Acute Aortic Syndromes

Evaluation by TTE and TEE
Role of Multi-Modality Imaging

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DISCLOSURES

Relevant Financial Relationship(s)
None

Off Label Usage
None
Acute Aortic Syndrome (AAS)

Aortic Dissection

Aortic Intramural Hematoma (IMH)

Penetrating Aortic Ulcer (PAU)

Aortic Dissection

 Courtesy of WD Edwards, MD
Risk Conditions for Aortic Dissection

- Hypertension
- Congenital
  - Bicuspid AV / aortopathy, coarctation
- Connective tissue disorders
  - Marfan & Ehlers-Danlos syndromes
- Iatrogenic
  - Prior cardiac surgery, catheterization
- Deceleration chest trauma
- Aortitis
Another admission with chest pain:

“... No interscapular back pain . . .”

“... No pulse deficits . . .”

“... The chest x-ray looks OK . . .”

“... This shouldn’t be dissection . . .”
# Acute Type A Aortic Dissection

**IRAD:** 526 Patients (1996-2001)

## Presenting Symptoms & Signs

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No pain reported</td>
<td>11%</td>
</tr>
<tr>
<td>Chest pain</td>
<td>82%</td>
</tr>
<tr>
<td>Syncope</td>
<td>19%</td>
</tr>
<tr>
<td>Neuro deficit</td>
<td>14%</td>
</tr>
<tr>
<td>Pulse deficit</td>
<td>31%</td>
</tr>
<tr>
<td>Shock or tamponade</td>
<td>16%</td>
</tr>
</tbody>
</table>

Acute Type A Aortic Dissection
IRAD: 526 Patients (1996-2001)

Chest X-Ray

- No widened mediastinum: 38%
- Entirely normal: 14%

ECG

- Ischemic ST-T changes: 20%
- Acute or recent infarction: 6%

Clinical Misdiagnosis of Acute Aortic Syndrome

AAS vs. ACS

66 Patients with AAS

Correct Initial Dx
40 Pts (61%); 15±5 hrs *

Incorrect Initial Dx
26 Pts (39%); 51±12 hrs*

Initial Dx in 21/26 Pts: ACS

Predictors of Missed Dx: Anterior chest pain & age

Clinical Misdiagnosis of Acute Aortic Syndrome

AAS vs. ACS

Incorrect Initial Dx
26 Pts (39%); 51±12 hrs*

Therapy given:
ASA 100%
Heparin 85%
Fibrinolytics 12%

Initial Diagnosis

<table>
<thead>
<tr>
<th>Correct</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhagic effusion (Pericardial or pleural)</td>
<td>13%</td>
</tr>
<tr>
<td>In-Hospital mortality</td>
<td>13%</td>
</tr>
</tbody>
</table>

P = 0.02

Evaluation of Suspected Aortic Dissection
Primary Goals of Imaging

Establish diagnosis
- Intimal flap

Localization of dissection
- Type A (ascending), Type B (descending)

Risk of pending or ongoing aortic rupture
- Periaortic hematoma
- Pericardial effusion/coagulum
- Saccular aortic aneurysm
Evaluation of Suspected Aortic Dissection
Secondary Goals of Imaging

Delineate false lumen
- Entry and exit tears, patency vs. thrombosis

Aortic root and aortic valve
- Severity and mechanism of AR
- Potential for aortic valve repair

Coronary artery compromise
- Dissection into coronary ostia, ostial obstruction by flap, LV function and RWMA

Other branch-vessel involvement
- Brachiocephalic, splanchnic, renal, iliac
Imaging Modalities In Acute Aortic Dissection
Aortography

Sensitivity $\sim 85-90\%$

False negative liability:
- False lumen thrombosis
- Aortic intramural hematoma
- Equal lumen contrast opacification

Hayter RG, et al. Radiology 2006; 238: 841
“... The ascending aorta was not dilated and looked OK on transthoracic echo ...”

“... This shouldn’t be dissection ...”
Type A Acute Aortic Dissection

Ascending Aortic Diameter at Presentation


Mean = 5.3 cm

Ascending aorta diameter (cm)

Noninvasive Diagnosis of Type A Aortic Dissection

Nienaber CA et al: NEJM 328:1, 1993

(*Early generation CT)
Contemporary Imaging in Aortic Dissection
Spiral CT, Multiplane TEE, and MRI: Meta-Analysis of 1,139 Patients

Sensitivity

<table>
<thead>
<tr>
<th></th>
<th>Spiral CT</th>
<th>MP TEE</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>100</td>
<td>98</td>
<td>98</td>
</tr>
</tbody>
</table>

Specificity

<table>
<thead>
<tr>
<th></th>
<th>Spiral CT</th>
<th>MP TEE</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specificity</td>
<td>98</td>
<td>95</td>
<td>98</td>
</tr>
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</table>
Acute Aortic Syndrome (AAS) CT Imaging

Advantages:
- Very readily available
- Very rapid (MDR-CT)
- Entire aorta imaged
- Branch vessels
- High resolution, 3-D reconstruction
- Least operator dependent

Limitations:
- Aortic valve and aortic regurgitation
- Site of intimal tear
- Contrast issues:
  - Renal dysfunction
  - Allergy
- Sequelae of pericardial effusion
Type A Aortic Dissection
2-D and 3-D CT Imaging

Courtesy of E.E. Williamson, MD
Type B Aortic Dissection
3-D CT Imaging
Acute Aortic Syndrome (AAS)

MRI/MRA Imaging

**Advantages**
- Very high resolution, 3-D reconstruction
- Gadolinium contrast *
- Entire aorta imaged
- Branch vessels
- Intraluminal flow
- Aortic regurgitation

**Limitations**
- Not readily available
- Long image acquisition time
- Pacemakers, ICDs, metallic implants
- Unstable patients, limited monitoring

* If GFR < 30 ml/min, ~ 4% risk of NFD/NSF
Aortic Dissection
MR Imaging

Courtesy of E.E. Williamson, MD
Acute Aortic Syndrome (AAS)

TEE Imaging

Advantages

• Readily available
• Rapid, bedside exam
• Aortic valve and aortic regurgitation
• Color Doppler of intraluminal flow
• Pericardial effusion and sequelae

Limitations

• Distal ascending aorta, innominate artery
• Thoracic aorta only
• Branch vessels
• Reverberation artifacts
• Highly operator dependent
### Acute Type A Aortic Dissection

**Intimal Flap:** TEE in 40 Patients

<table>
<thead>
<tr>
<th>Type</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Simple linear</td>
<td>55%</td>
</tr>
<tr>
<td>Circumferential</td>
<td>20%</td>
</tr>
<tr>
<td>Complex</td>
<td>25%</td>
</tr>
<tr>
<td>Prolapse into LVOT</td>
<td>15%</td>
</tr>
<tr>
<td>Entrance tear detected</td>
<td>78%</td>
</tr>
</tbody>
</table>

# Acute Type A Aortic Dissection

## TEE Findings in 74 Patients

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>False lumen thrombosis</td>
<td>8 - 41%</td>
</tr>
<tr>
<td>Aortic regurgitation (grade 2- 4/4)</td>
<td>35 - 45%</td>
</tr>
<tr>
<td>Coronary dissection or compromise</td>
<td>18 - 35%</td>
</tr>
<tr>
<td>Aortic rupture</td>
<td>6 - 10%</td>
</tr>
<tr>
<td>Pericardial effusion (small to large)</td>
<td>24 - 48%</td>
</tr>
</tbody>
</table>


*Ballal RS, et al: Circulation 1991; 84:1903*
Type A Aortic Dissection:
Rupture into the pericardial space

Courtesy of W.D. Edwards, M.D.
Type A Aortic dissection: Coagulum tamponade
Type A aortic dissection: Extension to left main coronary ostium
Type A aortic dissection:
Extension to left main coronary ostium
TEE in Acute Type A Aortic Dissection (IRAD; 522 Patients)

Multivariate Predictors of Mortality

Surgical Pts (n=434)
- Periaortic hematoma
- Pericardial tamponade

Medical Pts (n=88)
- False lumen patency

“Protective”
- False lumen thrombosis
- Flap localized to Asc aorta

# Imaging in Dissection of the Descending Aorta

## Impact of the False Lumen

<table>
<thead>
<tr>
<th>Initial false lumen diameter</th>
<th>Progression to aneurysm (≥6 cm)</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 22 mm</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>≥ 22 mm</td>
<td>42%</td>
<td>17%</td>
</tr>
</tbody>
</table>

\[ \text{P < 0.001} \quad \text{P = 0.09} \]

*Surgical Type A (n=51), Medical Type B (n= 49): CT follow-up 31± 27 mos.*

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Song JM, et al. JACC 2007; 50: 799
Aortic Intramural Hematoma (IMH)
Aortic Intramural Hematoma (IMH)

Pathoanatomic Mechanisms

- Spontaneous rupture and hemorrhage of vasa vasorum within aortic media

- Penetrating aortic ulcer (PAU)

## Aortic Intramural Hematoma
### Clinical Associations

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>70-90%</td>
</tr>
<tr>
<td>Extensive aortic atherosclerosis</td>
<td>20-30%</td>
</tr>
<tr>
<td>Trauma (deceleration or iatrogenic)</td>
<td>2-7%</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td>0-3%</td>
</tr>
</tbody>
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Intramedial Aortic Hemorrhage

Aortic Intramural Hematoma (IMH) Diagnostic Criteria

- Crescentic or circumferential thickening of aortic wall > 3-7 mm
  - TEE: thrombus echodensity ± lucencies
  - CT: high attenuation
  - MR: ↑↑↑ intensity on T1 imaging
- Central displacement of intimal calcium
- No mobile intimal flap
- No communicating blood flow from aortic lumen into IMH
Aortic Intramural Hematoma
CT Imaging

Noncontrast

Contrast
Type A Aortic Intramural Hematoma
MR Imaging
Type A Aortic Intramural Hematoma

TEE Imaging
Type A Aortic Intramural Hematoma
TEE Imaging
Type A Aortic Intramural Hematoma
80 y/o woman: Syncope at Wal*mart
CT Negative for PE; pericardial and pleural effusions
80 y/o woman: Syncope at Wal*mart
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Aortic Intramural Hematoma (IMH) Incidence Relative to Aortic Dissection

**Western Populations**
(n = 1,400)
- Aortic Dissection (86%)
- IMH (14%)

**Eastern Populations**
(n = 909)
- Aortic Dissection (61%)
- IMH (39%)

Aortic Intramural Hematoma (IMH)

Progression to “classical” dissection
- Ascending: 10-20%
- Descending: 5%

Nonprogressive localized intimal flap:
- 10-30%

Regression of IMH
- Descending: 50-70%
- Ascending: possible

Aortic rupture
- Type A > B: ~
- 5%

Sueyoshi E. J Vasc Surg 2002; 35: 1179
Evangelista A. Circulation 2003; 108: 583
Kodolitsch YV. Circulation 2003; 107: 1163
Song JK. JACC 2001; 37: 1604
Aortic Intramural Hematoma (IMH)
Predictors of Progression

- Ascending aorta involvement
- Aortic diameter > 4.0 cm
- Thickness of IMH ≥ 1.0 cm
- Presence of PAU
- Echolucent zones within IMH
- Late: absence of β-blocker therapy

Penetrating Aortic Ulcer (PAU)
Penetrating Aortic Ulcer (PAU)

- Complicates extensive aortic atheromatous disease
- Disruption of internal elastic lamina → extension into media
- Elderly, hypertensive (>90%) patients
- Symptoms of pain: May mimic aortic dissection or ACS
Penetrating Aortic Ulcer (PAU)

- Atheroma
- Intima
- Media
- Adventitia

Intimal plaque ulceration
Medial hematoma
Adventitial false aneurysm
Transmural rupture
87 y/o Male: Interscapular back pain; creatinine 2.7
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87 y/o Male: Interscapular back pain; creatinine 2.7
Penetrating aortic ulcer with saccular aneurysm
Penetrating Aortic Ulcer (PAU) Location in 131 Patients

- Descending Aorta (78%)
- Ascending Aorta (8%)
- Aortic Arch (6%)
- Multiple sites (8%)

Penetrating Aortic Ulcer (PAU)

Complications of PAU

- Intramural Hematoma (~80%)
- Localized Dissection (~30%)
- Saccular aneurysm (~50%)
- Complete Rupture (~10%)

High Risk PAU: Diameter > 2 cm, Depth > 1 cm

Vilacosta I, et al. JACC 1998: 32; 83
Interscapular back pain 4 yrs after CABG
Interscapular back pain 4 yrs after CABG
Endovascular Stenting: Angio

Before

After
Acute Aortic Syndrome (AAS)

Index of clinical suspicion is critical to making the correct diagnosis

Appropriate imaging must be pursued if AAS is in the differential diagnosis

Complimentary imaging modalities are often required for management