Echocardiographic assessment of Prosthetic Valves
Michael H. Picard, M.D.
Massachusetts General Hospital
Harvard Medical School
No disclosures


GUIDELINES AND STANDARDS
Recommendations for Evaluation of Prosthetic Valves
With Echocardiography and Doppler ultrasound

The bottom line
• 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
    • root enlargement / graft, valve type/size, etc
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
    - porcine (bovine)
    - Porcine (aortic leaflets)
  - stentless (porcine)
  - Homograft (cadaveric)
  - Stent mounted for TAVI (porcinal)
  - Autograft (Ross procedure)
- Mechanical
  - tilting Disc
    - Single
    - Double
  - Ball & cage
- composite – valved conduit

Valve sizes

- Outer diameter of the valve sewing ring/stent
Valve 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,
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

How accurate are Doppler gradients across prosthetic valves? comparison with catheter
Burstow et al Circ 1989
Echo discrepancies with cath when use of peak Doppler gradient

Burstow et al Circ 1989

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

Pressure recovery

- As flow expands into wider lumen beyond valve, velocity and kinetic energy drop and pressure recovers
- Catheter pressure will be lower than Doppler derived pressure
- 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
  – Severe PPM if < 0.65 cm²/m²

Prosthetic valve abnormalities – TEE is the echo gold standard

• Thrombus
• obstruction/stenosis
  – pannus, thrombus, vegetation
• Endocarditis
  – ring abscess
  – vegetations - leaflets, struts
• perivalvular leaks
• dehiscence
• structural failure
• transvalvular regurgitation

Bioprosthetic MV with pannus leading to MR
Note differing valve gradients on alternate beats differing leaflet excursions due to intermittent obstruction from thrombus/pannus

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

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


DVI= Doppler velocity index or dimensionless index
AT= acceleration time

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 excresence
  – sutures
  – nonbacterial thrombus

Pitfalls of AV imaging
Normal AV annular thickening/edema post-AVR mimicking abscess
Real-time 3D TEE-guided catheter based repair of severe paravalvular regurgitation in prosthetic valves

Treating AS when cross-clamping of aorta is too high risk: *apico-aortic valved conduit*
A conduit is constructed from the LV apex to the descending aorta; The conduit contains a bioprosthetic valve. 60-70% of flow goes through the conduit and 30-40% of stroke volume goes through the native stenotic valve.

What to report on TEE evaluation of prosthetic valve
- Valve well seated or excessive motion of ring?
- Occluder mechanism opening and closing ok?
- *Unexpected* valvar or paravalvular regurgitation?
- Prosthetic valve stenosis? Gradients?
- Unexpected masses on sewing ring or leaflets?
- Involvement of other cardiac structures?
- Implantation position (aortic)
  - Intra-annular, supra-annular
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