Evaluation of Prosthetic Valve Function

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No conflicts to report
Prosthetic Valves
Types of Prosthetic Heart Valves

**Biological**

*Stented*
- Porcine xenograft
- Pericardial xenograft

*Stentless*
- Porcine xenograft
- Pericardial xenograft
- Homograft (allograft)
- Autograft

*Percutaneous*

**Mechanical**

- Bileaflet
- Single tilting disk
- Caged-ball

> 25 Different Brand names worldwide…

> 44 Different Models!

Sizes: 17 - 35 mm
Normal Prosthetic Valves

Determinants of Velocity / Gradient:

- Valve size
- Valve Type
- Flow Rate
Different Flow Profiles and Effective Orifice Areas For Similar “Size”
Recommendations For Evaluation Of Prosthetic Valves With Echocardiography And Doppler Ultrasound

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Guidelines for Prosthetic Valves

GUIDELINES AND STANDARDS

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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Recommendations for the imaging assessment of prosthetic heart valves: a report from the European Association of Cardiovascular Imaging endorsed by the Chinese Society of Echocardiography, the Inter-American Society of Echocardiography, and the Brazilian Department of Cardiovascular Imaging

Parameters in the Comprehensive Evaluation of Prosthetic Valve Function

Clinical information

- Date of valve replacement
- Type and size of the prosthetic valve
- Height/Weight/Body surface area
- Symptoms and related clinical findings
- Blood pressure and heart rate
Prosthetic Aortic Valve CW Recording

? Normal or Abnormal
St Jude Medical Valve

ANOVA p=0.002
* p<0.05

Chafizadeh E. Circ 83:213, 1991
Derivation of Effective orifice Area

Effective Orifice Area = \( \frac{CSA_{LVO} \times VTI_{LVO}}{VTI_{JET}} \)
St Jude Medical Valve

Doppler Valve Area (cm²)

Valve Size (mm)

(n=9) (14) (16) (14) (6) (5) (3)

19 21 23 25 27 29 31

Chafizadeh E. Circ 83:213, 1991
Doppler Velocity Index

\[
\text{Doppler Velocity Index} = \frac{\text{Velocity}_{\text{LVO}}}{\text{Velocity}_{\text{jet}}}
\]

(Normal > 0.25)
DOPPLER VELOCITY INDEX

St. Jude Valve

Chafizadeh: Circulation 83: 213, 1991
Percutaneous Aortic Valves (TAVR)

Excellent Flow Profile

DVI is Normally close to 0.5

LVO

1 m/s

AV

2 m/s
Pulsed Doppler
LVO

Normal
MG = 22 mmHg
DVI = 0.4
AT = 75 ms

Obstructed
MG = 80 mmHg
DVI = 0.18
AT = 180 ms

CW Doppler
Prosthetic AV

2.8 m/s
1.1 m/s

AT

5.5 m/s
1.0 m/s

AT
Comparison with post-operative studies is essential in cases of high gradient.
Prosthetic Mitral Valve

Normal

Mean Gr = 4 mmHg
PHT = 123 ms
EOA= 2.5 cm$^2$

Obstructed

Mean Gr = 13 mmHg
PHT = 200 ms
EOA= 1.1 cm$^2$
Prosthetic Mitral Valve

Traditional Doppler Parameters

- Maximal Velocity
- Mean gradient: *Importance of heart rate*
- Pressure half-time
- Effective orifice area (continuity equation)
### Doppler Parameters of Prosthetic MV Function

Suggests Significant Stenosis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak velocity</td>
<td>≥ 2.5 m/s</td>
</tr>
<tr>
<td>Mean gradient</td>
<td>&gt; 10 mmHg</td>
</tr>
<tr>
<td>EOA (continuity)</td>
<td>&lt; 1 cm²</td>
</tr>
<tr>
<td>Pressure Half-time</td>
<td>&gt; 200 ms</td>
</tr>
</tbody>
</table>

Zoghbi W et al. JASE 22: 975, September 2009
Indications of TEE
In Prosthetic Valve Obstruction

• Non-diagnostic or borderline cases by transthoracic Echo / Doppler

• Assessment of concomitant regurgitation

• Patients with known severe obstruction: Candidates for thrombolysis
Mitral Position

Aortic Position
Fluoroscopy May be Needed to Assess Valve Mobility in *Mechanical Aortic* valves
CT Scan in Prosthetic Valves

Normal

Obstructed-Thrombus
Normal, “Physiologic” Regurgitation
Shadowing & Flow Masking

Mitral prosthesis

Aortic prosthesis

Parasternal

Apical

Zoghbi W et al. JASE 22: 975, September 2009
58 M with Prosthetic Mitral Valve
Clues from the Transthoracic Study for Significant MR in Mechanical Valves

• High E mitral velocity (> 1.9 m/s)
• High mean gradient (> 5 mmHg)
• Elevated $\text{VTI}_{\text{MV}}/\text{VTI}_{\text{LVO}}$ ratio (> 2.2)
• Good LV function but low systemic output (VTI)
• Pulmonary hypertension (TR velocity > 3 m/s)
Prosthetic Aortic Regurgitation
Prosthetic Aortic Regurgitation

Indicators of Severity

• Aortic Valve/ LV enlargement
• Color Doppler: Proximal jet width/CSA; Vena Contracta > PISA; Beware of eccentric jets
• Intensity of jet by CW
• Pressure half-time
• Regurgitant Volume/Fraction
• Diastolic retrograde flow in aorta
Prosthetic Aortic Regurgitation

TEE helps Identify Etiology & Complications
TAVR

...How severe is the Regurgitation?
# Paravalvular Regurgitation after TAVR

A Lingering challenge


<table>
<thead>
<tr>
<th>Prosthetic aortic valve regurgitation</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semi-quantitative parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic flow reversal in the descending aorta—PW</td>
<td>Absent or brief early diastolic</td>
<td>Intermediate</td>
<td>Prominent, holodiastolic</td>
</tr>
<tr>
<td>Circumferential extent of prosthetic valve paravalvular regurgitation (%)**</td>
<td>&lt;10%</td>
<td>10%-29%</td>
<td>≥30%</td>
</tr>
<tr>
<td><strong>Quantitative parameters‡</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regurgitant volume (mL/beat)</td>
<td>&lt;30 mL</td>
<td>30-59 mL</td>
<td>≥60 mL</td>
</tr>
<tr>
<td>Regurgitant fraction (%)</td>
<td>&lt;30%</td>
<td>30-49%</td>
<td>≥50%</td>
</tr>
<tr>
<td>EROA (cm²)</td>
<td>0.10 cm²</td>
<td>0.10-0.29 cm²</td>
<td>≥0.30 cm²</td>
</tr>
</tbody>
</table>
MitraClip
Residual Regurgitation
Comprehensive Evaluation of Prosthetic Valve Function

- Clinical evaluation, know valve Type and Size
- Baseline echo/Doppler study after surgery
- Transthoracic 2D/ Doppler evaluation of structure and function is the first line diagnostic method
- In cases with high velocity jet/gradient and suspected stenosis or regurgitation
  - Compare previous studies
  - TEE, (fluoroscopy if needed for Aortic mechanical PrV, ?CT)
  - CMR in some cases of PrV regurgitation