TEE Essential in Paravalvular Leak Closure and Pseudoaneurysm Repair.

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Structural Heart Disease: short history

- Rubio-Alvares and Limon 1952.
  - Relief of critical pulmonary stenosis with catheter
- Bill Raskind introduces balloon septostomy 1966
- Peripheral balloon interventions introduced
- Techniques adapted for pulmonary valvuloplasty
- Inoue performs first Mitral valvuloplasty
- Karl Amplatz creates plugs for defect closure
  - Specific devices for ASD, VSD, PDA
  - Devices migrate to other applications
  - Specific PVL devices emerge
• Incidence of PVL immediately after surgical valve replacement (SVR)
  – post AVR ranges 6 to 17.6%
  – post MVR ranges 22.6 to 32%
  – 90% trivial to mild – clinically insignificant
  – 2% moderate – severe
  – Mitral more common than aortic

Davila-Roman et al. J Am Coll Cardiol 2004;44:1467-72
Hammermeister K et al. J Am Coll Cardiol 2000;36:1152-8
Ionescu A et al. Heart 2003;89:1316-21

• Surgical closure vs percutaneous closure
  • Surgery has been mainstay for symptomatic leaks
  • Mortality high, 10% in recent large series
  • Paradoxically redo surgery has higher rate of PVL’s
    – First re-do PVL 13%, Second re-do PVL 35%

Akins et al. J Heart Valve Dis 2005 Nov 14;792-799
• Surgical closure vs percutaneous closure

• Percutaneous success rates high in recent large series with low mortality:
  – Two large USA series - success 77% to 86.5%
  – UK & Ireland n=259, device success 91%, 75% mild-or less residual regurgitation

Calvert PA et al. Circulation 2016

• Surgical closure vs percutaneous closure

• New consensus guidelines
• Better equipment and experience favours percutaneous approaches

Nishamura, Otto, Bonow et al. 2014 AHA/ACC Guideline for the management of patients with valvular heart disease: J Am Coll Cardiol 2014;63:e57-185
Paravalvular leak

- More common with advancing age
  - Extent of calcification
  - Tissue friability
- More common after surgery for bacterial endocarditis
  - Extensive abscess formation
  - Redo prosthetic valves
  - Emergent surgery for haemodynamic failure

Usual reasons for closure PVL and Pseudoaneurysm

- Haemodynamic burden – big holes
  - Heart failure
  - Progressive chamber enlargement
  - Deteriorating EF
- Haemolysis – small complex jet lesions
  - Need for transfusion
  - Persistent low grade anaemia
  - Low haptoglobins, high reticulocyte count

Pseudoaneurysm – risk of rupture
Detection

- Clinically suspected
- Transthoracic ECHO
- Transoesophageal ECHO
- Gated contrast CT reconstructions
- Contrast angiography
- MRI

TTE image: best for initial detection, often imprecise for location and shape
TTE: Jet frequently directed across face of valve
Anatomic size, shape and location obscured

TEE: biplane image, Aortic bioprosthesis
single, large, crescentic paravalvular leak, non-coronary sinus
Planning usually multi-modality
CT reconstructions directed by knowledge from TEE
9x4mm
Widest point in inlet as above
Figure 4. Devices used for closure of periprosthetic defects. (A) Amplatzer Septal Occluder; (B) Amplatzer Cribriform Occluder; (C) Amplatzer Vascular Plug II; (D) Muscular VSD Occluder; (E) Amplatzer Duct Occluder; (F) Amplatzer Vascular Plug III; (G) Occlutech Paravalvular Leak Closure Device.

Constructed of woven nitinol with or without dacron inserts

Closing Complex Holes: 1 Process

- Planning images TTE & TEE
  - Identify hole, often several, shape (buttoniere)
  - Position in relation to structures (valve ring)
  - Relationships eg coronary artery
- Sizing
- Access
- Exclude other pathologies (endocarditis)
Device shape

- Often buttoniere / linear defects
- Complex tunnel shapes from inlet - outlet

- Circular shape needs to be large to cover, encroaches on valve
- Better fit with oval or complex rectangle
- New “game changing” devices

Need to crush device into small catheter and regain shape on release

Closing Complex Holes: 2 Review

- Review TEE images with other planning images
  - CT reconstructions
  - Catheter based imaging
  - MRI
Closing Complex Holes: 3 Plan Access

- Route
- Device + sizing
- Deployment position
- Closure of access point
- Bail-out options

Potential approaches

- Retro-aortic
- Transseptal
- Transapical
Closing Complex Holes: 4 - Heart Team Meeting

- Structural interventionalist, TEE, Anaesthesia, CT, Cardiac Surgeon, Clinical
  - Risk assessment
    - Surgical
    - Anaesthetic
    - Mobilization/recovery
  - Alternatives
  - Bailout planning
  - Documentation
Closing Complex Holes: 5 Consent

- Informed consent
  - Patient and family/support
  - Realistic
  - Risk
  - Novel/unique/ uncommon procedures
  - Nothing vs percutaneous vs surgery

Complex case

- 83 year old man
  - Age 55 chronic atrial fibrillation ➔ dilated cardiomyopathy, CHF. Recovered EBMT.
- New symptoms LV normal,
  - (TOE) demonstrated severe mitral regurgitation
  - bileaflet myxomatous disease with severe posterior leaflet flail involving P2+P3
  - PA 70 systolic.
- Magna Ease 33mm tissue prosthesis
  - initially uncomplicated post-operative course.
- Around day 6 post-operatively developed breathless
  - loud pansystolic murmur was noted at all examinations (not noted up until that time) and large bilateral pleural effusions developed.
- TOE - severe para-prosthetic leak placed inferiorly and medially
• Options
  – Re-operation
  – Medical management
  – Percutaneous closure
    • Difficult place to get to via transseptal
    • Best via transapical approach
      – Thorough planning – access, delivery, closure, exiting LV

Potential approaches

Retro-aortic  Transseptal  Transapical
### Oval 11mm x 8mm

**Reorder Number** | **Long Axis Diameter (mm)** | **Short Axis Diameter (mm)** | **Unconstrained Device Length (mm)** | **Min. Internal Diameter Required (mm [Inch])** | **Min. Sheath Size Required (F)**<sup>2</sup> | **Min. Guide Catheter Size Required (F)**<sup>3</sup> | **Max. Delivery System Length (cm)**
--- | --- | --- | --- | --- | --- | --- | ---
9-AVP3-042 | 4 | 2 | 6.5 | 1.65 (0.065) | 4 | 6 | 120
9-AVP3-063 | 6 | 3 | 6.5 | 1.65 (0.065) | 4 | 6 | 120
9-AVP3-084 | 8 | 4 | 6.5 | 1.83 (0.072) | 5 | 7 | 120
9-AVP3-103 | 10 | 5 | 6.5 | 1.83 (0.072) | 5 | 7 | 120
9-AVP3-105 | 10 | 5 | 6.5 | 1.83 (0.072) | 5 | 7 | 120
9-AVP3-123 | 12 | 3 | 6.5 | 2.49 (0.098) | 7 | 9 | 120
9-AVP3-125 | 12 | 5 | 6.5 | 2.49 (0.098) | 7 | 9 | 120
9-AVP3-143 | 14 | 3 | 6.5 | 2.49 (0.098) | 7 | 9 | 120
9-AVP3-145 | 14 | 5 | 6.5 | 2.49 (0.098) | 7 | 9 | 120
21G
Direct
LV puncture
LV free wall
Avoiding LAD
7F sheath
Device orientation
Direct vision on how much tension for deployment
Correct orientation
Snugged up into
defect with tension

Amplatzer VP3
Closing Complex Holes: TEE Operator Run Sheet

a. During set up
   a. Organize key views,
   b. Repeat sizing
b. Assist with access
   a. Eg transseptal, transapical
c. Finding hole & confirming passage
d. Assist in device deployment
   a. Distal deployment (tension – flow-size)
   b. Proximal, orientation
   c. Adjacent valve function or structures
   d. stability
e. Guide device release - stability
f. Close access – transseptal/transapical/pericardium

Use multiple images during procedure
• Encroachment on valve mechanism
  – Mechanical
    • more likely affected
  – Bioprosthesis
Multiple defects

- Checking closure
  - Device porous
  - Closure imperfect
  - Other undiagnosed defects
  - Constantly checking for further PVL’s
Post redo for Endocarditis.
Severe LV impairment
Inoperable

Complex tunnel

Two large defects Non-coronary sinus region

Other PVL’s present.
Not initially seen on planning TEE
Third hole now obvious under left coronary
• Closing the entry point
  – Transapical PDA plug and Floseal glue
Closing apical entry point
Partial exposure of PDA device—confirming mid ventricle
PDA pulled down into apical endocardium

Not possible to visualize this relationship with fluroscopy.
TEE Operator Key Messages

- Mindset change
  - Not creating diagnostic images, participating in an intervention
- Time out – Theatre Universal Protocol
- Think ahead of what is needed
- Communication + Participation
- Think like a structural interventionalist
  - Find
  - Cross
  - Deploy
  - Avoid
  - Stable
- Understand other imaging modalities and devices