Learning objectives

$\S$ To be familiar with the definition, natural history, and imaging findings of acute aortic syndrome, including:

I. Aortic Dissection
II. Intramural Hematoma
III. Penetrating Aortic Ulcer

$\S$ Current updates in acute aortic syndrome

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Abdominal aorta

Aortic Dissection – risk factors

$\S$ Age 50 - 75 years: M > F 2:1
  - Hypertension
$\S$ Age < 40 years: M = F
  - Connective tissue disorder
  - Bicuspid aortic valve, coarctation
  - Pregnancy
  - Crack cocaine abuse
  - Prior cardiac or aortic valve surgery
$\S$ Mortality ↓ by 50% in last 20 years

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I. Aortic dissection

Spontaneous dissections almost always originate in the thoracic aorta and extend to involve the abdominal aorta.
Aortic Dissection: classification

- Ascending ± descending – 75%
  - Mortality – 58% unrepaired
- Descending only – 25%
  - May involve arch
  - Mortality – 11% unrepaired

Aortic Dissection: MDCT diagnosis

§ Presence
§ Type
§ Distal extent
§ True and false lumens
§ Entry and re-entry tears
§ Complications

Intimal flap and displaced intimal calcifications

Aortic Dissection: MDCT diagnosis

§ Presence
§ Type
§ Distal extent
§ True and false lumens
§ Entry and re-entry tears
§ Complications

Type A – Ascending aorta

Type A: Ascending and descending aorta
Type B: Descending aorta only

Aortic Dissection: MDCT diagnosis
- Presence
- Type
- Extent
- True and false lumens
- Entry and re-entry tears
- Complications

Extent of aortic dissection - proximal

Extent of aortic dissection - distal
- Most commonly extends into L. Common Iliac artery
- False lumen ends blindly

Aortic Dissection: MDCT diagnosis
- Presence
- Type
- Extent
- True and false lumens
- Entry and re-entry tears
- Complications

True lumen
- Give rise to coronary, SMA, celiac, right renal arteries
- Frequently located anterior in descending thoracic aorta
- Smaller than false
- May assume a concave orientation
Aortic Dissection: MDCT diagnosis

- Presence
- Type
- Extent
- True and false lumens
- Entry and re-entry tears
- Complications

**True lumen**
- Larger than true
- Left renal artery
- Acute angle
- Prone to dilate, thrombose
- May rupture
- Cobwebs

**False lumen**
- Larger than true
- Left renal artery
- Acute angle
- Prone to dilate, thrombose
- May rupture
- Cobwebs

**Entry and re-entry tears**

**Aortic Dissection: MDCT diagnosis**

- Presence
- Type
- Extent
- True and false lumens
- Entry and re-entry tears
- Complications
Aortic Dissection: Complications

- Involvement of aortic branches
- Perfusion deficit
- Impending rupture
- Rupture
- Involvement of ductus arteriosus

Involvement of aortic branches

Signs of potential perfusion deficit

- Concave true lumen
- Intimo-intimal intussusceptions
- Major branch vessel involvement
  - Static branch compromise - intimal flap enters or intersects ostium causing mechanical obstruction
  - Dynamic branch compromise - intimal flap prolapses across origin

Concave True lumen

Intimo-intimal intussusception: Windsock sign

Enlarging false lumen

Williams DM et al. Radiology 1997

10 months later: Rupture into mediastinum and pleural space
SUNDAY

Hemopericardium

Dissection into pulmonary artery adventitia

Acute extravasations and hemopericardium

Time-resolved CT Imaging of the Aorta

CT versus MR – When to use MR?

- Allergic reaction to contrast
- Mild and moderate renal failure: GFR > 30
- Severe renal failure – non-contrast MRI
- Annual follow-up of young patients

MRI – Balanced SSFP Sequence
Treatment of Aortic Dissection

§ Ascending aorta:
- Surgery
- Stent graft
- Simultaneous endoluminal stent graft repair of descending aorta

§ Descending aorta:
- Medical management in most cases
- Endoluminal stent graft in selected cases
- Percutaneous aortic fenestration +/- stent graft


Dissection surveillance

§ Thoracic inlet – symphysis pubis
§ 75 mL at 4 mL/sec
§ 30 mL saline
§ Aortic Arch 150 HU
§ Axial, MPR, 3D VR

Gated CTA - ?

§ Not routinely used
§ Myocardial perfusion jeopardy
§ Aortic valve involvement
§ Prospective vs. retrospective gating
  • lower radiation dose
  • equivalent image quality

Halpern EJ. Radiology. 2009
Wu W et al. AJR. 2009
Fleischmann et al. Semin Cardiovasc Surgery. 2008

To gate or not to gate?

Pros
§ Pulsation motion artifacts in the ascending aorta can be eliminated
§ Site of the primary intimal tear/re-entry tear
§ Location and extent of the intimal-medial flap
§ Detection of more subtle lesions and variants of aortic dissection
§ Involvement of sinuses of Valsalva, valve cusps, aortic annulus, and the coronary arteries

Cons
§ Radiation exposure (if retrospective gating used)
§ Purely an anatomic assessment (no ability to assess blood flow)

Fleischmann D. Sem Thorac Cardiov Surg 2008

Prospective vs. Retrospective Gating

**Prospective**
- 100 kV: 1.9 mSv
- 120 kV: 5.3 mSv

**Retrospective**
- 100 kV: 4.1 mSv
- 120 kV: 9.5 mSv

Prospective and Retrospective ECG Gating for Thoracic CT Angiography

**64-MDCT system GE**

**Prospective**
- CTDIvol: 30 mGy
- DLP: 834 mGy·cm
- ED: 11.6 mSv

**Retrospective**
- CTDIvol: 75 mGy
- DLP: 2,550 mGy·cm
- ED: 35 mSv

ED – 2.0-3.3 mSv
Total – IV contrast 60 ml
All but 1/64 cases – diagnostic for aorta, PA, coronary arteries

Prospective vs. Retrospective gating – Dual Source CT

- Similar length (23 cm)
- Similar image quality

Prospective
- 100 kV: 1.9 mSv
- 120 kV: 5.3 mSv

Retrospective
- 100 kV: 4.1 mSv
- 120 kV: 9.5 mSv

II. Intramural Hematoma

1. Rupture of the vasa vasorum
2. Spontaneous thrombosis of the false lumen
3. Penetrating atherosclerotic ulcer allowing blood to gain access to the aortic media

No flow in false channel !!!

IMH – 2 types

- **Traumatic** – usually good prognosis
- **Non-traumatic** – worse prognosis
  - Type A intramural hematoma
  - Coexisting PAU
  - Age > 70
  - Aortic diameter > 5.2 cm
  - Increasing aortic diameter
  - Hematoma thickness > 1.0 cm

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Blanke P. et al. Radiology 2010

Evangelista et al. Circulation 2005
IMH – natural history

- Acute phase:
  - Progression to dissection or rupture in 20-25%

- Late phase:
  - Resolution – 34%
  - Aneurysm formation – 54%
  - Frank dissection – 12%

IMH - CT

CT – Non-contrast scan is critical !!!

IMH - CT

Type A IMH

- Conversion to dissection – risk increases after 3-8 days
- Urgent surgical repair in most of the patients

IMH vs. thrombus

IMH and Dissection

IMH
Thrombus

Evangelista et al. Circulation 2003

Estrera et al. Circulation 2009
**III. Penetrating Atherosclerotic Ulcer**

- 2-8% of acute aortic syndromes
- Symptoms mimic aortic dissection
- Concomitant AAA
- Complications: IMH, dissection, pseudoaneurysm, rupture

**IV. Penetrating Atherosclerotic Ulcer**

- Overall: 40%
- Proximal PAU: ↑ complications
- Initial PAU size:
  - 20 mm or more in maximum diameter
  - 10 mm or greater in maximum depth
- 80% of PAU with Type A IMH - urgent or early surgical intervention
- Incidental finding vs. Acute presentation!!!
- Radiological F/U – first 30 days!

**Uncontrollable pain**

- and/or
- Increasing pleural effusion

- Open surgical or endovascular stent-graft repair

**PAU – progression over time**

- 1 Year later
Summary

CT, MRI, and Echocardiography are critical in detection, preoperative planning, and surveillance of acute aortic syndromes.

Familiarity with imaging appearance of these conditions is imperative.

Careful attention to optimal imaging technique.