Blunt Aortic Trauma: A Radiologic Diagnosis

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You are a 1\textsuperscript{st} year Radiology resident...
Patient KS: History

- 23 yo male involved in high speed MVA
- KS’s motorcycle collided with truck and KS was thrown from vehicle
- EMS found KS alert, but hemodynamically unstable at scene
Patient KS: Physical Exam

- Vitals: Temp 97.8  Pulse 110s  BP 190/60
- HEENT-PERRRL, TMs clear
- CV-RRR, Norm S1 and S2
- Lungs- CTAB with equal breath sounds
- Abd- Soft, ND, NT with no palpable pulsatile masses
- Ext- Numerous upper and lower extremity injuries with lack of palpable left dorsalis pedis pulse
Patient KS: Portable CXR
You immediately …

• Call the CT techs to ensure a chest CT with contrast is being obtained
• Page the ER resident to alert her of your findings
• **What is your primary concern?**

• **Why is a Chest CT with contrast so imperative?**

• **Are any additional studies necessary?**
Thoracic Aorta Anatomy

- Ascending aorta relatively unfixed and mobile
- Descending aorta fixed and immobile due to intercostal arteries and ligamentum arteriosum

Image: Gray’s Anatomy
Blunt Aortic Injury

- Aorta is most common vessel injured by blunt trauma of chest

- Due to rapid deceleration events
  - High speed MVA
  - Fall from significant heights
Blunt Aortic Injury

- Blunt chest trauma is the most common cause of acute tear through the aortic wall

- An acute, traumatic tear extending through the intima, media, and adventitia is termed:
  - *aortic transection*, *aortic rupture*, *aortic disruption*
  - Tears can involve one or more layers
Blunt Aortic Injury

- Incomplete aortic transections tend to form pseudoaneurysms
  - Evolve from spared adventitia
  - Increased hemodynamic stability due to maintenance of blood flow
  - Still emergency due to possible rupture --> death
Aortic Transection: Epidemiology

• Results in immediate death in 80-90% of cases (Marx: Rosen’s Emergency Medicine, 2002)
  – Due to complete transection and rapid exsanguination at accident site

• Scene survivors also have high rate of mortality
  – Hemodynamically unstable: mortality rate <90%
  – Hemodynamically stable: mortality rate as low as 25% (Gotway, Thoracic Aorta Imaging with Multislice CT, 2003)
  • Due to pseudoaneurysm formation, rapid diagnosis, and surgical intervention
Aortic Transection: Sites of Injury

- Aortic isthmus: 80-90%
- Ascending aorta: 5-10%
- Descending Aorta near diaphragmatic hiatus: 1-3%

(Marx: Rosen’s Emergency Medicine, 2002)
Aortic Transection: Mechanism of Injury

- Aortic Isthmus Injury - sudden deceleration causes mobile aortic arch to swing forward resulting in:
  1. Whiplash Effect: shearing force at isthmus
  2. Bending stress at isthmus: due to flexion of arch on left mainstem bronchus and pulmonary artery
  3. Osseous Pinch: inferior & posterior rotation of anterior chest wall structures (manubrium, 1st rib) cause pinching and shearing of isthmus as it strikes the vertebral column

- Ascending Aorta Injury
  1. Waterhammer Effect: aortic compression results in explosive rupture of ascending aorta due to increased intraaortic pressure
  2. Shearing stress: heart displacement into left posterior chest causing tear above aortic valve
Aortic Transection: Clinical Features

• Symptoms (Uncommon and nonspecific)
  – Interscapular or retrosternal pain
    • 25% of patients  (Marx: Rosen’s Emergency Medicine, 2002)
  – Dyspnea, hoarseness, dysphagia

• Physical Exam (rarely signs of chest trauma)
  – Generalized hypertension
    • Secondary to aortic isthmus sympathetic afferent nerves causing reflex htn due to stretch stimulus
  – Pseudocoarctation
    • Compression of aortic lumen by periaortic hematoma
  – Often no clinical signs of chest trauma
Aortic Transection: Diagnostic Imaging Modalities

- CXR
- CT
- Angiography
- Transesophageal echocardiogram
Patient KS: CXR

- **Sensitive Indicators:**
  - Widened mediastinum
  - Indistinct aortic knob
- **Less Sensitive Indicators:**
  - Displaced trachea
  - Widened R paratracheal stripe
  - Widened paraspinal line
- **Not So Sensitive Indicators:**
  - Depression of left main bronchus
  - Left hemothorax/effusion
  - Left apical pleural cap
Diagnostic Imaging: CXR

- **Widened Mediastinum**
  - Defined as >8cm on supine AP CXR
  - Sensitivity 81-100%
  - Specificity 60%
    - Numerous differentials: achalasia, hematoma/hemorrhage, lymphadenopathy, neoplasm (Reed, Gamuts of Radiology, 2003)
  - Normal CXR has NPV of 98% (Rivas, L, Multislice CT in Thoracic Trauma, 2003)
Diagnostic Imaging: CT

- Conventional CT failed at diagnosing aortic injury
- Helical and new multislice CT have proven great success in diagnosis
- Able to assess polytraumatized patient
- Uses nonionic contrast
- Reformations similar to angiographic projections
- Sensitivity 100%
- Specificity 96%

(Rivas, L, Multislice CT in Thoracic Trauma, 2003)
Patient KS: CT

- **Direct Signs**
  - Pseudoaneurysm
  - Intimal flap
  - Abnormal aortic contour
  - Active contrast extravasation
  - Abrupt changes in aortic caliber

- **Indirect Signs**
  - Mediastinal hematoma
  - Periaortic hematoma
Patient KS: CT

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  - Periaortic hematoma
Patient KS: CT

- Reformations
  - Give full visualization of ascending and descending aorta
  - Can be reformatted in oblique, sagittal, or coronal views for better localization and visualization
## Diagnostic Imaging: CT

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<th><strong>PROs</strong></th>
<th><strong>CONS</strong></th>
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<tr>
<td>- High sensitivity &amp; specificity</td>
<td>- Pulsation artifacts</td>
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<td>- Non-invasive</td>
<td>- IV contrast</td>
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<td>- Provides info on other injuries</td>
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<td>- Rapid and easily accessible</td>
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Diagnostic Imaging: Angiography

- Traditional imaging modality for aortic transections
- Enables intricate visualization of aorta and provides precise localization of aortic defects
- Sensitivity 100%
- Specificity 97%
  (Marx: Rosen’s Emergency Medicine, 2002)
- 1-10% procedure complication rate
  (Mechem, ICU Management of Trauma Patients, 2004)
- Thoracic aortograms quickly being phased out by multislice CT
  - No longer performed at BIDMC!

## Diagnostic Imaging: Angiography

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<td>- High sensitivity &amp; specificity</td>
<td>- Highly invasive</td>
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<tr>
<td>- Precise localization of defect</td>
<td>- Time consuming</td>
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<td>- IV contrast</td>
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<td>- Must be aware of “fake outs” (i.e. ductus diverticulum)</td>
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Diagnostic Imaging: TEE

- Transesophageal echocardiogram (TEE) provides accurate identification of:
  - Intimal flap
  - Periaortic hematoma
- Sensitivity 91-100%
- Specificity 98-100%

(Vignon, P, TEE in Traumatic Rupture of Aortic Isthmus, 2004.)
Diagnostic Imaging: TEE

Transverse View at Aortic Isthmus
- *Large arrow*- thick “medial flap”
- *Arrow heads*- localized deformity of aortic wall due to pseudoaneurysm

Color Doppler at Aortic Isthmus
- *Large arrow*- thick “medial flap”
- Similar blood flow velocities on both sides of flap
- Color mosaic is turbulent flow at site of disruption

## Diagnostic Imaging: TEE

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<td>- Extremely fast</td>
<td>- Ascending and descending aorta blind spots</td>
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<td>- Can be performed at bedside</td>
<td>- Operator and reader DE-pendent</td>
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<td>- No IV contrast</td>
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<td>- Simultaneous eval of cardiac fxn</td>
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**Patient KS: Summary**

- **What was your primary concern?**
  - Aortic Transection!
    - Critical injury to radiologically diagnose due to high mortality rate

- **Why was a Chest CT with contrast so imperative?**
  - CXR findings and clinical history of high speed MVA increased suspicion of a possible aortic transection
  - To date, multislice CT with contrast is the preferred modality in a trauma situation due to:
    - High diagnostic capabilities, rapid assessment, and concomitant evaluation of additional traumatic injuries

- **Were any additional studies necessary?**
  - No. Angiography and TEE are best used as confirmatory studies or primary diagnostic modalities in extremely stable patients
    - Numerous factors (i.e. time, invasiveness, expertise needed) limit use in emergent situations
References


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