Perioperative TEE for Aortic Dissection

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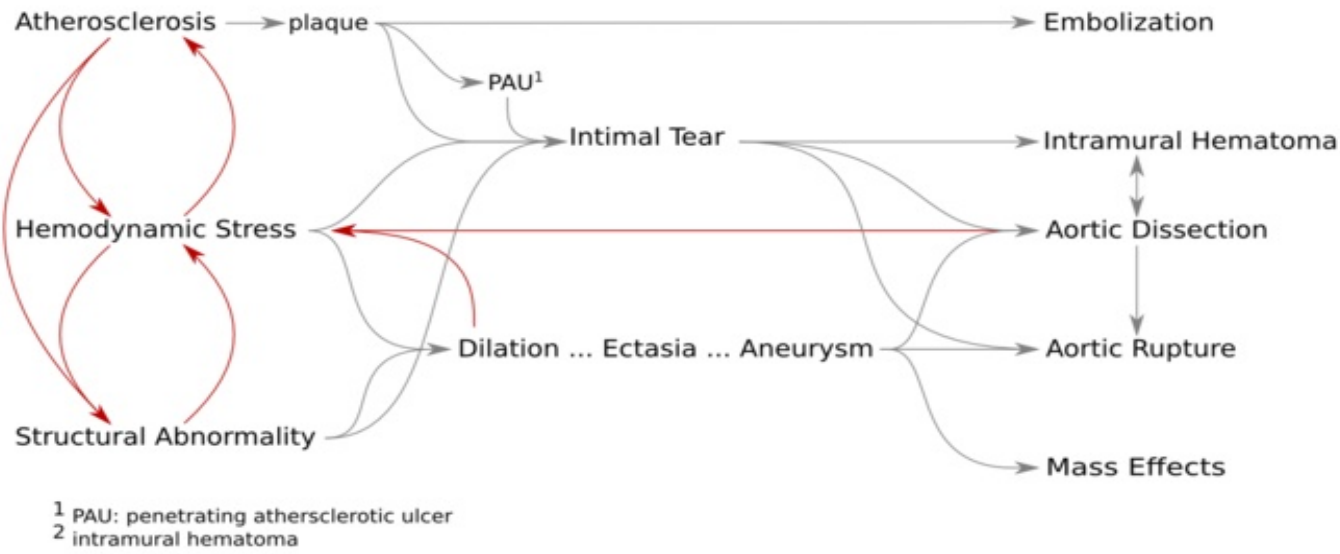
1 Objectives

1. Visualize and describe the anatomical relationship between the segments of the thoracic aorta, the tracheobronchial tree and the esophagus and identify the imaging windows and blind spots for transesophageal echocardiography (TEE) of the thoracic aorta
2. Describe the primary life-threatening complications of acute Type A aortic dissection and the corresponding clinical objectives of intraoperative TEE during emergency repair of aortic dissection
3. Describe the basic echocardiographic assessment of aortic dissection.

2 Focus

The primary focus of this session is **intraoperative echocardiography for emergency repair of acute type A aortic dissection (ATAD)**. While much of the content also applies to other settings (such as iatrogenic aortic dissection, traumatic dissection; type B dissection and subacute presentations of TAD) these situations involve specific considerations that are beyond of the scope of this session.

3 Pathophysiology



4 Anatomy & Echocardiographic Windows

1. Divisions of the aorta & Views
   - Root, Ascending Aorta, Aortic Arch, Descending Aorta
2. Relationship to other thoracic structures
3. "Blind Spot"
   - Caused by interposition of air-filled structures (tracheobronchial tree, lung)
   - Often includes the bracheocephalic (innominate artery) and left common carotid artery.
   - Very rare for dissections to start in or be limited to this area.
   - Dealing with the blindspot

- TTE suprasternal notch view
- Epiaortic imaging
- Bronchial balloon ("A-view" catheter)

5 TEE in emergency surgery for ATAD

"The primary purpose of intraoperative TEE is to detail the anatomy of the dissection and to better define its physiologic consequence" - Goldstein et al 2015 JASE(1)

Diagnosis: Define anatomy & physiologic consequences of ATAD

1. Assess presence of **pericardial or pleural effusion** suggestive of aortic rupture
   - Not always blood (may be inflammatory effusion secondary to irritation of adventitia by hematoma) but assume blood until proved otherwise.
   - Poor prognosis if present
   - **Absence does not rule our rupture:** periaortic hematoma or hemothorax may not been seen on echo. Best evaluated on CT.
2. Identify location of **intimal tears** (entry and re-entry tears)
   - Common locations:
     - Within 3 cm of STJ in ~70% of cases (typically distal to RCC or LCC along the greater curvature of the arch)
     - Ligamentum arteriosum (junction of aortic arch and descending aorta) in ~30%
   - Mimics & Artifacts:
     - beam width artifacts of lines (PAC, CVL)
     - Innominate vein
     - Hemiazygous sheeth
     - Reverberation artifacts e.g. double lumen aorta in Desc. Ao. LAX view
3. Identify **false & true lumens**:
   - Static morphologic features are most specific (follow structures from tear origin; relationship of layers at branch)
     - Diagram of vessel branch appearance
   - Dynamic / Functional features much easier to assess and relatively reliable but not perfect as most assume greater antegrade flow in TL than FL.
     - Table 3 from Evangelista 2010(2)
       - TL smaller
       - TL systolic antegrade; FL reduced or no systolic antegrade, possible retrograde.
       - TL systolic expansion; FL systolic compression: hence intimal flap moves toward FL during systole in LAX views
       - Flow at communications from TL to FL
       - Contrast filling: TL early and fast; FL delayed and slow
   - Q: In what situation does the intimal flap move **towards** the **true lumen** in systole? Which other typical findings of TL vs FL do not apply in this situation?
4. Define **extent of dissection**:
   - Proximal
     - Aortic root
     - Coronary arteries: 10-20% of cases. Most often right.
       - Patterns of coronary artery involvement(3)

- Distal
  - arch vessels, descending aorta
  - Are arch vessels fed by true or false lumen?

5. Asses **aortic insufficiency** (moderate or severe acute AI in 50-75%)(3)
   - Dimensions of aortic root (annulus, SOV, STJ)
   - Mechanisms
     - Dilation of root (annulus, STJ) or ascending
     - Rupture of commissure/leaflet support
     - Distortion of root by hematoma
     - Prolapse of intimal flap through valve (which can on occasion prevent or reduce AI caused by one of the other mechanisms!(1)
     - Pre-existing disease
6. Assess **ventricular function**
   - R/O major myocardial perfusion defect suggestive of coronary dissection.
   - Generalized dysfunction is most commonly related to acute, severe **aortic regurgitation(4)**
   - Concentric hypertrophy common given association with poorly controlled hypertension. Myocardial protection on CPB often suboptimal even in the absence of coronary artery compromise.
   - AD patients with acute heart failure and cardiogenic shock are less likely to present with classic severe and abrupt chest pain syndromes, often leading to delayed diagnosis
7. Assess **perfusion of branching vessels**
   - Malperfusion of arch vessels
   - Visceral malperfusion – two primary mechanisms
     - Compression of true lumen by false lumen ("dynamic obstruction" as it varies with cardiac cycle) impairing flow into otherwise normal branch; Distal fenestration of flap to allow decompression of FL and flow of blood back into TL.
     - Extension of dissection into branch ("static obstruction")
8. **Iatrogenic dissections** related to cardiac catheterization or aortic cannulation
   - Rare
   - Often retrograde dissection from site of injury (e.g. from coronary artery or ascending aorta into the aortic root.
   - Intraoperative dissections related to aortic cannulation often present as an aortic hematoma observed by surgeon, elevated pressure on CPB pumps or failure to generate systemic pressures on arterial line despite adequate pump flow.
   - Epiaortic and surface TTE imaging from the suprasternal notch can be useful adjuncts to assess extent of injury, cannula position and involvement of arch vessels.
   - Prompt diagnosis is essential for good outcome

Procedural planning: Provide information relevant to key surgical decisions(5)

The role of TEE support for procedural planning can be especially significant here as these emergency procedures are often performed by surgeons without specific expertise in aortic surgery

1. Cannulation: Venous: Central or femoral? Arterial: Axillary or femoral?
   - Presence of pericardial effusion suggesting aortic rupture
   - Hemodynamic instability suggesting tamponade or myocardial ischemia
2. Is arch repair required? (even if tear is in the arch, arch repair may be deferred in some circumstances)
3. Supracoronary ascending aorta repair? Replacement of aortic root?

    - Recommendations vary as to whether root repair should be considered at all (5) or whether any involvement of the sinuses of valsalva should trigger an aortic root replacement.(4)
4. Aortic valve: Spare or Replace?
    - Most ATAD-related anatomical causes are potentially repairable if mechanism is clearly identified
    - Risks of prolonging procedure vs. complications of prosthetic replacement need to be weighed
5. Are coronary bypasses necessary?
6. Should pathology in descending aorta be addressed acutely?

Monitoring & procedural guidance

Dissection is a very dynamic process and extent of injury and consequences can evolve in the course of the procedure

Key steps in typical repair procedure (no extension into arch)

1. Exposure of femoral vessels or placement of percutaneous wires into femoral artery and vein
2. Median sternotomy
3. For unstable patient **femoral cannulation**.
4. Start CPB and cooling (20-22 C)
5. Open pericardium
6. For stable patient CPB cannulation: venous in RA and right axillary graft for arterial line. For patient with femoral cannulation, possible addition of RA and/or right axillary lines.
7. Start (or continue) CPB and cooling.
8. Placement of LV vent (RUPV)
9. Placement of **retrograde cardioplegia cannula in coronary sinus**
10. Circulatory arrest
11. Opening of ascending aorta and inspect of arch
12. If no arch involvement transection of aorta below bracheocephalic take-off
13. Cardioplegia (antegrade or retrograde)
14. Distal anastomosis of tubular graft
15. If femoral arterial cannula, transfer to ascending graft and start antegrade CPB
16. Rewarm
17. Aortic root surgery if needed
    - +/- Aortic root/valve repair or replacement
    - +/- aortic valve replacement
18. +/- Aortocoronary bypass

Procedural guidance for EVAR

- Often under fluroscopy but TEE can distinguish false and true lumens
- Protruding aortic plaques can be seen on TEE to help improved selection of landing zone reduce risk of endoleaks

Post-operative assessment

- Aortic root and ascending aorta to confirm exclusion of entry tear and any proximal extension)
- Ventricular function
- Aortic valve function
- Adequacy of flow in descending thoracic aorta

6 References

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