Imaging of Thoracic Trauma Correlated with the American Association for the Surgery of Trauma Scale

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Where and How Bad?: Applying the AAST injury scale to thoracic trauma

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Learning Objectives

Target Audience: Residents and practitioners covering emergency rooms

After viewing this lecture, the listener should be able to:
1. Describe the five specific injury scales involving thoracic trauma
2. Describe the severity grading system and its implications for treatment and survival
3. Match the most common thoracic injuries (such as simple pneumothorax, clavicle fracture, flail segment) to the correct injury scale and grade
4. Identify specific types and severity of injuries to the thoracic vessels and heart
5. Know the specific injuries considered non-salvageable/non-survivable (Grade VI)

AAST Scaling System for Organ Injuries

This is a clinical scaling system based on anatomic description not an imaging scaling system, BUT there are imaging correlates to the clinical site and grade. Radiologists evaluating and reporting on Trauma patients need to be aware of the key descriptive findings affecting organ injury grade.

AAST Scales involve the thorax:

- Chest Wall Injury: graded by contusion, laceration and fracture type and extent.
- Heart Injury: graded by EKG findings, extent of injury to pericardium and myocardium, additional complications (tamponade, valve incompetence).
- Lung Injury: graded by contusion, laceration, hematoma and associated vessel disruption.
- Thoracic Vascular Injury: graded by type and location of the vessel.
- Diaphragm Injury: graded by contusion or degree of laceration.

AAST Grades

- Grades: Injuries in each scale are graded I to VI. Grade I is the least severe injury, Grade V the most severe survivable injury and Grade VI injuries are non-survivable.
- The five thoracic scales all contain grades I-V. Grade VI, non-survivable, injuries are only described for the Heart, Thoracic vascular, and Lung injury scales.
Intercostal artery/vein injury inflicted

INJURY DESCRIPTION

GRADE

I Blunt cardiac injury with minor ECG abnormality

Contusion

Skin, subcutaneous and muscle

Fracture <3 ribs, closed; nondisplaced clavicle, closed

Fracture Open or displaced sternum; flail sternum

Laceration Full thickness including pleural penetration

Laceration Avulsion of chest wall tissues with underlying rib fractures

Fracture Unilateral flail chest (clavicle fracture (B)

Chest Wall Contusion (A)

Grade I: Contusion Unilateral

Less than 1 Lobe
Thoracic Vascular Injury-Grade I

Grade I also includes injury to:
- Internal mammary artery/vein
- Bronchial artery/vein
- Esophageal artery/vein
- Hemit-zyzous vein
- Unamed artery/vein

Heart Injury – Grade I

Blunt Cardiac Injury with minor EKG abnormalities; or
Blunt or penetrating pericardial wound With Out
cardiac injury, cardiac tamponade, or cardiac
herniation

Diaphragm Injury – Grade I

Contusion to Diaphragm without laceration

Chest Wall Injury – Grade II

Grade II-fracture of the sternum, closed

Grade II also includes:
- 3 or more adjacent rib fractures
- Scapular Body fracture, open or closed

Lung Injury – Grade II

Grade II Laceration: Simple pneumothorax

29YOM with multiple stab wounds to back and right chest. Penetrating wound at the right 6-7th anterior intercostal space (B). Resulting simple pneumothorax (A).
**Lung Injury – Grade II**

Grade II Lung injury - unilateral contusion of a single lobe.

Axial image - Lung window - right upper lobe contusion

**Chest Wall Injury – Grade III**

Laceration - Full thickness including pleural penetration

Knife - Wound to left chest demonstrates laceration to the skin, subcutaneous tissue, muscle and pleura.

Axial image - Lung window

Axial image - Soft Tissue Window

Sag Oblique Soft Tissue Window

**Thoracic Vascular Injury – Grade II**

Coronal Chest and neck - IV Contrast injection into left arm with dense contrast in left subclavian (Sc) and innominate (I) vein. Focal extravasation from left subclavian just antegrade to junction with left jugular (J) vein.

Grade II Thoracic vascular injuries: Injuries to the Azygous vein, Internal Jugular vein, Subclavian vein or Innominate vein

**Thoracic Vascular Injury – Grade III**

Grade III Thoracic vascular injuries: Injury to the Azygous vein, Internal Jugular vein, or Subclavian vein.

**Chest Wall Injury – Grade III**

• Fracture-Open or displaced Sternum (Includes flail sternum)

B. Anterior sternal (a) and retrosternal (c) hematoma.

A. Fracture of the mid body sternum (a) and separation at the sternal manubrium junction (c) with posterior displacement of the upper sternal body.

**Heart Injury – Grade III**

• Penetrating tangential myocardial wound up to, but not extending through endocardium, with tamponade.

A, B, C - Stab wound pre-op with signs of tamponade - compressed RV and dilated IVC

D, E, F - Post-op with decrease of hemopericardium and normal size RV
Heart Injury – Grade III

MVA patient with initial EKG showing 4-6 mm ST elevation anterior leads. After arrival became pulseless with wide complex tachyarrhythmia.

Axial and Sagittal CT with low attenuation myocardium in the septum and apex (A, B).

Cine images show a mobile defect in the proximal LAD (C, D).

Diaphragm Injury – Grade III

Laceration 2 – 10 cm

Diaphragm defect [1] that is less than 10 cm in the coronal (7.5 cm) and sagittal (5.1 cm) plane.

Demonstrates “collar” sign and “dependent viscera” sign.

B. Sagittal Image showing waist-like constriction of the herniated stomach.

Collar Sign-

Diaphragm Injury – Grade III

Right Diaphragm Hernia

With Collar Sign

Diaphragm creating “waist” in dome of liver

Chest Wall Injury – Grade IV

Unilateral Flail chest >/= 3 ribs

Laceration - Avulsion of chest wall tissues with underlying rib fractures.

Axial CT lung window (A) with laceration showing lung extending into defect (B).

Magnified view (B) of laceration showing lung extending into defect (C).

A. Axial Image. Active extravasation of contrast (A) into the lung parenchyma representing active bleeding and expanding hematoma.

B. Coronal Image. Active extravasation of contrast into the lung parenchyma.

Lung Injury – Grade IV

Grade IV Lung Injury – Expanding Intraparenchymal Hematoma
Thoracic Vascular Injury – Grade IV

Grade IV: Thoracic Aorta. Descending; greater than 25% Circumference disruption.

*Less than 25% circumference decrease Grade IV or V by one grade

Axial (A) and Coronal 3d (B) images of a 40YO Male Patient with contained transection of the descending aorta. (Arrow) Treated with endovascular repair.

Heart Injury – Grade IV

Gunshot wound to chest with entrance in right supraclavicular region and bullet fragment posterior to left ventricle

At surgery there were penetrating wounds to the right atrium and the left ventricular apex as suspected from the tract.

Diaphragm Injury – Grade IV/V

Grade IV and Grade V diaphragmatic injuries both involve a greater than 10 cm laceration with less than or equal to 25 cm2 of tissue loss (IV) or greater than 25 cm2 of tissue loss (V).

On MDCT, with multi-planar reconstructions, it is possible to measure the length of separation of two sides of a diaphragmatic laceration but difficult to measure the area of tissue loss due to the diaphragm configuration.

Chest Wall Injury – Grade V

Bilateral Flail chest - >/= 3 ribs on both sides

Note Bilateral Scapular Fractures

Thoracic Vascular Injury – Grade V

Injury to Thoracic Aorta, Ascending and Arch

A. Axial Image of Ascending Aorta with focal wall laceration 1-4 and pseudo-aneurysm (PSA)

B. Coronal MIP showing Ascending Aorta injury with PSA

C. Coronal Oblique MIP showing Ascending Aorta, Arch and PSA

Heart Injury – Grade V

Penetrating Left Ventricular penetration

At surgery there were penetrating wounds to the right atrium and the left ventricular apex as suspected from the tract.
Grade VI- Non Survivable Injuries

- Patients with thoracic non-survivable injuries are rarely imaged but the radiologist handling trauma needs to be aware of these injuries.
- In the thorax the Grade VI injuries are:
  A. Uncontainted total transection of the thoracic aorta.
  B. Uncontainted total transection of the pulmonary hilum.
  C. Blunt avulsion of the heart or penetrating wound with greater than 50% tissue loss of a chamber.

References


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