Prosthetic valve dysfunction

- obstruction
- regurgitation
- endocarditis
- embolism / thrombosis without obstruction
Guidelines and Standards

JASE 09;22:975

Recommendations for Evaluation of Prosthetic Valves With Echocardiography and Doppler Ultrasound

A Report From the American Society of Echocardiography’s Guidelines and Standards Committee and the Task Force on Prosthetic Valves, Developed in Conjunction With the American College of Cardiology Cardiovascular Imaging Committee, Cardiac Imaging Committee of the American Heart Association, the European Association of Echocardiography, a registered branch of the European Society of Cardiology, the Japanese Society of Echocardiography and the Canadian Society of Echocardiography, Endorsed by the American College of Cardiology Foundation, American Heart Association, European Association of Echocardiography, a registered branch of the European Society of Cardiology, the Japanese Society of Echocardiography, and Canadian Society of Echocardiography

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Obstruction - when is the transprosthetic gradient too high?

- gradients are calculated by the simplified Bernoulli equation from CW-Doppler across a prosthesis (maximal and mean gradient)
- they depend on:
  - cardiac output and stroke volume (LV function)
  - heart rate (especially mitral prostheses)
  - prosthesis type (e.g., geometry conducive to pressure recovery) and size (e.g., “mismatch”)
  - prosthetic regurgitation
  - prosthesis function (obstruction)
mean gradient 14 mmHg
• **Tricuspid position (mech.or bioprosthetic valves):**
  mean gradient $3 \pm 1$ mmHg
  pressure half-time $142 \pm 42$ ms
  (Connolly, Circulation 1993;88:2722);
  note respiratory variation with maximum in inspiration !

• **Mitral position (normal heart rate, size > 25, mechanical or bioprosthetic):**
  mean gradient: $6 \pm 2$ mmHg
  pressure half-time $100 \pm 30$ ms (except Starr-Edwards ball-in-cage)

• **In mitral or tricuspid prosthetic obstruction, the mechanism (impaired occluder motion, thrombus, pannus) usually can be detected directly by TTE / TEE**
Three issues make assessment of aortic prosthetic obstruction difficult:

- relatively small valve which is difficult or impossible (mech. prostheses) to visualize
- patient-prosthesis mismatch
- pressure recovery
- baseline values are very helpful!

60 yr old patient with bileaflet aortic valve replacement
Sugawara et al.,
Blood flow... 1989
In-vitro pressure recovery in bileaflet mechanical prostheses
Baumgartner et al. Circulation 1990;82:1467

normal gradients from ASE guidelines

<table>
<thead>
<tr>
<th>Valve</th>
<th>Size</th>
<th>Peak gradient (mm Hg)</th>
<th>Mean gradient (mmHg)</th>
<th>Effective orifice area (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>42.0± 10.0</td>
<td>24.5± 5.8</td>
<td>1.5± 0.1</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>25.7± 9.5</td>
<td>15.2± 5.0</td>
<td>1.4± 0.4</td>
<td></td>
</tr>
<tr>
<td>St Jude Medical Standard</td>
<td>23</td>
<td>21.8± 7.5</td>
<td>13.4± 5.6</td>
<td>1.6± 0.4</td>
</tr>
<tr>
<td>Bileaflet</td>
<td>25</td>
<td>18.9± 7.3</td>
<td>11.0± 5.3</td>
<td>1.9± 0.5</td>
</tr>
</tbody>
</table>
patient-prosthesis mismatch

- too small prosthesis for patient
- applies mainly to aortic prostheses
- EOA difficult to measure
- prognostic value unclear

To avoid any significant gradient at rest or during exercise, the indexed EOA of an aortic valve prosthesis should ideally be no less than 0.85 to 0.90 cm²/m² (2,4,19,20). This observation is consistent with the generally accepted concept that moderate aortic stenosis is present in a native valve when its indexed EOA is <0.90 cm²/m² (with small STJ: 1.5 cm²/BSA)

Pibarot, Dumesnil JACC 2000;36:1131
55 yr old female patient w double valve replacement due to rheumatic fever
Figure 5  Pannus formation on a St Jude Medical valve prosthesis in the aortic position as depicted by TEE. The mass is highly echogenic and corresponds to the pathology of the pannus at surgery. The pannus is depicted by the arrows. LA, Left atrium; LV, left ventricle.
Doppler velocity index
acceleration time

Pulsed Doppler
LVO

Normal
Obstructed

CW Doppler
Prosthetic AV

MG = 22 mmHg
DVI = 0.4
AT = 75 ms

MG = 80 mmHg
DVI = 0.18
AT = 180 ms
Figure 10  Algorithm for evaluation of elevated peak prosthetic aortic jet velocity incorporating DVI, jet contour, and AT.  *PW Doppler sample too close to the valve (particularly when jet velocity by CW Doppler is ≥4 m/s).  **PW Doppler sample too far (apical) from the valve (particularly when jet velocity is 3-3.9 m/s).  †Stenosis further substantiated by EOA derivation compared with reference values if valve type and size are known.  Fluoroscopy and TEE are helpful for further assessment, particularly in bileaflet valves.  AVR, Aortic valve replacement.
obstructive thrombus:
consider surgery / fibrinolysis

non-obstructive thrombus:
anticoagulation, fibrinolysis, or surgery (eg., < 10 mm)
Summary

• prosthetic dysfunction should prompt TEE
• baseline data (gradients) are very valuable
• diagnosis of obstruction in aortic prostheses cannot rely on gradients alone; ruling out mechanical dysfunction frequently requires additional imaging (X-ray)
• prosthetic regurgitation: characterize morphology
• one of the most difficult tasks in echocardiography