ACUTE AORTIC DISSECTION

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Acute Aortic Syndromes

- **Aortic Dissection:** (70 – 80 %)
- **Intramural Haematoma:** (10 – 20%)
- **Penetrating Aortic Ulcer:** (2 – 11%)

*Nature reviews / cardiology* vol 8 February 2011:103
Background

- **Definition:** Disruption of media layer of aorta with bleeding within & along the wall of the aorta resulting in separation of layers of aorta of variable longitudinal and circumferential extension.
  - 95% of patients intimal disruption (tear) is present
- **Incidence:** 2–3.5/100 000 person years
  - more common than AAA rupture
- Mean age of presentation 63yrs (males) & 67yrs (females)
- Male to female ratio – 2:1
- Laennec credited with having 1st used the term “dissecting aneurysm” (1826)
- The first attempt at surgical repair was in 1935 by Gurin et al
- DeBakey and colleagues published the first series of attempted repairs in 1955 with survival in 4 of 6 patients
Pathophysiology

- Initiating event is intimal tear in areas of high hydraulic stress
- Media exposed to pulsatile aortic flow separating media into 2 layers longitudinally & circumferentially, creating intimomedia flap, separating false lumen & true lumen
- Blood flow usually antegrade (uncommonly retrograde as well)
- Longitudinal course of dissection is fairly predictable
- False lumen:
  - inner 2/3s of media & intima form internal wall (intimomedia flap) & outer 1/3 of media & adventitia the outer wall
  - is highly thrombogenic
  - size of false lumen increases as % circumference of dissection increases & may compress true lumen
Pathophysiology (cont.)

- Fate of false lumen:
  - external rupture, reentry tear, aneurysm formation or end in a thrombosed cul-de-sac
- Thinness of outer wall related to propensity for aortic rupture
  - rupture site usually related to area of the entry tear
- Most AoD have reentry site(s) distally (esp. in abd. aorta / iliacs)
  - are severed ostia of IC / lumbar & other arteries
  - reentry tears allow for continued flow in false lumen (persistent patency)
- False lumen dilates with time – aneurysm formation (most frequent late complication).
- Intimomedial flap may compromise aortic branches resulting in critical ischaemia (malperfusion syndromes)
Malperfusion syndromes

- present in 16 - 33% of acute dissections
- 2 types, viz. **dynamic** (80%) & **static** (20%)
- both mechanisms may be present simultaneously in the same patient at different levels
- dramatically increases morbidity & operative mortality
  (operative mortality doubles in presence of malperfusion)
A Dynamic

B Static

C Reentry tear

J Vasc Surg 2006;30A
Classification

**Anatomical:**

- **De Bakey Type I** (60%)
- **Type II** (10%)
- **Type III** (30%)

**Stanford**

**Type A**
- All dissections involving the ascending aorta, regardless of the site of origin.

**Type B**
- All dissections not involving the ascending aorta.

**Chronological:**

- **Acute:** < 2 wks of pain onset
- **Subacute:** 2–6 wks
- **Chronic:** > 6 wks from pain onset

*Circulation* 2005, 112:3802–3813
Risk Factors

Conditions associated with increased aortic wall stress:

- Hypertension, particularly if uncontrolled
- Aortic dilatation / aneurysm
- Pheochromocytoma
- Weight lifting / Valsalva maneuver
- Trauma (including iatrogenic eg. catheterization, IABP insertion, prior cardiovascular surgery)
Risk Factors continued

Conditions associated with aortic media abnormalities:

- Genetic: (especially younger patients < 40yrs)
  - Marfan syndrome
  - Ehlers–Danlos syndrome type IV, Loeys–Dietz syndrome, Turner syndrome
  - Bicuspid aortic valve (including prior aortic valve replacement)
  - Familial thoracic aortic aneurysm and dissection syndrome

- Inflammatory vasculitides:
  - Takayasu arteritis
  - Giant cell arteritis
  - Behçet arteritis
Conditions associated with aortic media abnormalities:

- **Other:**
  - Pregnancy
  - Chronic corticosteroid / immunosuppression agents
  - Infections involving the aortic wall
Natural History

- Acute type A AoD: 
  - causes sudden death at time of onset
  - leads to various life-threatening complications.
- Untreated mortality rate reported @ 1 – 2%/hour after onset with:
  - 24 hr mortality – 30%
  - 48 hr mortality – 50%
  - 30 day mortality – 90%
- **THUS**: Acute type A AoD = SURGICAL EMERGENCY
- Surgery converts a 90% mortality to at least a 75% survival chance
- Only 2 patients need to be treated to gain survival benefit
- Survival advantage of surgery vs. medical therapy persists in the longterm

*JACC* Vol. 58, No. 24, 2011
Why patients die

- **Exsanguination** due to:
  🔄 false channel rupture

- **Cardiac failure** due to:
  🔄 acute AR
  🔄 acute myocardial infarction
  🔄 tamponade

- **End–organ ischaemia** due to:
  🔄 malperfusion syndromes
  ✗ coronary (10 – 15%)
  ✗ cerebral (7–14%)
  ✗ extremity (12%)
  ✗ visceral (5–8%)

JACC Vol. 58, No. 24, 2011:2455–74
Table 12. Differential Diagnosis for High-Risk Pain or Examination Features

<table>
<thead>
<tr>
<th>Pain Type</th>
<th>Differential Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest pain</td>
<td>Acute myocardial infarction</td>
</tr>
<tr>
<td></td>
<td>Pulmonary embolism</td>
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<tr>
<td></td>
<td>Spontaneous pneumothorax</td>
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<td></td>
<td>Esophageal rupture</td>
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<tr>
<td>Abdominal pain</td>
<td>Renal/biliary colic</td>
</tr>
<tr>
<td></td>
<td>Bowel obstruction/perforation</td>
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<tr>
<td></td>
<td>Non-dissection-related mesenteric ischemia</td>
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<tr>
<td>Back pain</td>
<td>Renal colic</td>
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<tr>
<td></td>
<td>Musculoskeletal pain</td>
</tr>
<tr>
<td></td>
<td>Intervertebral disk herniation</td>
</tr>
<tr>
<td>Pulse deficit</td>
<td>Non-dissection-related embolic phenomena</td>
</tr>
<tr>
<td></td>
<td>Non-dissection-related arterial occlusion</td>
</tr>
<tr>
<td>Focal neurologic deficit</td>
<td>Primary ischemic cerebrovascular accident</td>
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<tr>
<td></td>
<td>Cauda equina syndrome</td>
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</tbody>
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Circulation. 2010;121:e266-e369
Initial screening

- **ECG:** performed in all patients
  - STEMI findings should be treated as primary cardiac event without delay unless pt. is high risk for dissection
  - STEMI in 7% & myocardial ischaemia in 19% of AoD

- **CXR:** performed in all low and intermediate risk patients
  - Findings suggesting aortic disease – proceed to definitive aortic imaging
  - If alternate diagnosis made – manage accordingly
  - CXR × normal in 16% of cases
    × lack of mediastinal widening in 40% of cases

- **High risk** patients should directly undergo TEE, CT or MRI
- D-dimer screening / monoclonal Ab to myosin heavy chains not recommended at present as screening tests

*Circulation. 2010;121:e266–e369*
Evaluation

- **Intermediate risk patient:**

- **High risk patient:**
Diagnostic modalities

- Has seen a dramatic shift from invasive to non-invasive diagnostic strategy in recent yrs
- Results of imaging also help to plan further management
- Important findings include:
  - Classify the dissection/delineate the extent
  - Differentiate true and false lumen
  - Localize intimal tears
  - Assess side branch involvement
  - Detect and grade aortic regurgitation
  - Detect extravasation (periaortic or mediastinal haematoma, pleural or pericardial effusion ± tamponade)
## Diagnostic modalities

### CT vs TOE vs MRI vs Aortogram

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
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</table>
| **CT**    | - easy availability in emergencies  
            - high sensitivity and specificity  
            - assess complications (ischaemic gut, tamponade, dissection or aorta)  
            - easier to monitor vs MRI  
            - quicker than MRI | - remote location  
            - iodinated contrast  
            - can't assess AR, LVF or coronaries  
            - radiation exposure     |
| **TOE**   | - bedside  
            - can detect intimal flap, true and false lumen, AR, tamponade  
            - can assess LV function  
            - no contrast needed | - semi-invasive  
            - may need anaesthesia/intubation  
            - may cause hypertension  
            - not widely available  
            - special expertise required  
            - oesophageal trauma  
            - doesn't quantify distal complicat. |
| **MRI**   | - high sensitivity and specificity  
            - Gadolinium contrast better safety profile  
            - can detect AR  
            - no radiation exposure  
            - cardiac MRI could also be performed | - not readily available  
            - inconvenient (> 30 min)  
            - limited access and monitoring  
            - limited applic. (claustrophobia, pacemakers) |
| **Aortography** | - detection of intimal flap and AR  
                        - assess LV function, tamponade, blocked coronaries | - not readily available  
                        - invasive  
                        - contrast load  
                        - remote location |
Coronary angiography

- routine coronary angiogram to identify dissection involvement of coronary ostia is not indicated. (TEE, direct intraoperative examination)
- coronary angiogram to detect atherosclerotic disease in stable patients who are to undergo surgery is controversial

surgical outcome. This is a strong argument used by some authors to recommend coronary angiography for all stable patients. However, whether or not selective coronary angiograms should be performed in patients being considered for surgical repair remains indetermined\(^{[145]}\). Mortality after surgery for aortic dissection does not seem to be related to myocardial ischaemia and, therefore, it is unlikely that systematic coronary angiography prior to surgical repair can influence outcome. It should be left up to the clinical judgment of the physician and surgeon whether coronary angiography is to be performed.
8.6.1.5. Recommendations for Initial Management

Class I

1. Initial management of thoracic aortic dissection should be directed at decreasing aortic wall stress by controlling heart rate and blood pressure as follows:
   a. In the absence of contraindications, intravenous beta blockade should be initiated and titrated to a target heart rate of 60 beats per minute or less. (*Level of Evidence: C*)
   b. In patients with clear contraindications to beta blockade, nondihydropyridine calcium channel-blocking agents should be used as an alternative for rate control. (*Level of Evidence: C*)
   c. If systolic blood pressures remain greater than 120 mm Hg after adequate heart rate control has been obtained, then angiotensin-converting enzyme inhibitors and/or other vasodilators should be administered intravenously to further reduce blood pressure that maintains adequate end-organ perfusion. (*Level of Evidence: C*)
   d. Beta blockers should be used cautiously in the setting of acute aortic regurgitation because they will block the compensatory tachycardia. (*Level of Evidence: C*)

8.6.1.6. Recommendations for Definitive Management

Class I

1. Urgent surgical consultation should be obtained for all patients diagnosed with thoracic aortic dissection regardless of the anatomic location (ascending versus descending) as soon as the diagnosis is made or highly suspected. (*Level of Evidence: C*)
2. Acute thoracic aortic dissection involving the ascending aorta should be urgently evaluated for emergent surgical repair because of the high risk of associated life-threatening complications such as rupture. (*Level of Evidence: B*)
Management of hypotensive patient

- hypotension / shock in acute AoD – mandates need for immediate surgery
- Present in 20 – 38% of patients with acute AoD
- Medical management options limited:
  - Volume administration is reasonable 1st line
  - Vasopressors / inotropes will increase aortic wall stress
- Pericardiocentesis for dissection related haemopericardium:
  - Controversial
  - May be associated with recurrent bleeding & mortality
  - AHA/ACC recommend pericardiocentesis in cardiac tamponade patients who cannot survive until surgery
    * withdraw just enough fluid to restore perfusion
Prior AVR

A type A dissection is less virulent if there has been a prior aortic valve replacement.
- Dissection cannot cross a suture line, so the right coronary artery is protected.
- Aortic insufficiency is impossible due to the prosthetic valve in place.
- Adhesions discourage free rupture into the pericardial sac.

Surgical goals

- **Primary goal**: to correct immediate life-threatening pathology
  - Resect aorta most likely to rupture
  - Restore/preserve AV competence:
    - resuspend / repair / replace
  - Restore vital organ perfusion (coronary, brain, spinal cord, viscera, extremities):
    - resect intimal tears
    - direct flow into true lumen

- **Secondary goals**:
  - Prevent aortic root dilatation:
    - replace
  - Promote healing / remodelling of distal aorta:
    - obliterate false lumen
8.6.4. Recommendation for Surgical Intervention for Acute Thoracic Aortic Dissection

Class I

1. For patients with ascending thoracic aortic dissection, all of the aneurysmal aorta and the proximal extent of the dissection should be resected. A partially dissected aortic root may be repaired with aortic valve resuspension. Extensive dissection of the aortic root should be treated with aortic root replacement with a composite graft or with a valve sparing root replacement. If a DeBakey Type II dissection is present, the entire dissected aorta should be replaced. (Level of Evidence: C)
Surgical options

Standard procedures:
- Supracommissural ascending aorta replacement.
  ± Aortic valve repair / commissural resuspension
- Composite conduit root replacement.
  ➢ modified button Bentall procedure
  ➢ bio Bentall procedure
- Aortic valve–sparing root replacement.
  ➢ David procedure (reimplantation)
  ➢ Yacoub procedure (remodeling)

Above 3 primary surgical options may be combined with:
- open distal anastomosis & arch inspection
- Hemiarch Replacement
- Total Arch Replacement ± conventional elephant trunk
- Hybrid–Procedures (Frozen elephant trunk)
Acute type A aortic dissection has high mortality and morbidity:
- Operative mortality 15 – 35%
- 5–year need for reoperation 5–25%

Less complex procedures have traditionally been used:
- “Get in and get out” strategy
- Thought to reduce operative mortality

Recent studies have promoted more complex procedures to decrease need for late reoperation at the cost of possible increased operative mortality – CONTROVERSIAL! (studies both for & against)

Rationale for routinely extending classic repair:
- distal patent false lumen (PFL) present in 47 – 75% of cases
- PFL increases rate of expansion of distal aorta
- PFL increases need for reoperation @ 10 yrs (35% vs 6%) & reduces survival @ 5 yrs by 20%

(Englin et al) JACC Vol. 58, No. 24, 2011:2455–74
Extent of surgery (cont.)

- **Absolute minimum:**
  - Inspection of aortic arch for tears under open distal anastomosis (no x-clamp)

- **Hemiarch replacement:**
  - If intimal tear in concavity of arch
  - Esp. if patient unstable / elderly

- **Total arch replacement performed if:**
  - Pre-existing arch aneurysm
  - Connective tissue disorders
  - Complex / multiple arch tears
  - Tears compromising arch vessels
  - Severely compressed true lumen distally ± malperfusion

Hybrid procedures:

- **Frozen elephant trunk procedure**
  
  Operative strategy to promote obliteration of distal PFL with minimal increase in operative mortality (avoid prolonged circulatory arrest)

- Hybrid procedure combining aortic arch surgery with open antegrade stent grafting of desc aorta

  Indicated in:

  - younger patients
  - dilated proximal desc aorta
  - entry tears in proximal desc. Aorta
  - distal malperfusion
Endovascular options

- No stents designed for use in asc aorta – off label usage
- Development of newer devices may allow for endovascular approaches
- Anecdotal reports of usage
- Combination of TAVI & endovascular stenting may become a solution for non-surgical candidates

Nordon et al.; European J Vasc and Endovasc Surg., 2012
Acute Type B Aortic Dissection
Management

- 25 – 40% of all acute dissections

- **Uncomplicated disease:**
  - 80 – 85% of cases

- **Complicated disease:**
  - 15 – 20% of cases
  - presence of:
    - rupture
    - malperfusion
    - refractory pain
    - uncontrolled hypertension

Semin Thorac Cardiovasc Surg 17:224–235
UNCOMPLICATED:
Medical therapy is preferred therapy BUT medical compliance is critical

8.6.1.6. Recommendations for Definitive Management

Class I
3. Acute thoracic aortic dissection involving the descending aorta should be managed medically unless life-threatening complications develop (e.g., malperfusion syndrome, progression of dissection, enlarging aneurysm, inability to control blood pressure or symptoms).285,288,334–337 (Level of Evidence: B)

Acute descending (type B) aortic dissection is not as life-threatening as acute type A aortic dissection. Early survival is satisfactory using medical management alone, unless distal ischemic complications (“malperfusion”) or aortic rupture occurs. In patients with uncomplicated acute type B aortic dissection, this constitutes a benchmark that will be difficult to surpass, or even to match, by endovascular stent-graft treatment.

Circulation. 2010;121:e266–e369
Ann Thorac Surg 2008;85:S1–41
COMPLICATED:

- Little to no debate in literature for TEVAR vs open surgery for acute complicated Type B AoD
- Latest IRAD (International Registry of Aortic dissection) results: (Fattori et al, JACC 2008)
  - Surgical repair – mortality 33.9% & morbidity 40% (esp. renal failure & neurologic)
  - TEVAR – mortality 10.6% & morbidity 20%
- THUS: TEVAR is preferred Px measure
Longterm mortality after hospital discharge is greater for type B dissection than for type A dissection.

1/3 of patients will require surgery for aortic related complications < 5 yrs of initial dissection.

- risk greatest in 1st few months

Beta blockade is cornerstone of Px

- maintain BP <135/80
- recent IRAD data – Ca channel blockers beneficial

Serial imaging vital

- 1, 3, 6 & 12 mths post D/C & then annually
THANK YOU