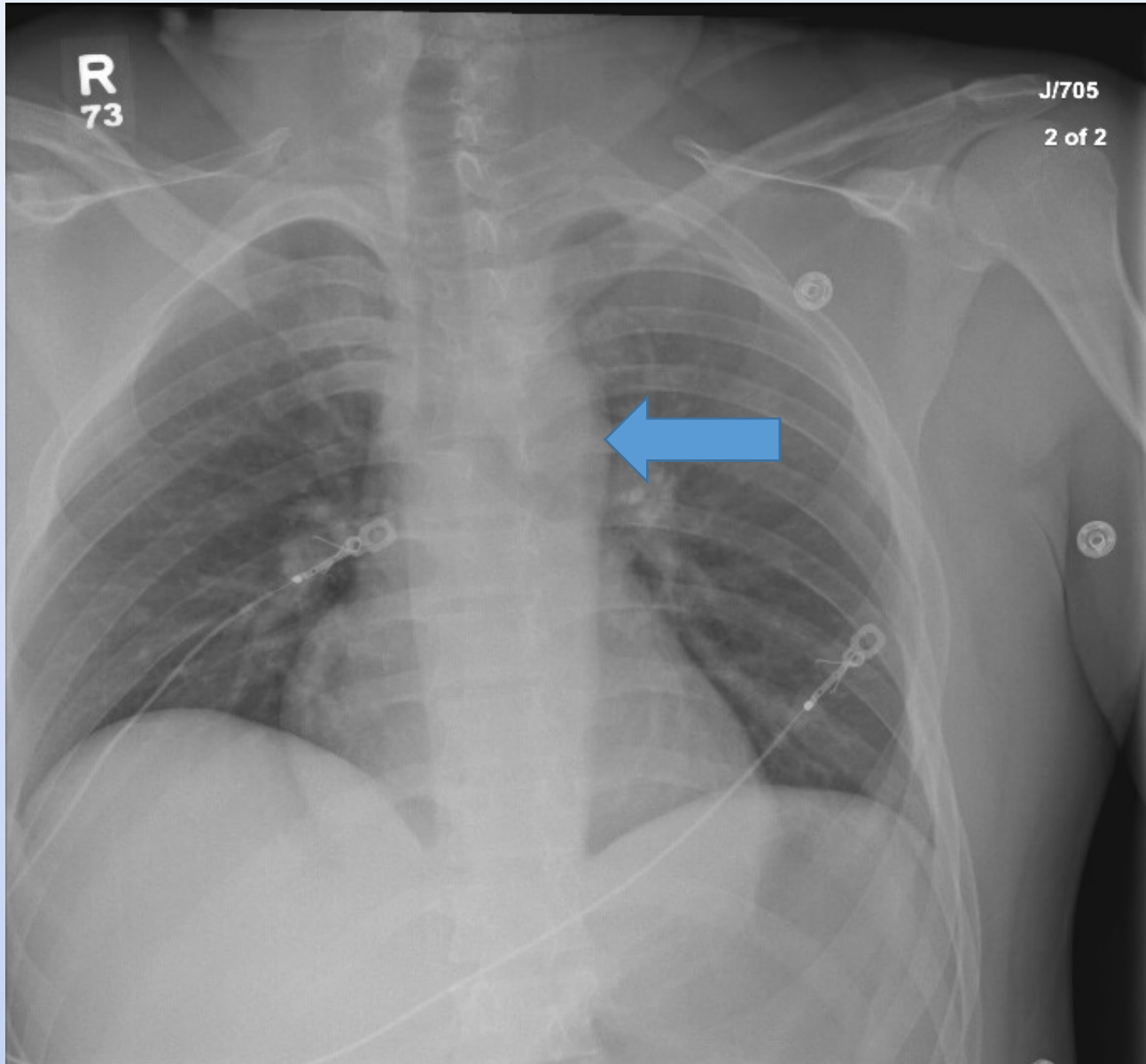
Systematic review of chest radiographs s/p blunt trauma

- A – Assessment of image quality / Airway
 - Position, Inspiration, Exposure, Rotation
- B – Bones and soft tissues
- C – Cardiac
 - Heart: <50% on PA, <60% on AP
- D – Diaphragm
 - check for hemidiaphragm and for free gas below
- E – Effusions / Extrathoracic soft tissue
 - check the costophrenic angles, lateral films for small post. effusions
- F – Fields, Fissures, and foreign bodies
 - Check for infiltrates, masses, consolidation, and vascular markings
- G – Great vessels / gastric bubble
- H – Hila and mediastinum
 - check for lymphadenopathy, calcifications, and masses, L>R, trach. dev.
- I - Impression

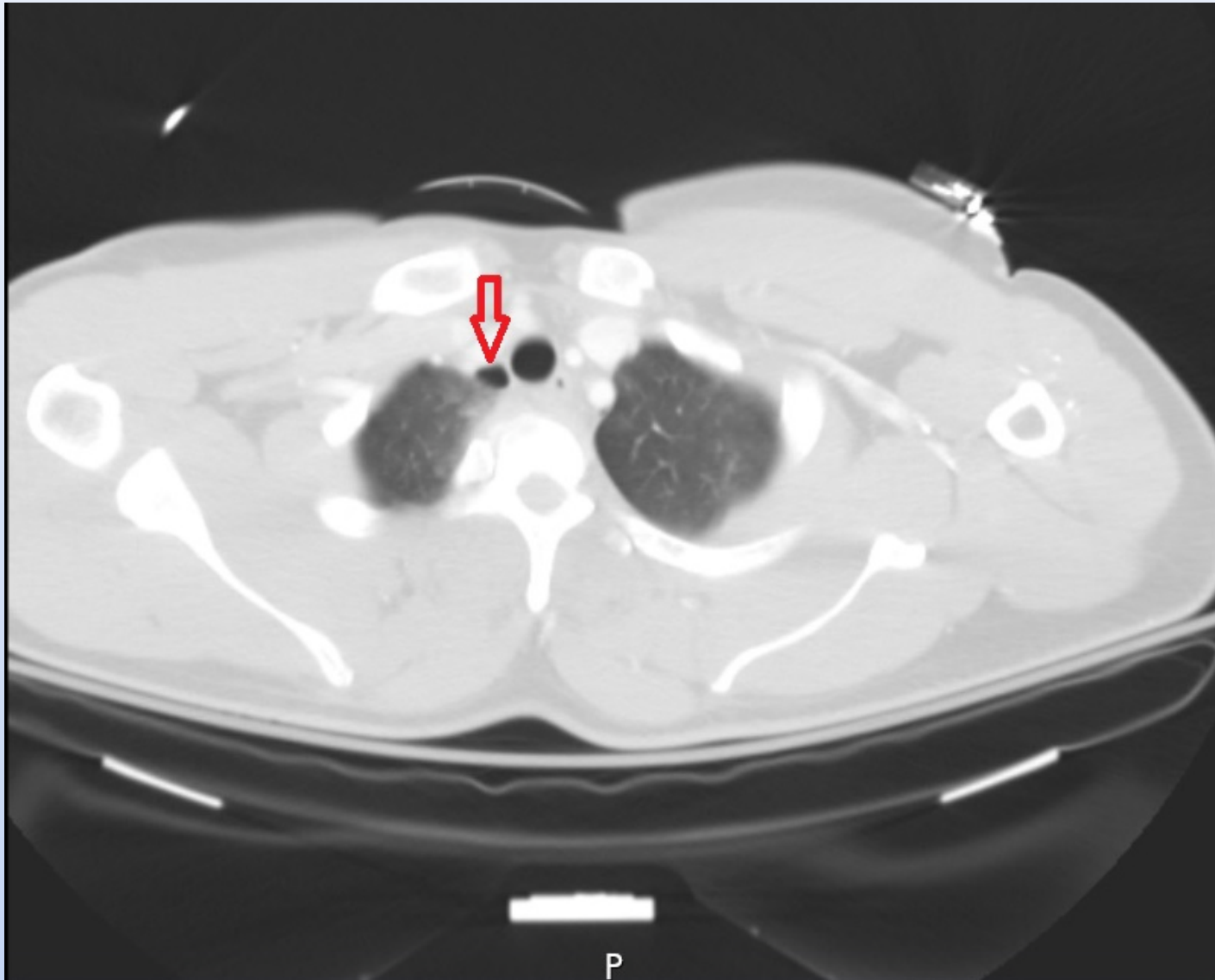
AP Chest – Single View



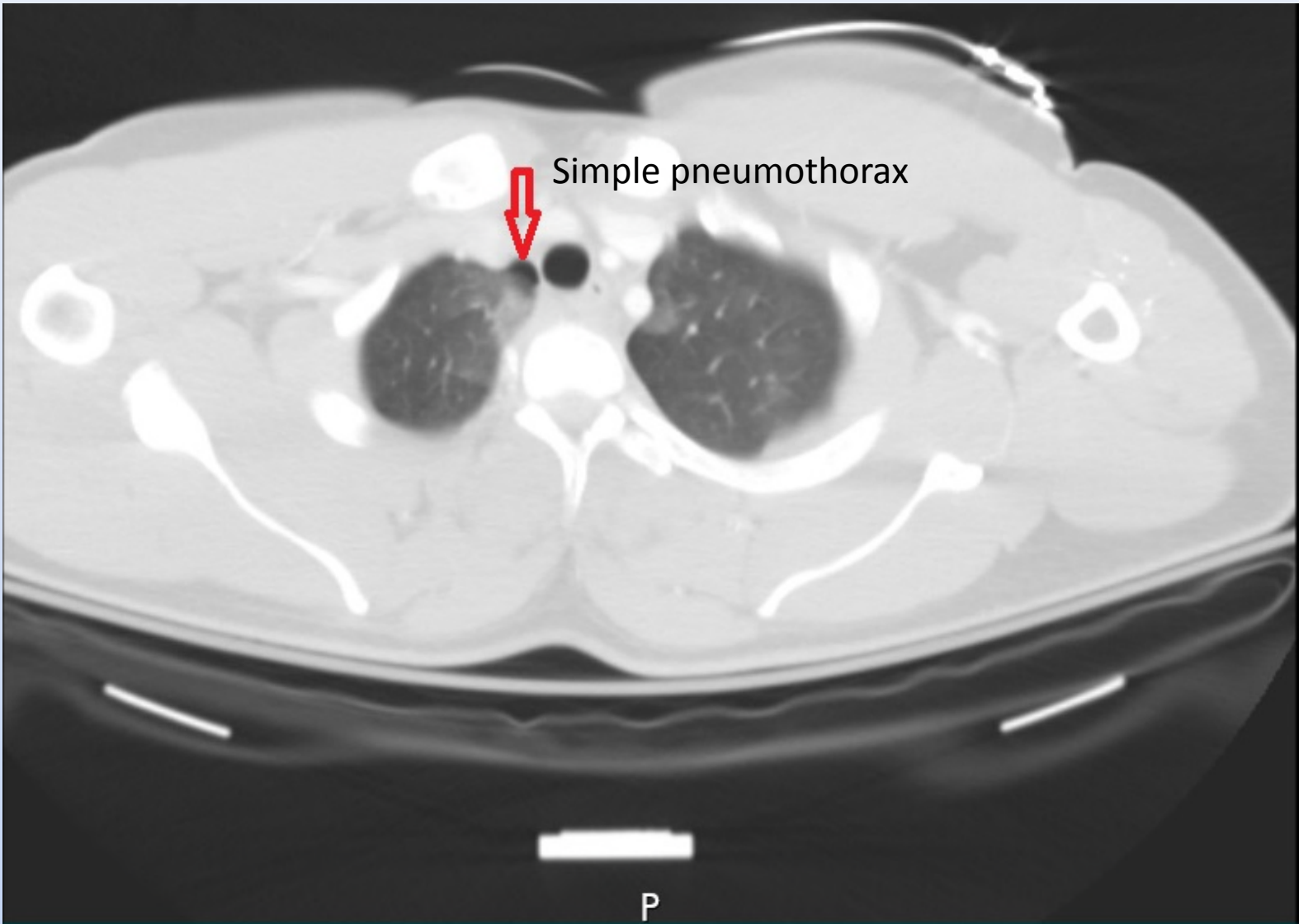
AP Chest – Single View



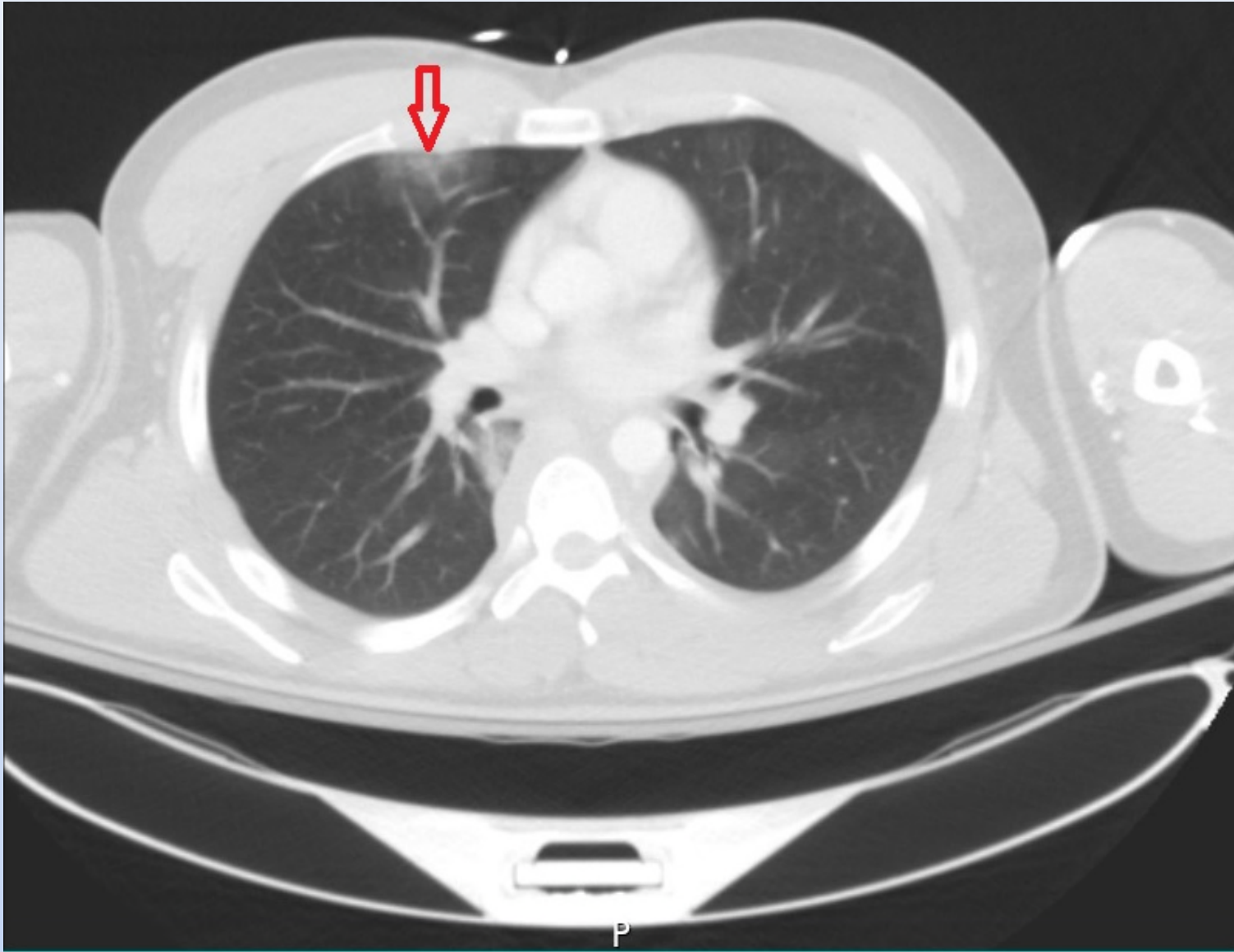
Axial Chest CT



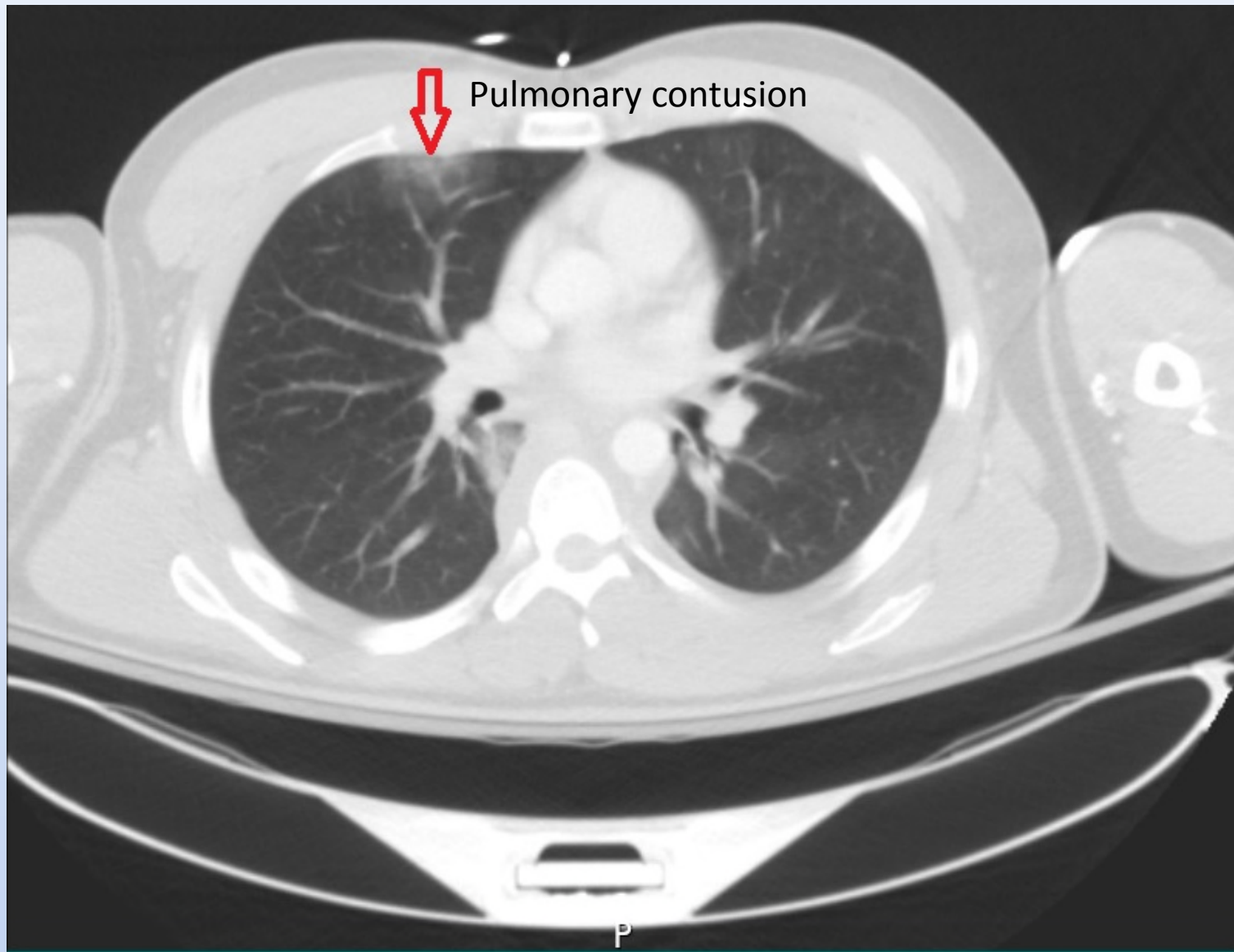
Axial Chest CT



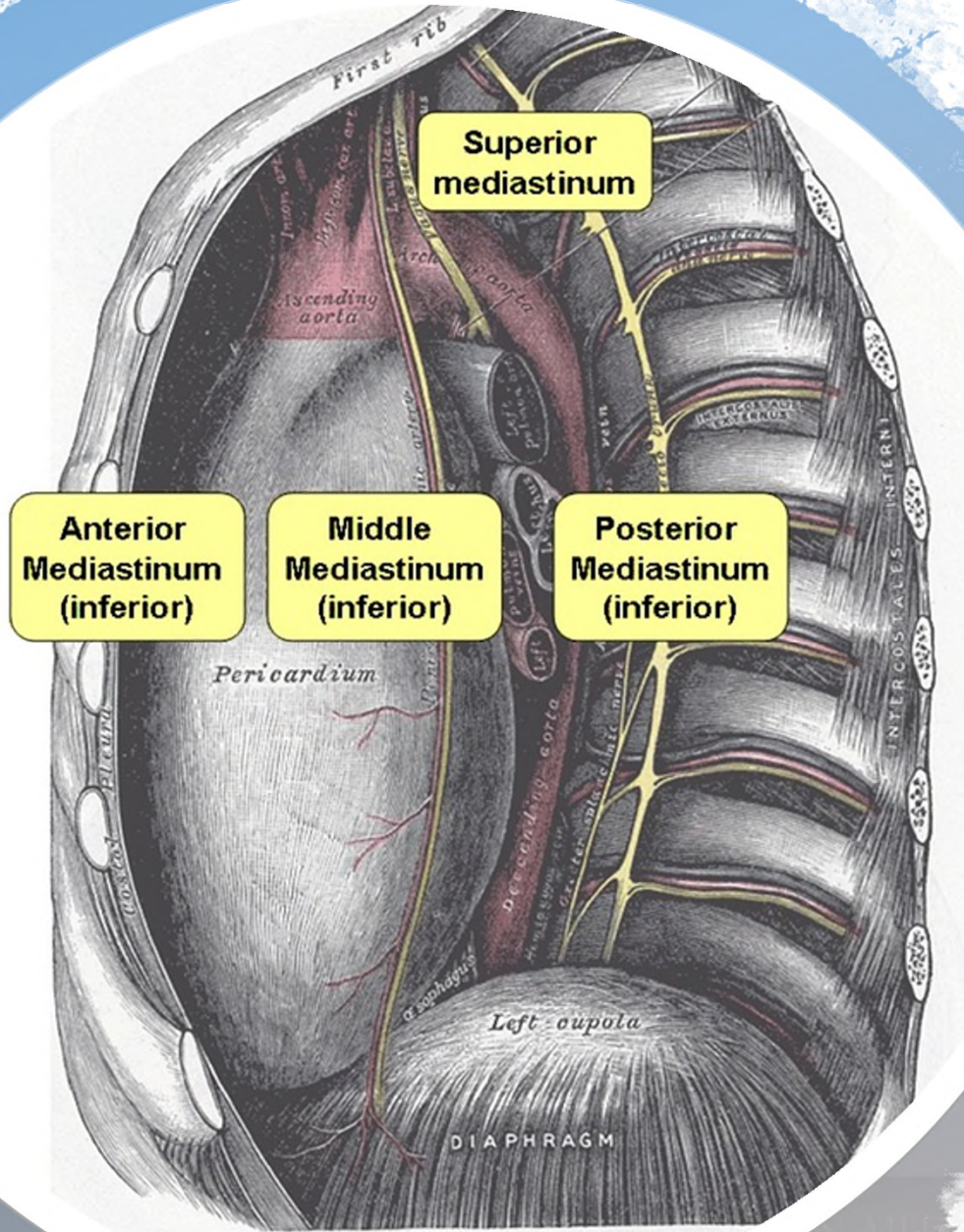
Axial Chest CT



Axial Chest CT



Approach to evaluation of chest imaging



- **Superior mediastinum:** above the upper level of the pericardium and plane of Ludwig
- **Inferior mediastinum:** below the plane of Ludwig
 - Anterior mediastinum: anterior to the pericardium
 - Middle mediastinum: within the pericardium
 - Posterior mediastinum: posterior to the pericardium

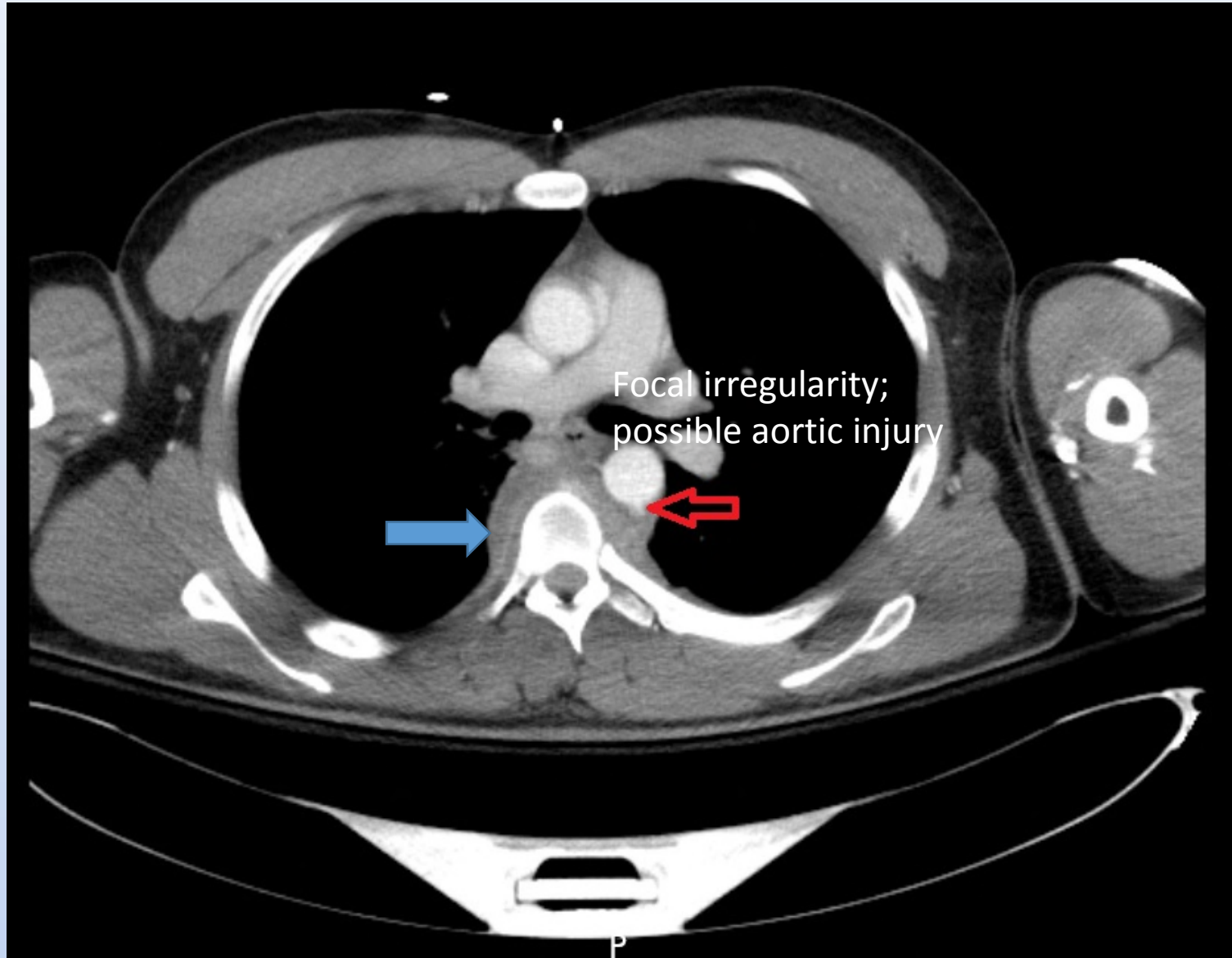
Parasagittal Chest CT with contrast



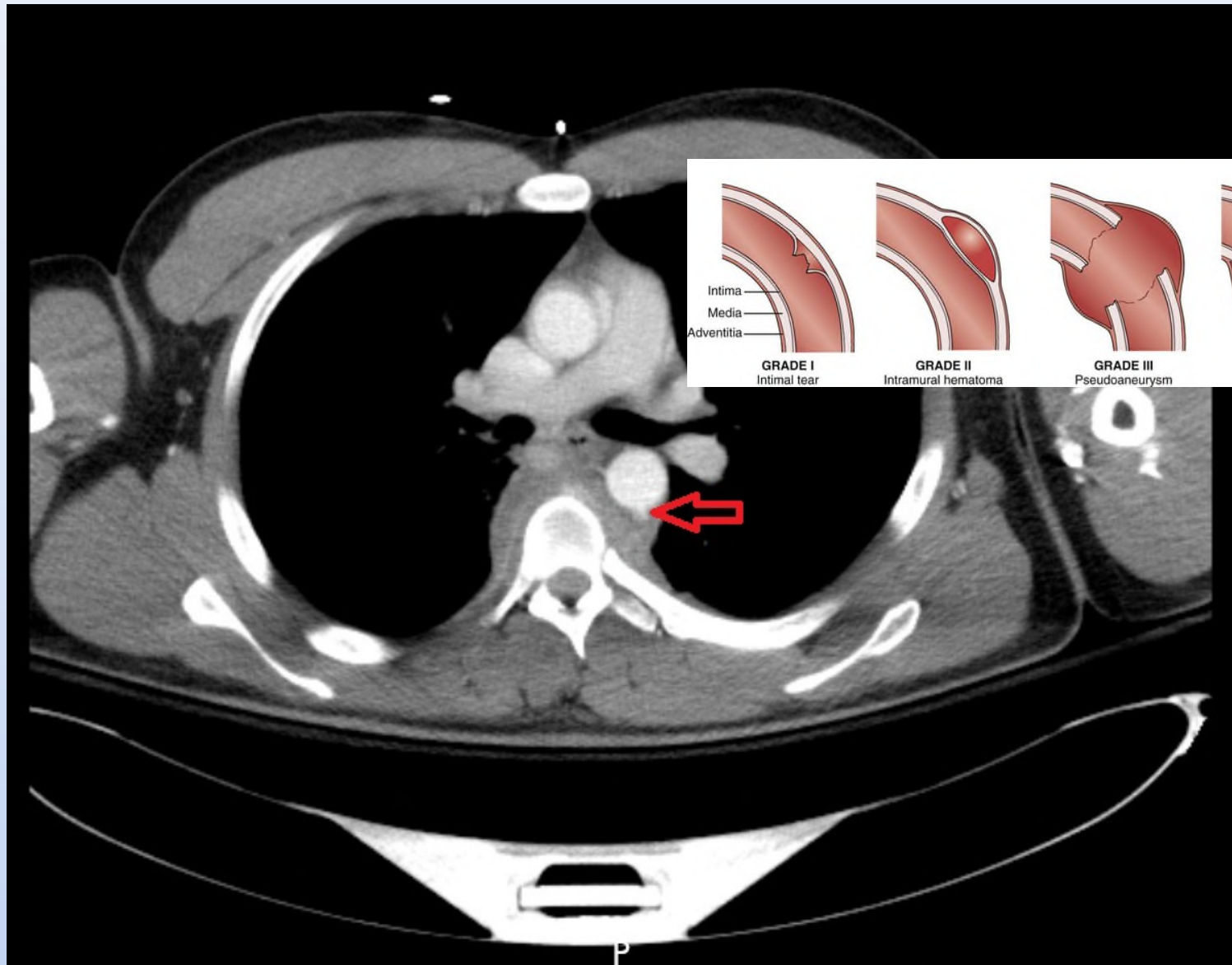
Axial Chest CT with contrast



Axial Chest CT with contrast



Axial Chest CT with contrast

















Differential Diagnosis

- Patchy airspace opacities at the anterior aspects of both lungs
 - Pulmonary contusion secondary to lung trauma
 - Focal atelectasis
 - Fat embolism
 - Pulmonary hemorrhage
 - Pneumonia
- Defined area of lucency between the visceral and parietal pleura at right lung apex
 - Simple pneumothorax secondary to lung trauma
 - Tracheobronchial rupture
 - Esophageal rupture
- Focal irregularity at the external surface of the posterior wall of the descending aorta at the T4-T5 level
 - Thoracic aortic injury secondary to trauma (Grade 1 vs. Grade 2)
 - Congested/injured spinal artery at its aortic origin

Evaluation of cervical spine trauma



AOSpine Subaxial Classification System

Type A. Compression Injuries	Type B. Distraction Injuries	Type C. Translation Injuries
A0. Minor, nonstructural fractures 	B1. Posterior tension band injury (bony) 	C. Translational injury in any axis-displacement or translation of one vertebral body relative to another in any direction 
A1. Wedge-compression 	B2. Posterior tension band injury (bony capsulo-ligamentous, ligamentous) 	
A2. Split 	B3. Anterior tension band injury 	Type F. Facet Injuries
A3. Incomplete burst 		F1. Nondisplaced facet fracture 
A4. Complete burst 	BL. Bilateral Injuries	F2. Facet fracture with potential for instability 
	BL. Bilateral injury 	F3. Floating lateral mass 
		F4. Pathologic subluxation or perched/dislocated facet 

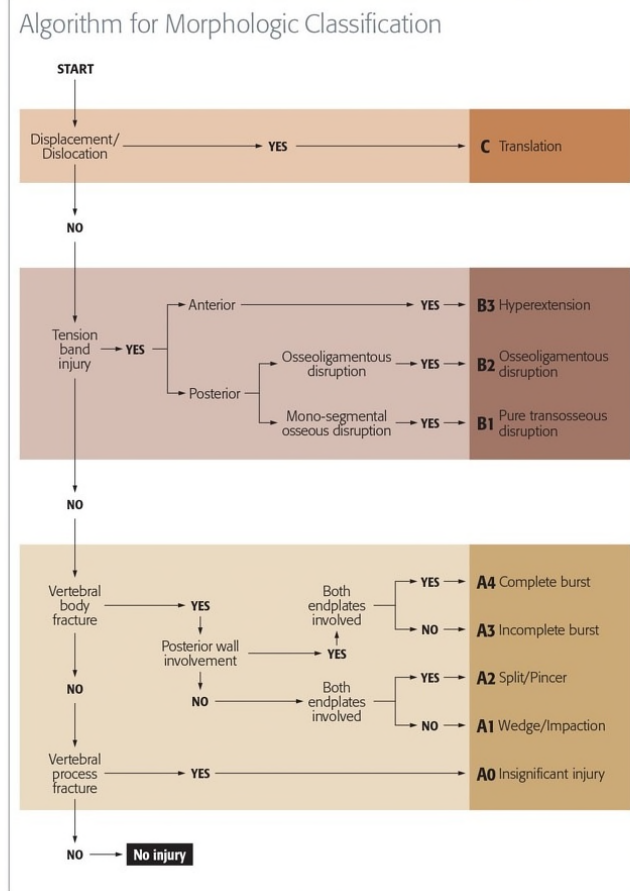
Contact: research@aospine.org
Further information: www.aospine.org/classification

courtesy of AO Foundation, Radiopaedia.org, rID: 59372

Evaluation of cervical spine trauma



AOSpine Subaxial Classification System

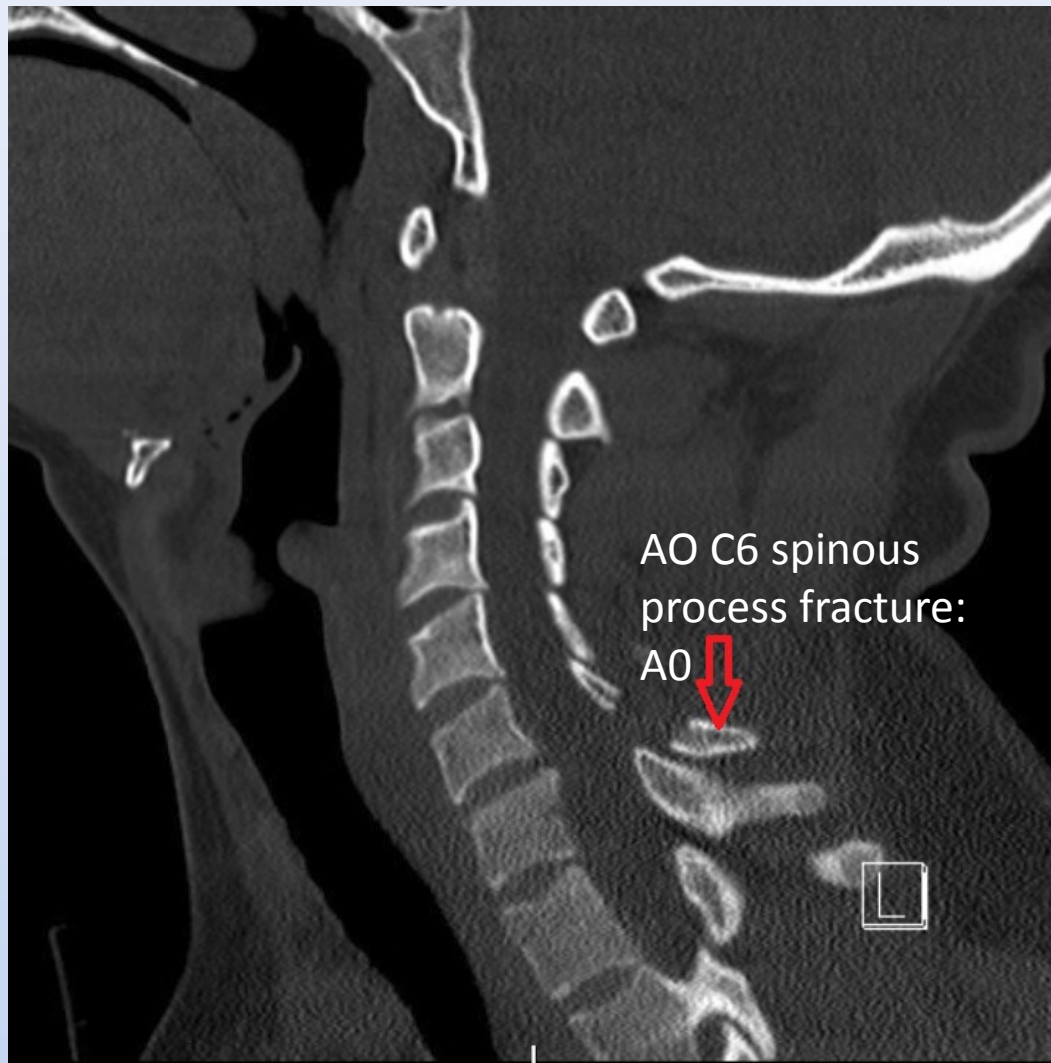


courtesy of AO Foundation, Radiopaedia.org, rID: 59372

Sagittal C-spine CT without contrast



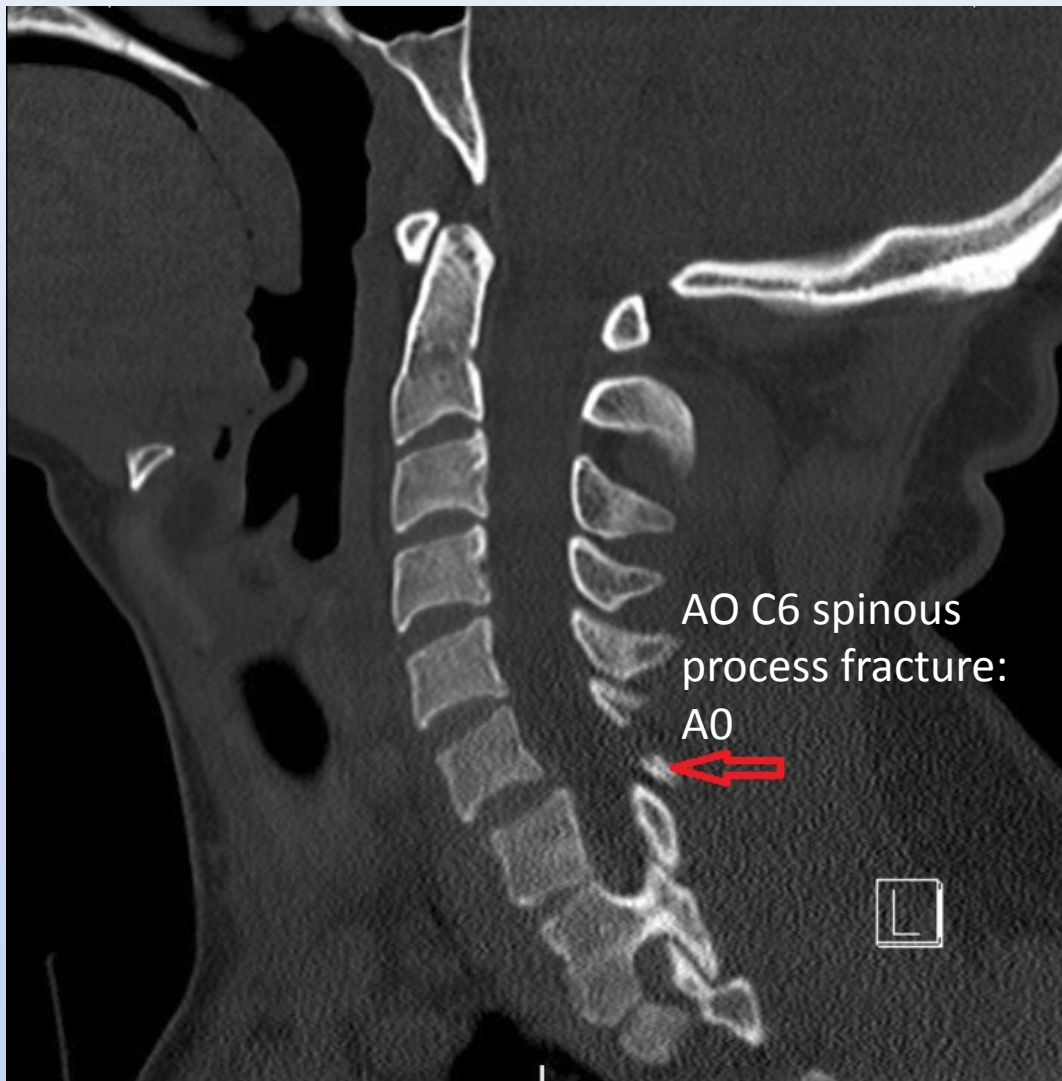
Sagittal C-spine CT without contrast



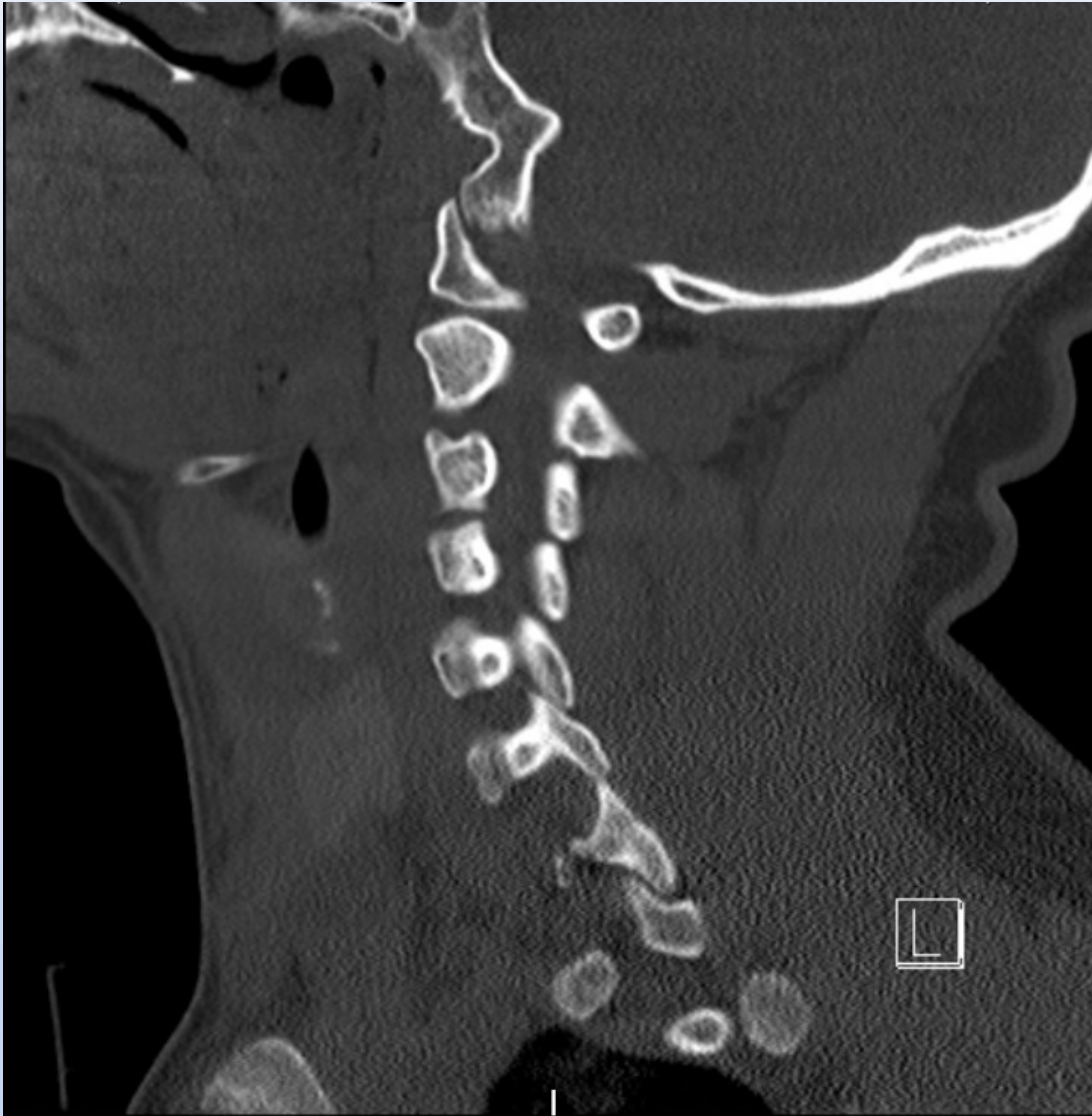
Sagittal C-spine CT without contrast



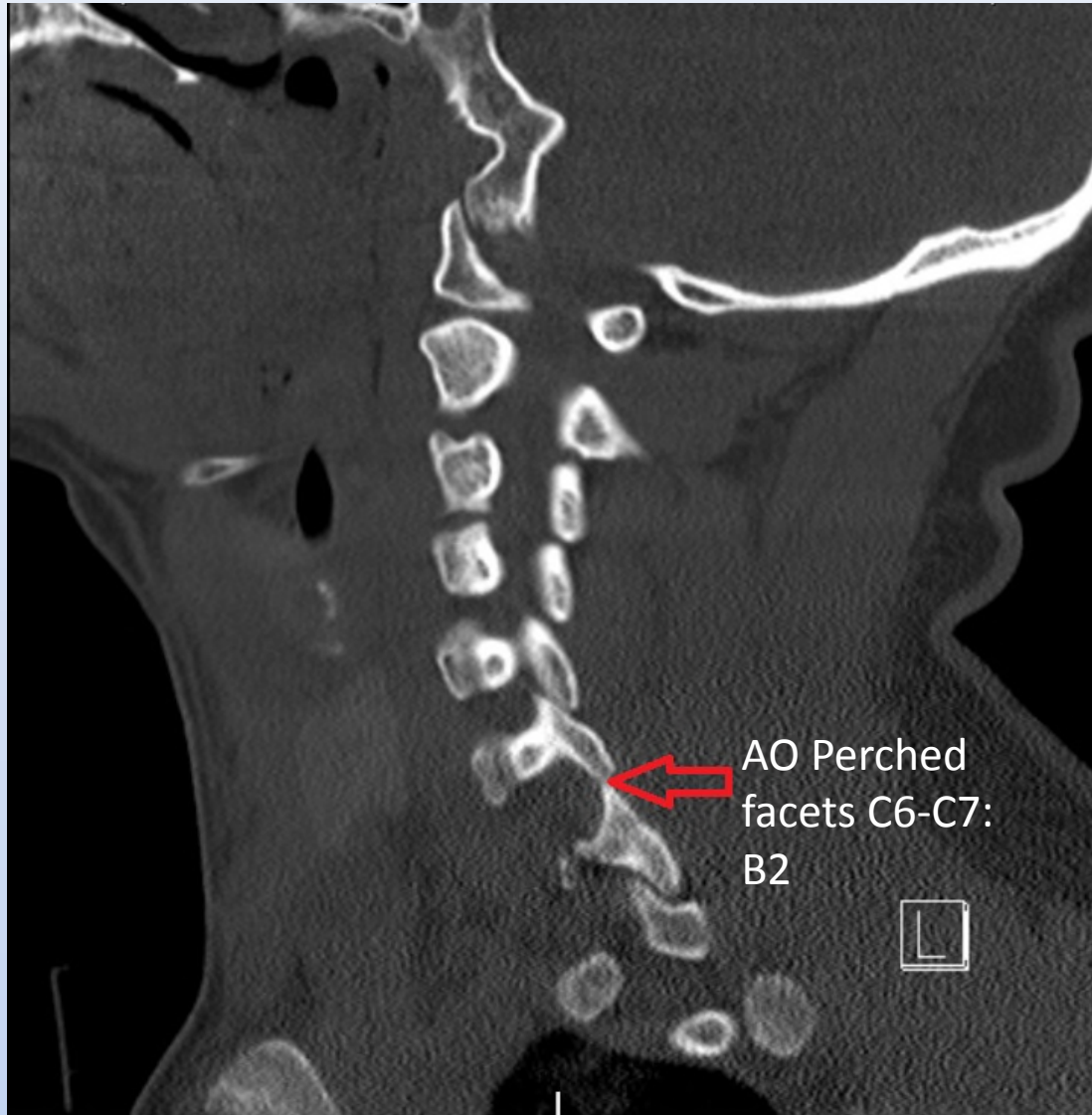
Sagittal C-spine CT without contrast



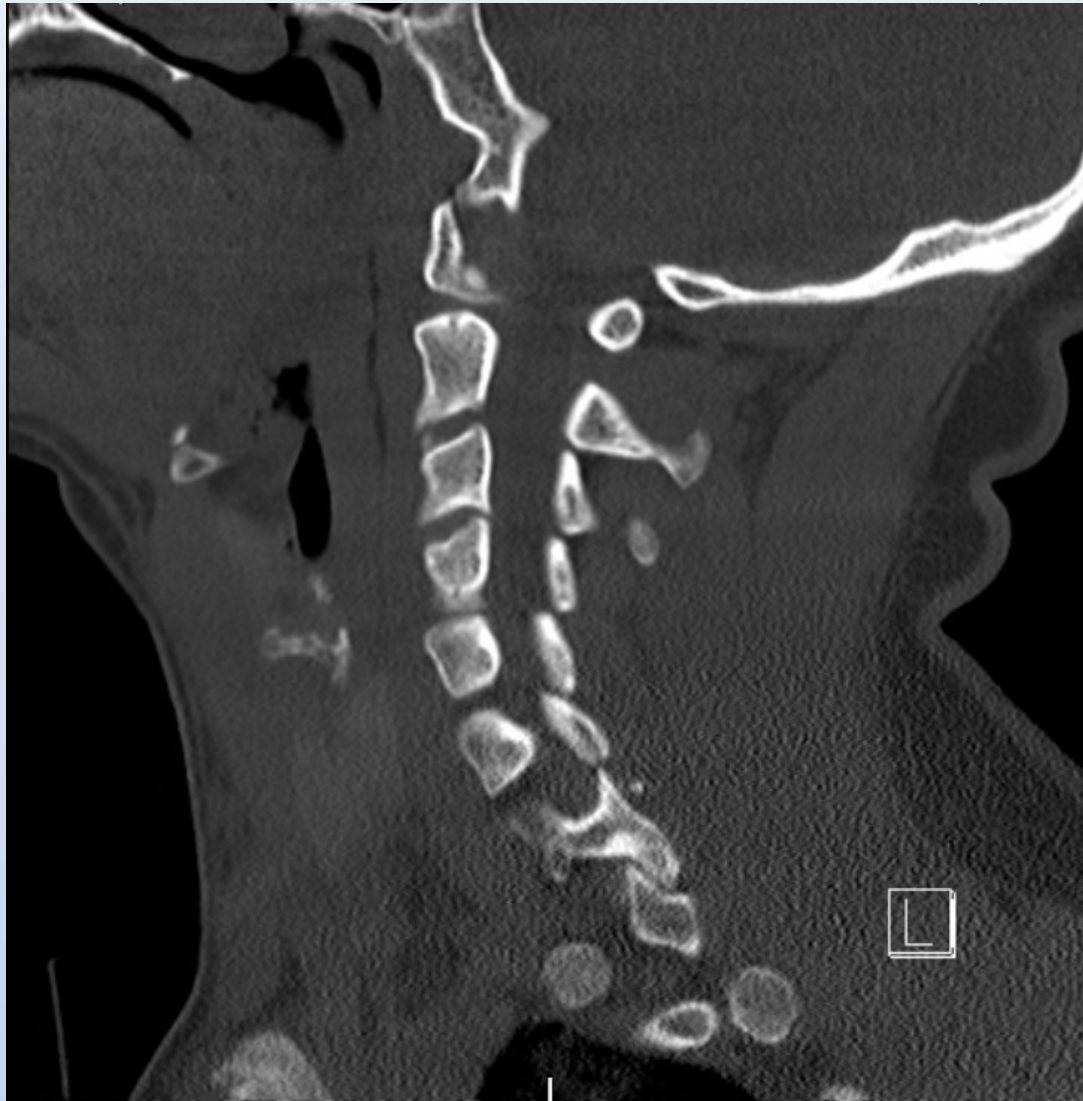
Sagittal C-spine CT without contrast



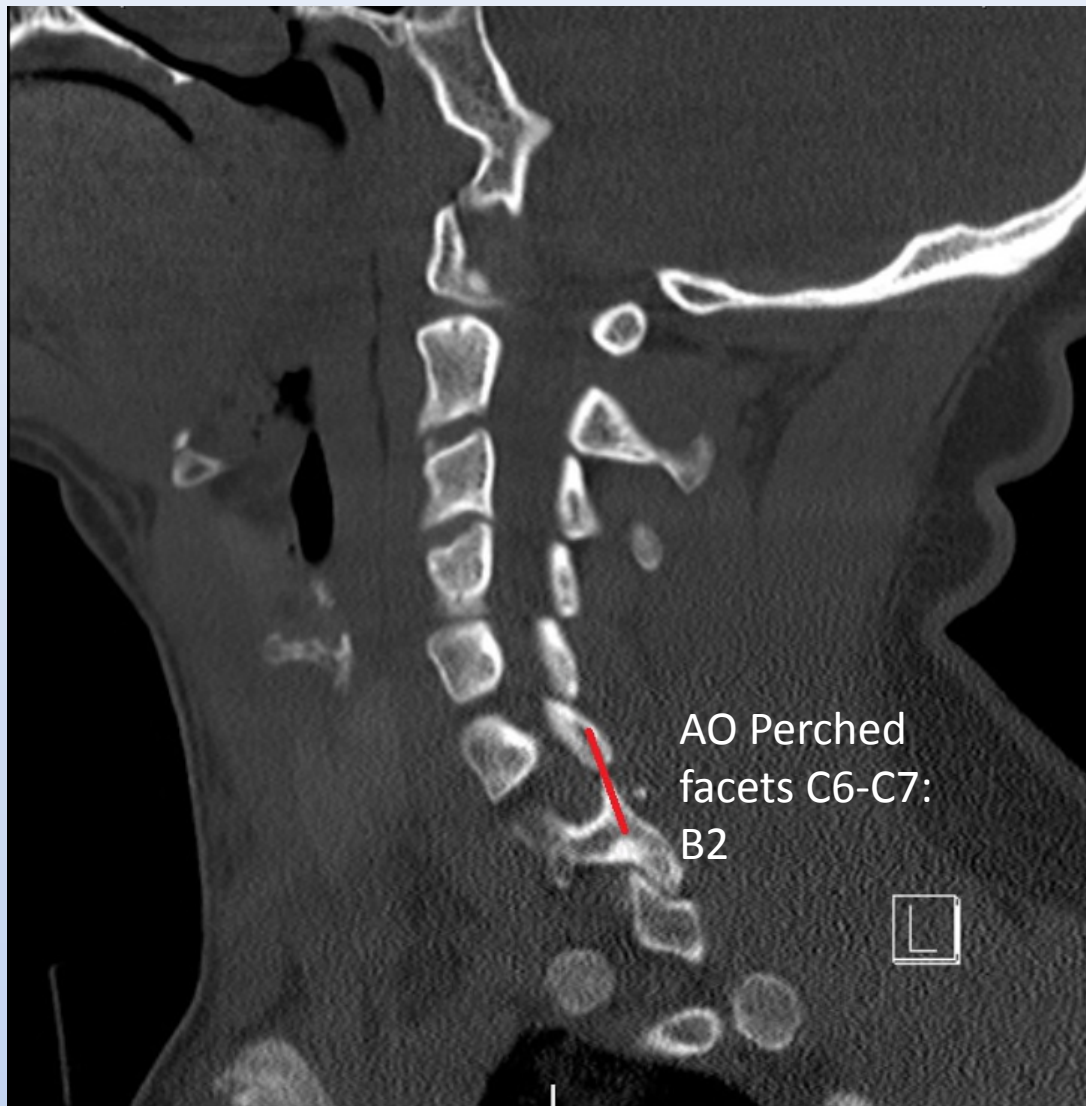
Sagittal C-spine CT without contrast



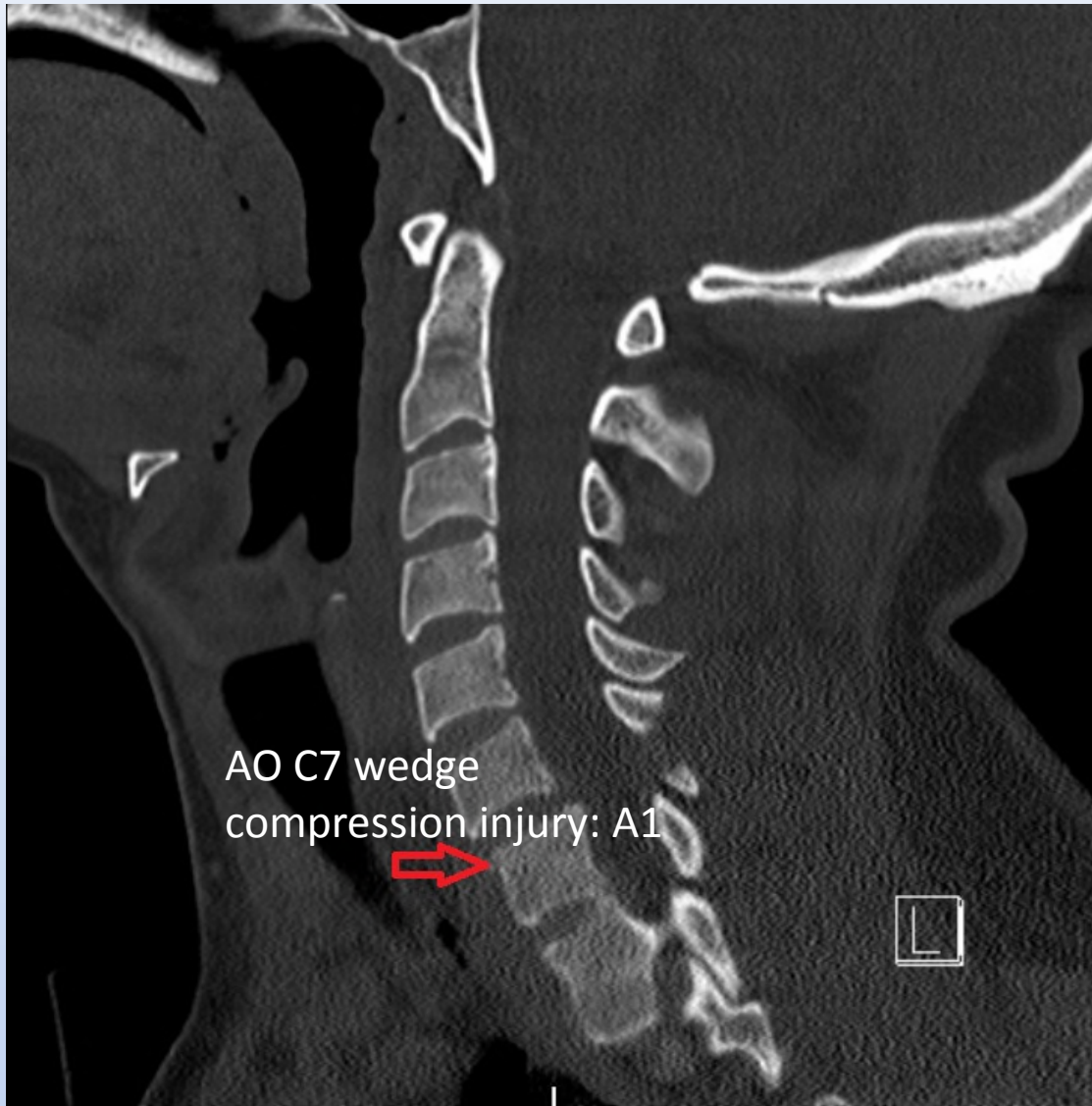
Sagittal C-spine CT without contrast



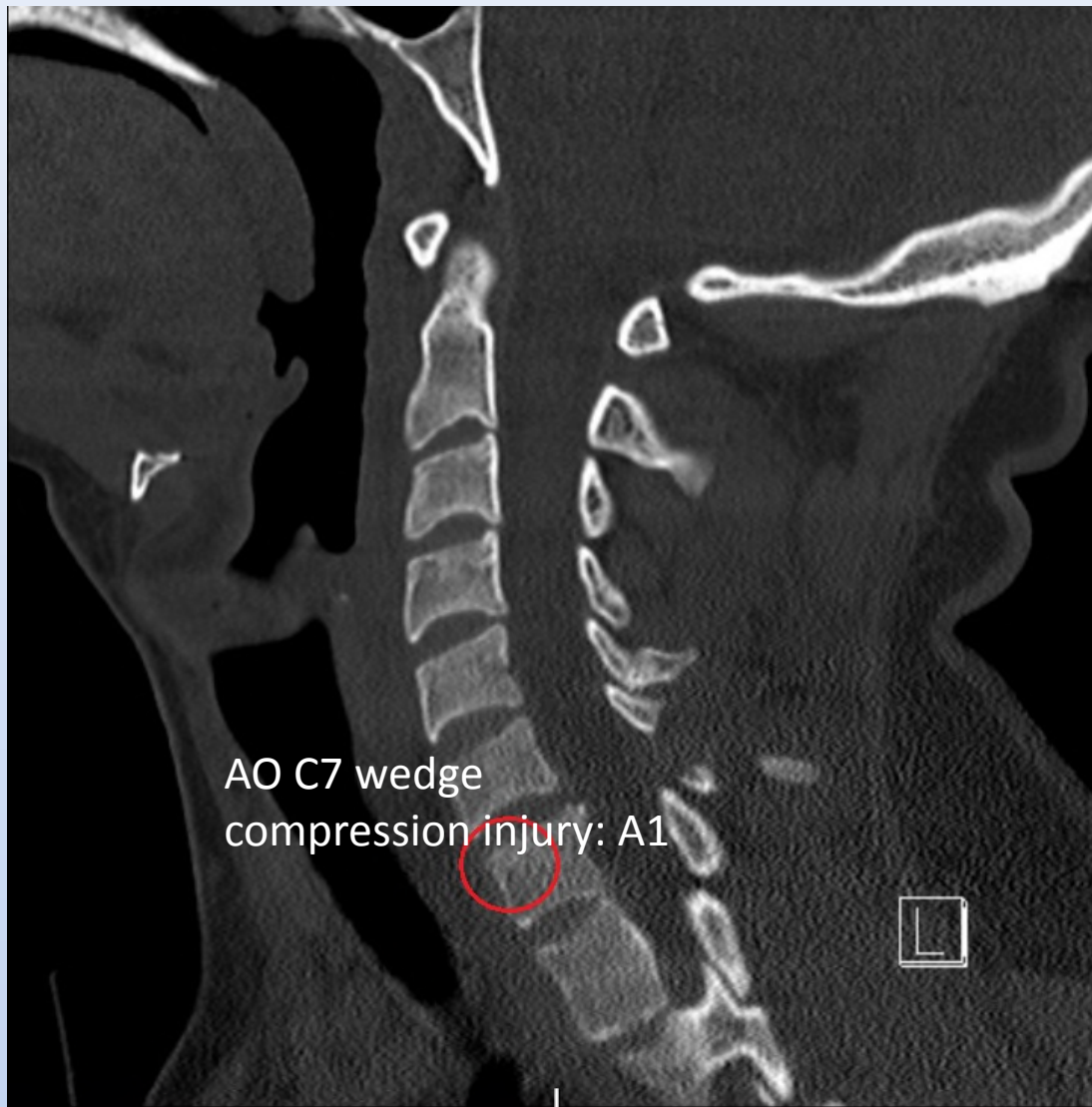
Sagittal C-spine CT without contrast



Sagittal C-spine CT without contrast



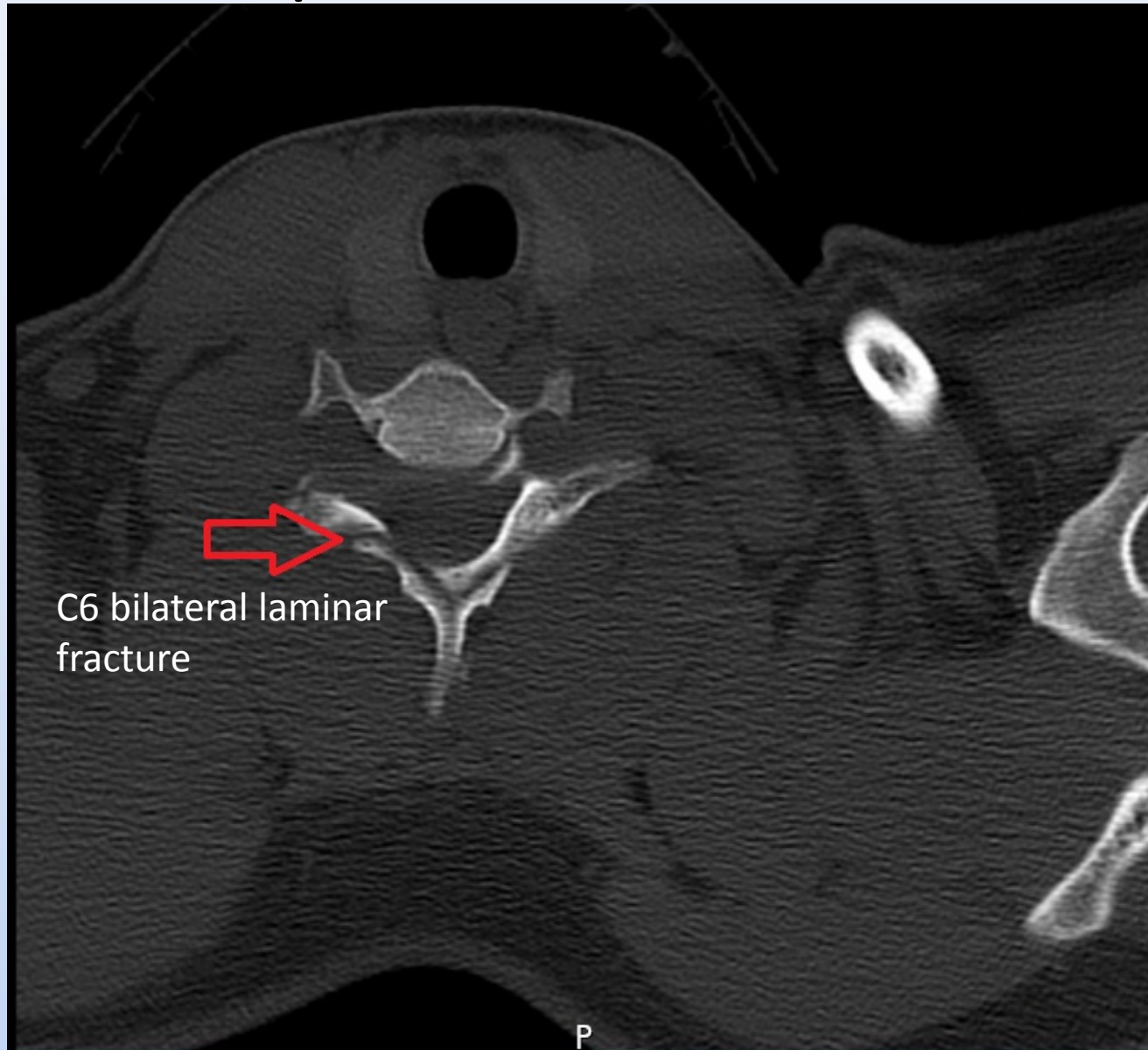
Sagittal C-spine CT without contrast



Axial C-spine CT without contrast



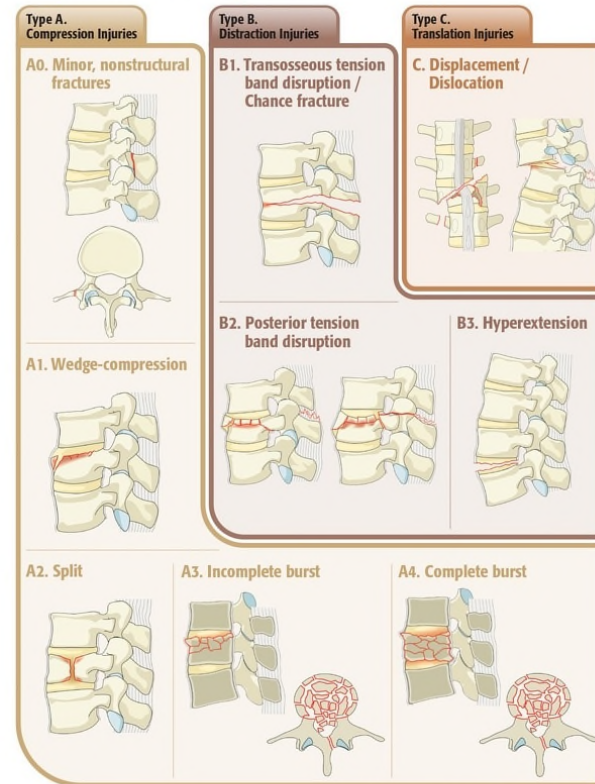
Axial C-spine CT without contrast



Evaluation of thoracolumbar spine trauma



AOSpine Thoracolumbar Classification System



Contact: research@aospine.org

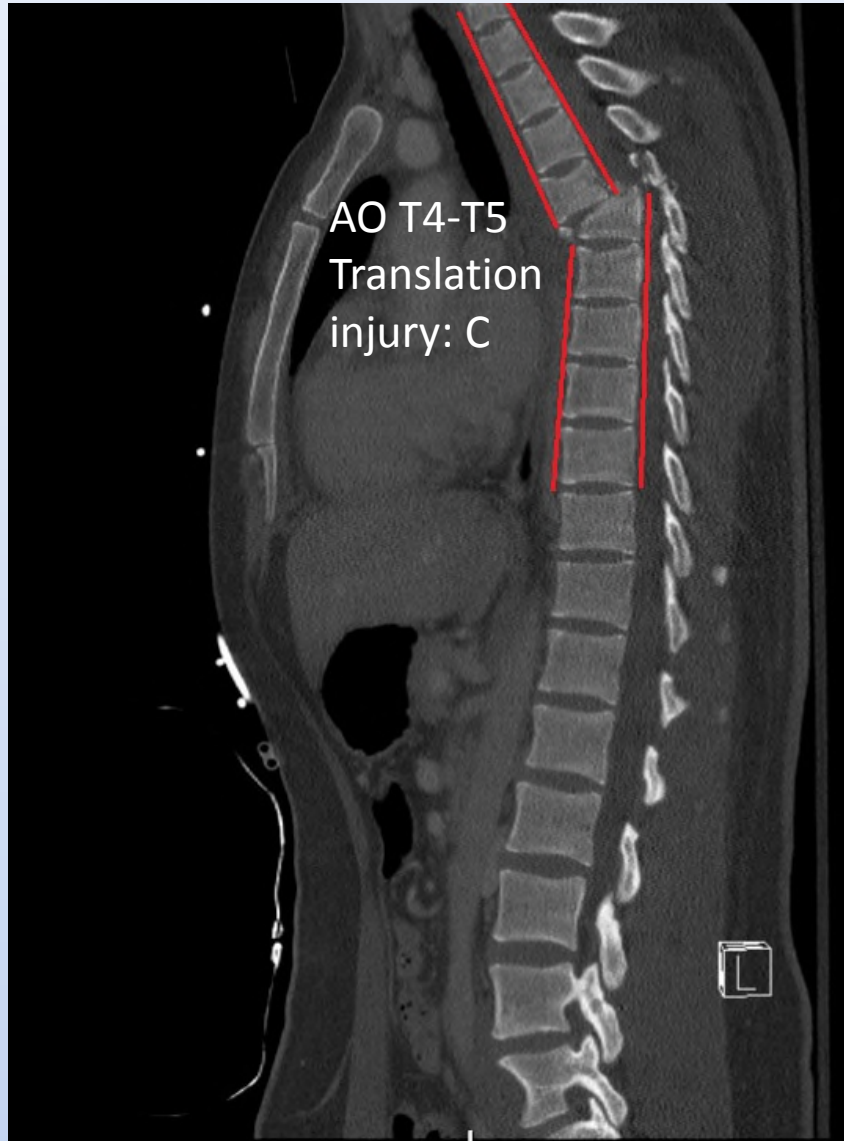
Further information: www.aospine.org/TLclassification

courtesy of AO Foundation, Radiopaedia.org, rID: 59354

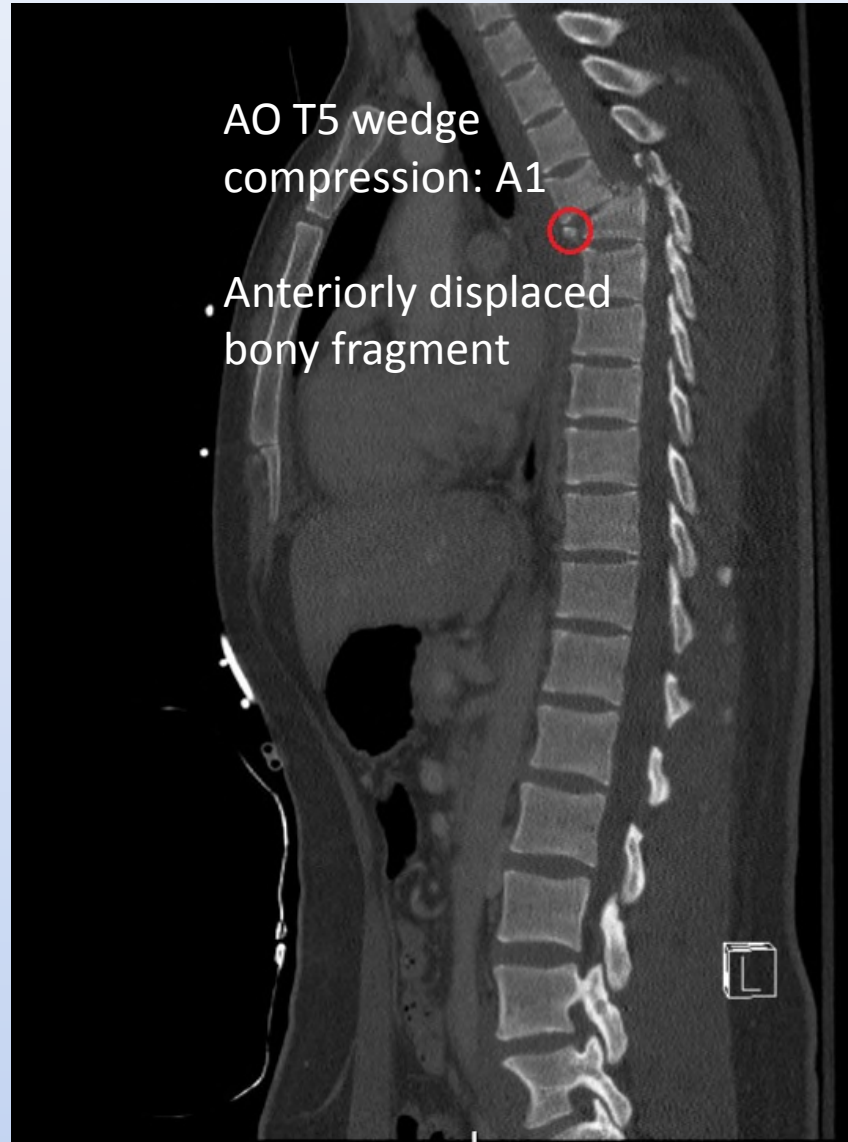
CT Chest/Abd/Pelvis



CT Chest/Abd/Pelvis



CT Chest/Abd/Pelvis



Discussion

The mechanism of injury for all the findings shown is consistent with motor vehicle collision. Both kinetic and potential energies play a role in the development of injury in each organ system.

- Impact Sequence

1. Vehicle impacts another object, resulting in passengers launching forward
2. Vehicle comes to abrupt stop, resulting in passenger coming into contact with inside of car (seatbelt, steering wheel, airbag, etc.)
3. Internal structures of the body collide within the body cavities. This provides the indication of trauma assessment and determination of injuries secondary to violent energy transfer.

Expected injuries: head, neck, chest, and abdominal

Imaging is absolutely crucial to identify emergent injuries and direct next steps in treatment.

- Information allowed for the coordination of trauma surgery, neurosurgery, and vascular surgery for future direction during the initial stabilization and will continue to be used throughout this patient's recovery

Cost of Imaging Services

- Chest X-ray: \$160 (2 APs were ordered) = \$320
- CT C-Spine: \$625
- CT Chest: \$825
- CT Abdomen: \$2,550
- CT Pelvis: \$2,700
- Total cost for just these images: \$7,020.00

* Information consists of current averages for self-pay in the Houston area, as provided by:
<https://www.newchoicehealth.com/x-ray-cost>

Final diagnosis - CXR

* Final Report *

Reason For Exam

Radiology Report

EXAM: XR CHEST 1 VIEW

DATE: 5/27/2019 19:00 CDT

INDICATION: - ptx

COMPARISON: X-ray and CT of 05/27/2019.

TECHNIQUE: AP chest.

FINDINGS:

Lines, tubes and hardware: None.

Lungs and pleura: Tiny right apical pneumothorax described on prior CT is not distinctly appreciated. Low lung volumes with bronchovascular crowding. The lungs are clear. No pleural effusion.

Heart and mediastinum: The heart size is normal for technique. The mediastinal contours are normal. Pulmonary vascularity is normal.

Bones: No acute abnormality.

IMPRESSION:

No acute cardiopulmonary abnormality. A previously described tiny right apical pneumothorax on CT is not appreciated on this study.

Signature Line

Final diagnosis – C-spine CT

* Final Report *

Reason For Exam

acute pain due to trauma / mvc

Radiology Report

EXAM: CT CERVICAL SPINE WITHOUT CONTRAST

DATE: 5/27/2019 8:24 CDT

INDICATION: acute pain due to trauma / mvc - acute pain due to trauma / mvc

COMPARISON: None

TECHNIQUE: Volumetric CT of the cervical spine is acquired without contrast. Axial, coronal and sagittal images are provided.

IV contrast: None.

DLP: 1713 mGy-cm

UT SECTION: ER

FINDINGS: The spine is imaged from the skull base to the level of T1.

- * The right C6 inferior facet is perched on the fractured C7 superior facet.
- * Mildly displaced fracture of the C6 spinous process, which extends into the bilateral lamina.
- * Minimal anterior wedging of the C7 vertebral body with about 5-10% height loss.
- * Moderate soft tissue swelling about the C6-C7 level.
- * Patchy bilateral apical opacities and a small right apical pneumothorax are seen.
- * The focus of gas at the right posterolateral aspect of the upper thoracic trachea is favored to represent a tracheal diverticulum (series 5 image 84).

IMPRESSION:

1. The right C6 inferior facet is perched on the fractured right C7 superior facet (AO spine C6: F4, C7: F2).
2. C6 spinous process and lamina fractured (AO spine C6: A0).
3. Anterior wedging of the C7 vertebral body with a minimal height loss (AO spine C7: A1).
4. Moderate soft tissue swelling about the C6-C7 level.
5. Patchy bilateral apical contusions and small right apical pneumothorax.

This was communicated to Dr. Guindon at 9:08 am on 5/27/2019.

Final diagnosis – Chest/Abd/Pelvis CT

* Final Report *

Reason For Exam

acute pain due to trauma / MVC

Radiology Report

EXAM: CT CHEST WITH CONTRAST

EXAM: CT ABDOMEN AND PELVIS WITH CONTRAST

DATE: 5/27/2019 8:24 CDT

INDICATION: acute pain due to trauma / MVC

ADDITIONAL INFORMATION: Chief complaint - "21 year old MVC, unrestrained driver. Pt's car went off road and rolled numerous times into a ditch. + SB, + AB, +LOC. Prolonged extrication. Hypotensive on scene. GCS 15. No PMH. NKDA.

COMPARISON: Chest and pelvis radiographs acquired earlier today.

TECHNIQUE: Volumetric CT of the chest, abdomen and pelvis is acquired following intravenous administration of contrast. Axial, coronal and sagittal images are provided.

IV contrast: 100 mL Omnipaque 350

Oral contrast: None.

DLP: 3728 mGy-cm

UT SECTION: ER

FINDINGS:

Lines and tubes: None.

Lower Neck: Supraclavicular soft tissues are unremarkable.

Thoracic Aorta and Mediastinum: Focal irregularity at the external surface of the posterior wall of the descending aorta at the T4-T5 level could represent an injured or congested spinal artery arising from the aorta, or minimal aortic injury (series 4 image 20). Normal heart and pericardium.

Lungs, Pleura, Diaphragm: There are patchy airspace opacities at the medial aspects of the apices and peripheral airspace opacities at the anterior aspects of the upper lobes and right middle lobe, consistent with contusions. There is a small pneumothorax noted in the right lung apex and posteroinferior to both hila (for example series 4 image 26). A 1 cm diameter nodular opacity is present at the posterolateral aspect of the right lower lobe base (series 4 image 31) consistent with diaphragmatic injury.

Spine/ Bones: There is approximately 0.8 cm anterior translation of T4 on T5 with comminuted fractures of the inferior T4 facets bilaterally, anterior wedge compression deformity of T5 with as much as 60% height loss and an anteriorly displaced vertebral body fragment, and with associated anterior paraspinal hematoma. Multiple bone fragments are located within the spinal canal. There are mildly displaced fractures of the bilateral T4 and T5 transverse processes. No other bony abnormalities identified.

ACR Appropriateness Criteria

American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: Blunt Chest Trauma

Variant 1: First-line evaluation. High-energy mechanism.

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9	Chest x-ray and CT/CTA are complementary examinations.	☢
CT chest with IV contrast	9	Ideally, this procedure should be performed with CTA. Chest x-ray and CT/CTA are complementary examinations.	☢ ☢ ☢
CTA chest with IV contrast	9	Chest x-ray and CT/CTA are complementary examinations.	☢ ☢ ☢
CT chest without IV contrast	5		☢ ☢ ☢
US chest	5		○
CT chest without and with IV contrast	2		☢ ☢ ☢
MRI chest without and with IV contrast	2		○
MRI chest without IV contrast	1		○
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

ACR Appropriateness Criteria

Variant 3: Age greater than or equal to 16 years. Suspected acute cervical spine blunt trauma. Confirmed or suspected cervical spinal cord or nerve root injury, with or without traumatic injury identified on cervical CT. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
MRI cervical spine without IV contrast	Usually Appropriate	0
CT myelography cervical spine	May Be Appropriate	*****
Arteriography cervicocerebral	Usually Not Appropriate	***
CTA head and neck with IV contrast	Usually Not Appropriate	***
MRA neck without and with IV contrast	Usually Not Appropriate	0
MRA neck without IV contrast	Usually Not Appropriate	0
MRI cervical spine without and with IV contrast	Usually Not Appropriate	0
Radiography cervical spine	Usually Not Appropriate	**

Variant 4: Age greater than or equal to 16 years. Acute cervical spine injury detected on radiographs. Treatment planning for mechanically unstable spine.

Procedure	Appropriateness Category	Relative Radiation Level
CT cervical spine without IV contrast	Usually Appropriate	***
MRI cervical spine without IV contrast	Usually Appropriate	0
CT cervical spine with IV contrast	Usually Not Appropriate	***
CT cervical spine without and with IV contrast	Usually Not Appropriate	***
CT myelography cervical spine	Usually Not Appropriate	*****
MRI cervical spine without and with IV contrast	Usually Not Appropriate	0

Variant 5: Age greater than or equal to 16 years. Suspected acute cervical spine blunt trauma. Clinical or imaging findings suggest arterial injury with or without positive cervical spine CT. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
CTA head and neck with IV contrast	Usually Appropriate	***
MRA neck without and with IV contrast	Usually Appropriate	0
Arteriography cervicocerebral	May Be Appropriate	***
MRA neck without IV contrast	May Be Appropriate	0

Take home points

- In a scenario of blunt trauma, CXR, CT chest/abd/pelvis, and CT spine provides rapid assessment of the extent of patient injury and need for further workup/treatment.
- When it comes to high-energy impacts/injuries, the combination of imaging modalities increases the sensitivity for identifying injuries not apparent on routine imaging.

References

Learning Radiology – William Herring

www.radiopaedia.org

AO Foundation – AO Classification criteria

Toney-Butler TJ, Varacallo M. Motor Vehicle Collisions (MVCs) [Updated 2019 Jan 19]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2019 Jan. Retrieved May 2019.