Acute Aortic Syndromes
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Non-Traumatic Acute Thoracic Aortic Syndromes
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Acute Thoracic Aortic Syndromes
Background
• Most common cause of aortic emergency
• Spectrum
  – Aortic dissection
  – Intramural hematoma
  – Penetrating atherosclerotic ulcer
  – Aortic aneurysm rupture

Objectives
• To discuss the pathophysiology and CT appearance of the different types of acute thoracic aortic syndromes
• To highlight the CT imaging technique and potential diagnostic pitfalls which the radiologist should be aware of

Outline
• Normal aortic anatomy
• Aortic imaging
  – CT technique
• Spectrum of acute aortic syndromes
  – Aortic dissection
  – Intramural hematoma
  – Penetrating atherosclerotic ulcer
  – Aortic aneurysm rupture

The Normal Thoracic Aorta
• Four segments
  – Root
  – Ascending
  – Arch
  – Descending
• Wall composed of 3 layers
  – Intima - inner layer
  – Media - middle layer
  – Adventitia – outer layer

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CT Technique

- Pre (thorax) and post-contrast (thorax/abdo/pelvis)
- 0.625 mm helical acquisition/pitch 1:1 - 1.25 mm thick reconstruction
- IV contrast/saline
  - 120-140 cc at 4 cc/sec/40 cc saline at 4 cc/sec
  - Bolus trigger
- Post-processing
  - Reformatted 2D (sagittal oblique, coronal)
  - Multiplanar/3D
- +/- ECG-gated thoracic portion

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Aortic Dissection

- Most common acute aortic syndrome
- Definition
  - Tearing of intima into media with entry of luminal blood into wall, forming false lumen partitioned from true lumen by intimal flap

Dissection - Pathology

Aortic Dissection - Risk Factors

- Hypertension
- Age 50 - 75 years
  - Males > females 2:1
- Age < 40 years
  - Males = females
  - Connective tissue disorder - Marfan’s
  - Bicuspid aortic valve
  - Pregnancy
  - Crack cocaine abuse
  - Prior cardiac or aortic valve surgery
- Mortality fallen by 50% in last 20 years

Aortic Dissection – Approach to CT Interpretation

- Type
- Distal extent
- True and false lumen
- Entry and re-entry tears
- Complications
- Diagnostic pitfalls
Aortic Dissection - Classification

- Based on location
- Correlates with prognosis
  - Involvement of ascending aorta – risk of intrapericardial rupture
- Stanford classification
  - A – Ascending aorta (75%)
    - Mortality 56% - unrepaired
  - B – No ascending aorta (25%)
    - May involve arch
    - Mortality 11% - unrepaired

Type A - Ascending Only

Type A – Ascending and Descending

Type B Dissection

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Distal Extent

False lumen disappears
Most commonly extends into left common iliac artery
Aortic Dissection – Approach to CT Interpretation

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Tips to Identify True and False Lumen

- Lumens spiral around each other as they progress distally
- True lumen
  - Smaller than false
  - Prone to collapse
  - Gives rise to coronary arteries, SMA, celiac and right renal artery
- False lumen
  - Larger than true
  - Prone to dilate
  - Prone to thrombosis
  - May rupture
  - Gives rise to left renal artery (usually)

True vs False Lumen

- Cobweb sign
- Beak sign
- RCA
- LCAT
- TF
- F

True vs False Lumen

<table>
<thead>
<tr>
<th>True vs False Lumen</th>
<th>True vs False Lumen</th>
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<tbody>
<tr>
<td>Cobweb sign</td>
<td>Text</td>
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<tr>
<td>Beak sign</td>
<td>RCA, LCAT, TF, F</td>
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True vs False Lumen

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Entry and Re-entry Tears

Re-entry Tears

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Complications

- Impending/rupture
- Malperfusion (30%)
Impending/Rupture

Enlarging False Lumen
Presentation One week later

Mediastinal Leak - High Density Stranding of Mediastinal Fat

Hemopericardium

Dissection into Pulmonary Artery Adventitia

Mediastinal Rupture - Dissection into Pulmonary Artery Adventitia
Dissection into Pulmonary Artery Adventitia and Interstitium

Rupture into Pericardium, Mediastinum and Pleural Space

Signs of Potential Malperfusion

• Concave true lumen
• Intimointimal intussusception
• Major branch vessel involvement
  – Static branch compromise - intimal flap enters or intersects ostium causing mechanical obstruction
  – Dynamic branch compromise - intimal flap prolapses across origin

Williams DM et al. Radiology 1997;203:37-44

Intimointimal Intussusception - Windsock Sign

Static Branch Compromise
Dynamic Branch Compromise

Aortic Dissection – Approach to CT Interpretation
• Type
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• True and false lumen
• Entry and re-entry tears
• Complications
• Diagnostic pitfalls

Diagnostic Pitfalls
• Technical – incorrect contrast timing
• Streak artifacts – contrast in SVC
• Motion artifact - aortic sinuses
• Anatomic pitfall
  – Atelectasis adjacent to aorta

Incorrect Contrast Timing

Streak Artifacts

Cardiac Motion Artifact
Periaortic Structures - Atelectasis

Aortic Dissection - Treatment
- Type A → urgent surgery
  - Avoid fatal complications
    - Pericardial/mesothelial extension
    - Coronary artery dissection
    - Involvement of aortic valvular ring (acute aortic insufficiency)
- Type B → medical
  - Control of blood pressure
  - Close follow-up for extension or aneurysm
  - May require surgery or image-guided endovascular intervention for branch vessel occlusion, expansion or persistent pain

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Intramural Hematoma (IMH)
- Definition - hematoma within aortic wall without intimal flap, no intimal tear or direct communication of flow with lumen
- Pathogenesis
  - Bleeding from vasa vasorum - hypertension
  - Ulcerated plaque extending into wall

Intramural Hematoma
- 5 - 10% of acute aortic syndrome
- Presentation
  - Similar to aortic dissection
- Classification
  - Similar to aortic dissection
  - Type A = Type B
  - Majority end at celiac artery

Intramural Hematoma CT Features
- Unenhanced scan
  - Increased attenuation of aortic wall
  - Internal displacement of intimal calcification
- Enhanced scan
  - Thickened aortic wall > 7 mm
  - Increase in attenuation no longer apparent
Intramural Hematoma
Without and With Contrast

C-  C+

Intramural Hematoma - Treatment

- Controversial
  - Similar to aortic dissection
- Natural history variable
  - Acute phase
    - Progression to dissection or rupture - 20-25%
  - Late phase
    - Resolution - 34%
    - Aneurysm formation - 54%
    - Frank dissection - 12%

Intramural Hematoma
Predictive Signs of Progression

- Type A
- Aortic diameter ≥ 4.8 cm
- Hematoma thickness ≥ 11 mm
- Associated penetrating atherosclerotic ulcer
- Pericardial effusion
- Pleural effusion
- Age > 70 years

Intramural Hematoma
Diagnostic Pitfalls

- Enhanced scan only
- IMH vs. mural thrombus
- IMH vs. thrombosed dissection
- Anatomic pitfalls
  - Pericardial reflections and recesses
  - Pleural thickening/effusion

Diagnostic Pitfall
Enhanced Scan Only

Diagnostic Pitfall
IMH vs Thrombus
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Penetrating Atherosclerotic Ulcer

- Advanced atherosclerosis
- Ulceration of atherosclerotic plaque
- Extension of ulcer through intima and inner media
- Variable result
  - Intramural hematoma
  - Dissection (usually short) associated with intramural hematoma
  - Penetration into adventitia → pseudoaneurysm or external rupture
  - ? Source of most saccular aneurysms

Aortic Atheroma

Benign Ulcer Formation

Penetrating Atherosclerotic Ulcer

Penetrating Atherosclerotic Ulcer Clinical Features

- Similar to classic dissection
- Uncommon - thromboembolism
Penetrating Atherosclerotic Ulcer
CT Features

- Extensive atherosclerotic disease
- Focal, contrast-filled outpouching surrounded by intramural hematoma
- Size range
  - Diameter – 5-25 mm
  - Depth – 4-30 mm
- Diagnostic pitfall - Atheromatous plaque with ulceration
  - No contrast material extends beyond intima
  - No intramural hematoma

Penetrating Atherosclerotic Ulcer

PAU – 3 month Follow-up
Short dissection vs. pseudoaneurysm

Outline

- Normal anatomy of aortic wall
- Aortic Imaging
  - CT and MR technique
- Types of acute aortic syndromes
  - Aortic dissection
  - Intramural hematoma
  - Penetrating atherosclerotic ulcer
  - Aortic aneurysm
    - Rupture or leaking
    - Unstable aneurysm

Aortic Rupture – Causes

- Pre-existing aneurysm, dissection, IMH, penetrating ulcer
- Spontaneous?
Aortic Aneurysm – Natural History

- < 4 cm – 2-4 mm/year
- 4-5 cm – 2-5 mm/year
- > 5 cm – 3-7 mm/year

Aortic Rupture – Clinical Features

- Acute chest/back pain
- Usually hemodynamic instability
- High mortality without surgical intervention

Rupture and Leaking – Imaging Features

- Rupture
  - Abnormal contour of aortic lumen
  - Frank extravasation of contrast outside borders of aorta
  - Evidence of large amount of high density fluid outside aorta
    - Pericardial effusion/hemopericardium, mediastinal hematoma
    - +/- Pleural effusion or hemothorax
- Leaking
  - Less of all the above

Unstable Aortic Aneurysms – Imaging Features

- Rapid increase in size
- Evidence of current or previous leaking
- Intramural hematoma – “crescent sign”
- Hemorrhage into thrombus or plaque
- Inflammation of aortic wall
  - Enhancement on delayed CT/MR

Aortic Rupture

Leaking Aneurysm
Leaking Aneurysm

Spontaneous Rupture?

Spontaneous Rupture?

One Year Earlier

Summary

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