A Comprehensive Approach to Prosthetic Valves

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No disclosures
Echo Reporting for prosthetic valve

• Valve type (description rather than brand)
• Implant position
• Stability / mobility
• Struts / cage
• Disc / ball / leaflet motion
• Leaflet thickening
• Doppler
  – Transvalvular gradients
  – Regurgitation
    • Location - Central vs. Paravalvular
Valve types

• Biologic / Tissue
  – Stented
    • pericardial (bovine)
    • Porcine (aortic leaflets)
  – stentless (porcine)
  – Homograft (cadaveric)
  – Stent mounted for TAVR (pericardial)
  – Autograft (Ross procedure)

• Mechanical
  – tilting Disc
    • Single
    • Double
  – Ball & cage

• composite – valved conduit
Valve sizes

• Outer diameter of the valve sewing ring/stent
Valve imaging characteristics

• Stented bioprostheses
  – 3 struts
    • Porcine aortic
      – Central leaks only as valves are degenerating
    • Bovine pericardial
      – Sharper edges, small central leak

• Single tilting disk
  – Hall Medtronic - Central hole (disk hung on strut), central leak, large central strut
  – Bjork Shiley – large profile disk, no central hole (disk held by strut), peripheral leak
    • Modifications of struts led to failure/recalls

• Bileaflet
  – Peripheral leaks, low profile disks,
Central hole
Strut extends below sewing ring
Zoghbi et al, JASE 2009:22:975-1014
TEE is gold standard for assessing prosthetic valve complications

- Thrombus
- Obstruction/stenosis
  - pannus, thrombus, vegetation
- Endocarditis
  - ring abscess
  - vegetations - leaflets, struts
- Perivalvular leaks
- Dehiscence
- Structural failure
  - Calcification, leaflet tear, perforation
Prosthetic valve regurgitation

• Physiologic regurgitation of mechanical valves
  – washing jets
  – backflow closure volumes

• Pathologic
  – central valvular (within sewing ring)
    • Bioprostheses - degeneration, flail, vegetation
    • mechanical - occluder malfunction
      (thrombus/veg/suture/HITT/pannus)
  – paravalvular
    • dehiscence, abscess, improper seating/annular Ca+
Physiologic leak patterns
Flachskampf et al. JACC 1991

Orthogonal plane to disk axes
Parallel plane to disk axes
Normal prosthetic valve Doppler gradients

• Normal values for peak and mean velocities and gradients vary:
  – prosthesis location
  – prosthesis type
  – prosthesis size

• See appendices in ASE prosthetic valve guidelines paper for normal values for all valve types
Mean gradients - aortic prostheses

- Ball and cage 23 mm HG
- Stented bioprosthesis, disc 13-15 mm HG
- Homograft 8 mm Hg

- Higher gradient?
  - Stroke volume (check velocity before valve)
  - Pressure recovery
  - Patient prosthesis mismatch (valve size)
  - Valve dysfunction, fibrous ingrowth
Mean gradients – MV/TV prostheses

- Mitral - All types: 4-5 mm Hg
- TV prostheses: 2-3 mm Hg
Gradients across 2 bileaflet mechanical MVs

13 mm Hg / 4 mm Hg

31 mm Hg / 24 mm Hg
Bioprosthetic AV with gradients 80/45 mm Hg
High prosthetic valve gradients

• High flow state
• Obstruction
  – Pannus, thrombus, vegetation, valve degeneration
• Pressure recovery
  – Small bileaflet valve and small aorta
• Patient prosthesis mismatch
  – Gradients high, leaflets appear normal
Pressure recovery

- As flow expands into wider lumen beyond valve, velocity and kinetic energy drop and pressure recovers
- Catheter pressure gradient will be lower than Doppler derived pressure gradient
- Rarely an issue except:
  - Small aorta (< 3cm)
  - Ball in cage valve
  - Small bileaflet valve with high flow

Zoghbi et al, JASE 2009:22:975-1014
Patient – Prosthesis mismatch
related to post-op gradients and adverse outcome

• EOA of prosthesis too small for patient body size
  – Results in abnormally high gradients

• Normal aortic EOA / BSA ≥ 0.85 cm²/m²
  – Moderate PPM if 0.65 – 0.85 cm²/m²
  – Severe PPM if < 0.65 cm²/m²

• Normal mitral EOA / BSA > 1.2 cm²/m²
  – Moderate PPM if 0.9 – 1.2 cm²/m²
  – Severe PPM if < 0.9 cm²/m²
  Cont eq not PHT
High gradient across AV prosthesis

High velocity below sewing ring in LVOT suggests the gradient due to pannus rather than valve thrombosis or mis-match.
Pannus vs thrombus

- Thrombus
  - Larger
  - Softer appearance
  - Mobile elements

- Pannus
  - More common in aortic prostheses
Paravalvular regurgitation
Real-time 3D TEE-guided catheter based repair of severe paravalvular regurgitation in prosthetic valves

Dehiscence of mechanical AV + Ao graft
Bioprosthetic AV abscess
Dehiscence of MV annular ring
Dehiscence of MV annular ring
Bioprosthetic MV with pannus leading to MR
Transcatheter valve in valve
treatment of bioprosthetic valve failure

Seiffert et al, JACC Int 2012;5:341-9
Prosthetic Mitral Valve Dysfunction?

n = 134

E < 1.9
n = 62

PHT < 130
n = 58

Any Dysf 5%
Regurg 5%
Obstr 0%

PHT ≥ 130
n = 3

Any Dysf 100%
Regurg 0%
Obstr 100%

E ≥ 1.9
n = 72

PHT < 130
n = 52

Any Dysf 71%
Regurg 69%
Obstr 2%

PHT ≥ 130
n = 20

Any Dysf 100%
Regurg 5%
Obstr 95%

Fernandes et al, Am J Cardiol 2002;89:704-710
Evaluating elevated prosthetic AV peak velocity

DVI= Doppler Velocity Index or Dimensionless Index (V1/V2)
(for native valves nl =1; mild sten 0.5-1; Mod sten 0.25-0.5; Severe < 0.25)

AT= acceleration time

54 yo M with mechanical MV with fever, chills, new painful swelling of wrist
Gp B strep bacteremia
Prosthetic valve endocarditis: pitfalls of TEE

• Assessment of entire aortic annulus
  – shadowing by prosthesis – integrate deep transgastric and tte views

• Not all paravalvular leaks = infection

• Not all unusual echoes = vegetation
  – degenerative changes
  – Lambl’s excrescence
  – sutures
  – nonbacterial thrombus
Pitfalls of AV imaging
Normal AV annular thickening/edema post-AVR mimicking abscess
What to report on TEE evaluation of prosthetic valve

- Valve well seated or excessive motion of ring?
- Implantation position (aortic)
  - Intra-annular, supra-annular
- Occluder mechanism opening and closing ok?
- Unexpected valvular or paravalvular regurgitation?
- Gradients
  - Prosthetic valve stenosis?
- Unexpected masses on sewing ring or leaflets?
- Involvement of other cardiac structures?
Prosthetic valves: role of echo

• Routine screening of prosthetic valves should be performed with TTE
• TEE used for specific indications when TTE not adequate
  – valve dysfunction, regurgitation, endocarditis, etc
• before performing a TTE or TEE you should know
  – details of implantation
    • valve type/size, annular support, root enlargement / graft, etc