Diseases of the Aorta

ASE Review 2018

Susan E Wiegers, MD, FASE, FACC
Professor of Medicine
My great friend Dr. Roberto Lang

Disclosure
None related to this presentation
Objectives

- Aneurysm
- Dissection
- Intramural hematoma & ulcer
- Coarctation
- Trauma
- Atherosclerosis
Cardiovascular Ultrasound

• Don’t forget to image the aorta
  – Parasternal long axis – ascending aorta view
  – Off axis 2 chamber – descending aorta view
  – Suprasternal notch – short axis and long axis
  – Subcostal view – include assessment of aorta

Aortic Regurgitation Morphology

<table>
<thead>
<tr>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Cusp Motion with Aortic Dilation or Cusp Perforation</td>
<td>Type II Cusp Prolapse</td>
<td>Type III Cusp Restriction</td>
</tr>
<tr>
<td>a</td>
<td>b</td>
<td>c</td>
</tr>
</tbody>
</table>

- Sinotubular Junction enlargement and dilatation of the Asc AO
- Dilatation of sinuses of Valsalva and sinotubular junction AO
- Dilatation of the ventriculo-arterial junction

New Recommendations for Non-Invasive Evaluation of Native Valvular regurgitation
Identification of patients at risk for dissection is difficult
• Hypertension
• Ao dilatation and aneurysm

Even pts with Marfans, Ehlers Danlos, familial aortic aneurysms, congenital bicuspid valve who are known to be at increased risk for dissection even go unrecognized until they present with acute aortic syndrome

Identify the Reason for this Emergency TEE
PATHOPHYSIOLOGY

- Deterioration of medial collagen and elastin
- A tear in the intimal layer allows blood to enter the intima-media space
- Blood then propagates down this new space creating a “true” and a “false” lumen

Cystic Medial Change

- Hypertension
- Marfan’s and Ehler-Danlos
- Coarctation and bicuspid aortic valve
- Pregnancy
- Trauma
- Perforation through an intimal atheromatous plaque
Figure 1. Aortic dissection is caused by bleeding within the aortic wall. The aortic wall comprises three layers: the intima, the media and the adventitia. Bleeding within the medial layer forces the layers apart to form an intimal flap. Aortic dissection probably results from an intimal tear in most cases. In some cases, aortic dissection may also be caused by rupture of the vasa vasorum (the capillaries that supply the aortic wall). This bleeding results in an intimal haematoma that may progress to form an aortic dissection.

Age Specific and Sex Specific rates per 100,000 individuals for Incidence of acute aortic dissection subtype
**Types of Aortic Dissection**

<table>
<thead>
<tr>
<th>De Bakey</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanford</td>
<td>Type A</td>
<td>Type A</td>
<td>Type B</td>
</tr>
</tbody>
</table>

**Clinical Presentation: Physical Exam**

<table>
<thead>
<tr>
<th></th>
<th>A + B</th>
<th>Type A</th>
<th>Type B</th>
<th>P =</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI on exam</td>
<td>32%</td>
<td>44%</td>
<td>12%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Pulse deficit</td>
<td>15%</td>
<td>19%</td>
<td>9.2%</td>
<td>.006</td>
</tr>
<tr>
<td>CVA</td>
<td>4.7%</td>
<td>6.1%</td>
<td>2.3%</td>
<td>.07</td>
</tr>
<tr>
<td>CHF</td>
<td>6.6%</td>
<td>8.8%</td>
<td>3.0%</td>
<td>.02</td>
</tr>
</tbody>
</table>
68 yo woman collapses during family argument
Predicting Death in Patients with Acute Type A Aortic Dissection

- 547 pts; IRAD; Jan 96-Dec 99
- In hospital mortality 32.5%
  - Age ≥ 70 years
  - Abrupt onset of Cx pain
  - Hypotension, shock, tamponade
  - Kidney failure
  - Pulse deficit
  - ECG abnormalities

Circulation 2002;105:200-206
Distal or descending – Type III Aortic Dissection

Iatrogenic (intra-arterial catheterization) – Type IV

Incidence of Mortality in Type B Aortic Dissection With Different Indications for Surgical Treatment

Surgery: rupture, aortic expansion, mal-perfusion and intractable pain

Hospital mortality: 10%
Early intervention: 16%
Three year survival 78%

Circulation 2006; 114 (suppl I): I – 357-364
GOALS OF DIAGNOSTIC IMAGING

- Confirm the diagnosis
- Classify the dissection and determine extent
- Detect extravasation
- Detect and Grade AI

- Aortography
- Spiral CT
- MRI
- TTE / TEE

Aortic Dissection: Choice of Imaging Technique

- Fine tradeoff in sensitivity and specificity
- Availability of technique
- Experience and expertise at a given institution
- Degree of urgency
- Stability of the patient
Aortic Dissection: Why Multiple Studies?

- Initial study often done at referral site
  Confirmation needed or desired

- If CT first
  Still need cardiac anatomy, valve status etc

- If echocardiography first
  Still need assessment of abdominal aorta in many instances

POCUS In ER – CVA – tachy on way to CT scanner
Leg pain - hypotension
### Diagnostic value of different imaging modalities in acute aortic syndromes

<table>
<thead>
<tr>
<th>Lesion</th>
<th>TTE</th>
<th>TEE</th>
<th>CT</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascending aortic dissection</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Aortic arch dissection</td>
<td>+</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Descending aortic dissection</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Size</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Mural thrombus</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Intramural hematoma</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Penetrating aortic ulcer</td>
<td>++</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Involvement of aortic branches</td>
<td>+²</td>
<td>(+)</td>
<td>+++</td>
<td>+++</td>
</tr>
</tbody>
</table>

²Can be improved when combined by vascular ultrasound (carotid, subclavian, vertebral, celiac, mesenteric, and renal arteries).
+++=excellent; ++=moderate; +=poor; (+)=poor and inconstant; CT=computed tomography; MRI=magnetic resonance imaging, TOE=transesophageal echocardiography; TTE=transthoracic echocardiography.
Aortic Dissection: Intimal Flap and Entry Site

3D Epicardial Echo in Aortic Dissection
TEE assessment

- Extent of flap
- Location of intimal tears
- Side branch evaluation - CORONARIES
- Pericardial effusion
- Mediastinal bleeding
- Aortic regurgitation and valve compromise

Aortic Dissection: Mechanism of AR

Intimal Flap Prolapse
Pseudoaneurysm

Atypical Aortic Dissection

Intramural Hematoma

Penetrating Atherosclerotic Ulcer
Intramural Hematoma

- Rupture of the VASA vasorum
  - Discrete hematoma
  - Extends for a variable distance by dissecting along the outer media beneath the adventitia

Intramural Hematoma: Diagnosis

- Contained hemorrhage within the medial layer of the aortic wall
- Crescentic area along the aortic wall
Atypical Aortic Dissection
(Intramural Hematoma)

- Prevalence 10-15% in CT/MRI/TEE studies
- Type III more common
- Normal size lumen
- False negative aortograms

Imaging features of IMH

- Focal aortic wall thickening (crescentic > concentric)
- Preserved luminal shape with smooth luminal border
- Absence of dissection flap and false lumen
- Echolucent regions may be present in the aortic wall
- Central displacement of intimal calcium
**Intramural hematoma**

- Maximal thickness of the IMH (≥ 11mm) predicts Ao dissection
- Type A IMH and ulcer like projection should be monitored for the development of Ao aneurysm (common complication of IMH)

*J Comput Assist Tomogr 2007; 31:435-440*
Poor prognostic features

- Type A
- Persistent pain
- Wall thickness > 11 mm
- Aortic diameter > 50 mm or enlarging
- Penetrating ulcer or ulcer like projections
- Bleeding consistent with subacute rupture

Penetrating Atherosclerotic Ulcer

- Almost exclusively in the descending Ao
- Usually remains localized
- Elderly HTN, evidence for other atherosclerotic CV disease
- Chest and back pain without associated AR or neurological deficits
Details required from imaging in Penetrating Aortic Ulcer

- Localization of the lesion (length and depth)
- Co-existence of intramural hematoma
- Involvement of the peri-aortic tissue and bleeding
- Thickness of the residual wall

Saccular arch aneurysm?
Blunt Chest Trauma

Generates shearing forces that act maximally on the aortic isthmus
Aortic Disruption: Anatomical Types

Grading system for severity of aortic atherosclerosis

<table>
<thead>
<tr>
<th>Grade</th>
<th>Severity (atheroma thickness)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal</td>
<td>Intimal thickness &lt;2mm</td>
</tr>
<tr>
<td>2</td>
<td>Mild</td>
<td>Mild(focal or diffuse) intimal thickening of 2-3 mm</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>Atheroma &gt;3-5mm (no mobile/ulcerated components)</td>
</tr>
<tr>
<td>4</td>
<td>Severe</td>
<td>Atheroma &gt;5mm (no mobile/ulcerated components)</td>
</tr>
<tr>
<td>5</td>
<td>Complex</td>
<td>Grade 2,3, or 4 atheroma plus mobile or ulcerated components</td>
</tr>
</tbody>
</table>
Grading system for severity of aortic atherosclerosis
Figure 51.
Abdominal aortic pulsed-wave Doppler examination in a patient with severe aortic coarctation demonstrates reduced and delayed systolic forward flow and persistent forward flow during diastole (yellow arrow). This “diastolic fall” is a pathognomonic sign of a hemodynamically significant coarctation.
Cardiovascular Ultrasound

• Don’t forget to image the aorta
  – Parasternal long axis – ascending aorta view
  – Off axis 2 chamber – descending aorta view
  – Suprasternal notch – short axis and long axis
  – Subcostal view – include assessment of aorta

Thank you for your attention
GOOD LUCK WITH THE EXAM