CT and MR Imaging of Acute Aortic Syndrome

Diana Litmanovich, MD
Learning Objectives

- To be familiar with the definition and natural history of acute aortic syndrome, including:
  - Aortic Dissection
  - Intramural Hematoma
  - Penetrating Aortic Ulcer
- To be familiar with the imaging principles of CT and MRI for diagnosis and follow-up
Aorta – normal diameter

- Root: up to 4 cm
- Ascending: up to 4 cm
- Descending: up to 3 cm
- Abdominal: up to 2.0 cm
Technique at BIDMC

- Pre: Thorax (low dose)
- IV contrast/saline: Thorax 100/30 mL, 4 mL/sec
- Trigger at LA (100 HU)
- If positive: abdomen and pelvis (50 mL)
- 120 kVp, Dose modulation, (NI ~16)
- 0.625 mm helical acquisition, 2.5 mm recons
- Axial, MPR, 3D VR
Optimal timing window

Lee CH et al, AJR Feb 2007
Gated CTA - ?

- Not routinely used
- Myocardial perfusion jeopardy
  - Prospective vs retrospective gating
    - lower radiation dose
    - ↑ contrast load
    - ↑ aortic attenuation values
    - equivalent image quality

Halpern EJ. Radiology. 2009
Wu W, et al. AJR, 2009
Spontaneous dissections almost always originate in thoracic aorta and extend to involve the abdominal aorta.
Aortic Dissection – risk factors

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

- Ascending ± descending – 75%
  - Mortality – 58% unrepaired

- Descending only – 25%
  - May involve arch
  - Mortality – 11% unrepaired
Aortic Dissection: MDCT diagnosis

- Type
- Distal extent
- True and false lumen
- Entry and re-entry tears
- Complications
Intimal flap and displaced intimal calcifications
Aortic Dissection: MDCT diagnosis

- Type
- Distal extent
- True and false lumen
- Entry and re-entry tears
- Complications
Type A: Ascending and descending aorta
Type B: Descending Aorta Only
Aortic Dissection: MDCT diagnosis

- Type
- Extent
- True and false lumen
- Entry and re-entry tears
- Complications
Extent of aortic dissection - proximal
Extent of aortic dissection - distal

- Most commonly extends into Left Common iliac Artery
- False lumen usually ends blindly
Aortic Dissection: MDCT diagnosis

- Type
- Extent
- True and false lumen
- Entry and re-entry tears
- Complications
True and false lumen

True lumen

- Give rise to coronary aa, SMA, celiac a, r. renal a
- Frequently located anterior in descending thoracic aorta
- Smaller than false
- May assume a concave orientation
False lumen

- Larger than true lumen
- Gives rise to L renal a
- Acute angle
- Prone to dilate
- Prone to thrombosis
- May rupture
False Lumen

- Most specific indicator for the false lumen - irregular strands within the lumen, "cobwebs"
- Cobwebs - residual fragments of aortic media separated during the dissection
Aortic Dissection: MDCT diagnosis

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

- Type
- Extent
- True and false lumen
- 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

Williams DM et al. Radiology 1997
Intimo-intimal intussusception: Windsock sign
Enlarging False Lumen

10 months later: Rupture into mediastinum and pleural space
Hemopericardium
Dissection into pulmonary artery adventitia

Courtesy of Carole J. Dennie, Ottawa
Dissection into pulmonary artery adventitia

Courtesy of Carole J. Dennie, Ottawa
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

Lohan et al. MRI Clinic N Am. 2008
Cardiac Gated MRI - BIDMC

I. Dark Blood HASTE for intramural hematoma characterization

II. Balanced SSFP sequence (3D imaging)
   Balanced FIESTA
   True FISP
   Balanced FFE
   Provides dynamic information

III. MRA (Gd) – when possible

mymri.com
Treatment of Aortic Dissection

- **Ascending aorta**:  
  - Surgery  
  - 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
Acute Aortic Syndrome:

2. 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 – clinical presentation

- Persistent chest pain
- Syncope
- Paraparesis
- Instability/hypotension
- Coronary ischemia
- Altered mental status
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

Evangelista et al. Circulation 2005
CT – Non-contrast scan is critical !!!
IMH - CT
IMH – CT and MRI

Low MR signal surrounding the ascending aorta

Low density tissue surrounding the ascending aorta
IMH – natural history

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

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

Evangelista et al. Circulation 2003
Type A IMH

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

Estrera et al. Circulation 2009
Tamponade physiology
Treatment: surgical & endovascular

Eggebrecht H et al. Eur J Vasc Endovasc Surg 2009
3. Penetrating Atherosclerotic Ulcer (PAU)

- 2.3 - 7.6% of acute aortic syndromes
- Symptoms mimic aortic dissection
- Concomitant AAA
- Complications – IMH, dissection, pseudoaneurysm, rupture

2003 by Radiological Society of North America
Deep ulcerated lesion in the thickest part of the IMH in the involved aorta
Most often descending aorta
Rare - ascending aorta
Older patients
PAU – progress over time

1 Year later
PAU – risk of complications

- 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 !!!

Vilacosta I et al. Am Heart J 1997
Uncontrollable pain
and/or
Increasing pleural effusion

Open surgical or endovascular stent-graft repair

Ganaha et al. Circulation 2002
PAU - Treatment

- PAU + Type A IMH – surgery vs. stent
- Desc PAU - conservative
- Radiological F/U – first 30 days!

Eggebrecht H et al. Eur J Vasc Endovasc Surg 2009
PET-CT

Evaluation of inflammation accompanying acute aortic syndrome by PET-CT may help to identify patients at risk for disease progression

Kuehl et al. Heart 2008
Learning Objectives

- Review of definition and natural history of acute aortic syndrome, including:
  - Aortic Dissection
  - Intramural Hematoma
  - Penetrating Aortic Ulcer

- Review of the imaging principles of CT and MRI for diagnosis and follow-up
Summary

- CT and MRI 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
CT and MR Imaging of Acute Aortic Syndrome

Diana Litmanovich, MD