Echocardiographic Assessment of Aortic Valve Prosthesis

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DISCLOSURE

Relevant Financial Relationship(s)
None

Off Label Usage
None
Bioprosthetic Valve Thrombosis Versus Structural Failure

- 11.6% (n=397); 63% aortic position
- 65% > 12 months post-op
- Median longevity 24 months (vs 108 in controls)
- Independent predictors: >50% increase in mean gradient within 5 years; PAF; subtherapeutic INR; increased cusp thickness and abnormal mobility
Timing of Bioprosthetic Valve Explanation by Position

Timing of Bioprosthetic Valve Failure by Position

- **Aortic**: Structural failure
- **Mitral**: Structural failure
- **Tricuspid**: Structural failure
- **Pulmonary**: Structural failure

*\( p < 0.05 \)
43 year old female S/P Bentall with #21 St. Jude AVR

Presents for evaluation of shortness of breath

LV size
LVEDD 50mm, ESD 32mm

Septum 12mm

Wall thickness
Posterior 12mm

LV function
LVEF 60%
CW Aortic prosthesis

5.7 m/s  68 mmHg
High Gradients across aortic prostheses

- Obstruction
  - Thrombus
  - Pannus
  - Bioprosthetic degeneration
  - Subvalvular narrowing

- Functional
  - Regurgitation
  - High flow states
  - Pressure recovery

- Patient prosthesis mismatch
Dimensionless Index: DVI

\[ \text{PW}_{\text{LVOT}} \frac{\text{CW}_{\text{AS}}}{\text{Normal}} \geq 0.30 \]
<table>
<thead>
<tr>
<th>Gradient (mmHg)</th>
<th>DVI</th>
<th>AT (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL</td>
<td>14</td>
<td>0.52</td>
</tr>
<tr>
<td>OBSTRUCTED</td>
<td>68</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>177</td>
</tr>
</tbody>
</table>
AT/ET
Normal: $ \leq 0.25 \pm 0.05 $
DVI : 0.22
AT : 177
AVA: 0.59 cm²

Expected gradients for normal # 21 St. Jude AVR:
Mean gradient 15±5
EOA:2±0.7 cm²
What is wrong with AVR?

1. Patient-prosthesis mismatch
2. Obstructed
3. Severe AI; mild obstruction
4. High flow state
Comprehensive Evaluation
Peak aortic prosthesis velocity > 3m/s

Jet contour
AT (ms)

>100

Jet contour
>100

Consider PrAV stenosis with:
- Sub-valve narrowing
- Underestimated gradient
- Improper LVOT velocity

<100

Normal PrAV
EOA index
High flow
PPM

<100

Suggests prosthetic aortic valve stenosis

>100

Consider improper LVOT velocity

DVI

DVI

DVI

≥0.30

0.25 – 0.29

<0.25

DVI

DVI

DVI

JASE 2009;22(9):975
Our patient

Peak velocity 5.7 m/s
Mean grad 68 mmHg
DVI 0.22
AT: 177 msec

Obstructed AVR
Suspected Prosthetic Valve Thrombosis

TTE to evaluate hemodynamic severity (Class I)

Left-sided prosthetic valve thrombosis

TEE for thrombosis size

NYHA class III-IV symptoms

Mobile or larger (≥0.8 cm^2) thrombus

Emergency surgery (Class I)

Emergency surgery (Class IIa)

Recent onset (<14 days)
NYHA class I-II symptoms; small thrombus (<0.8 cm^2)

Fibrinolytic prescription if persistent valve thrombosis after IV heparin therapy (Class IIa)

CT or fluoroscopy to evaluate valve motion (Class IIa)

Right-sided prosthetic valve thrombosis

JACC 2014;63(22):2438
Case

• 80 year old woman: progressive dyspnea on exertion
• NYHA Class III
• S/P tissue AVR #19 2001
Septum/posterior wall 14 mm
EF 63%
Septum/posterior wall 14 mm
EF 63%
LVOT_{TVI} : 21

AS_{TVI} : 99
DVI: 21
EOA: 0.6 cm²
AT: 100 ms
What is wrong with AVR?

1. Patient-prosthesis mismatch
2. Obstructed
3. Severe AI; mild obstruction
4. High flow state
Case

- 28 year old female ESRD
- S/P AVR 1 year previous size/type unknown
- Functional Class I
LVOT: 1 m/s
TVI_{LVOT}: 17.6
AV velocity: 3.4 m/s
DI: 0.27
Mean gradient (mmHg): 30
EOA: 1.13 cm²
AT: 100 ms
What to do next?

1. Re-do AVR
2. Get valve size
3. TEE
4. Repeat TTE
Normal ATS #19

- Peak gradient: 47 ± 12.6 mmHg (46)
- Mean gradient: 25.3 ± 8 mmHg (30)
- EOA: 1.1 ± 0.3 cm² (1.13)
73 year old female; SOBOE; severe COPD
S/P St. Jude AVR #21 and MVR #29
CW Aortic prosthesis
What is wrong with AVR?

1. Patient-prosthesis mismatch
2. Obstructed
3. Significant AI; mild obstruction
4. High flow state
Comprehensive evaluation

DVI
0.25 – 0.29

<100

Normal PrAV
EOA index
High flow
PPM

>100

Suggests prosthetic aortic valve stenosis

JASE 2009;22(9):975
“Mismatch can be considered to be present when the effective prosthetic heart valve area, after insertion into the patient, is less than that of a human heart valve. All PHV’s are smaller than normal and inherently stenotic.”
Patient Prosthesis Mismatch for Aortic Valve Replacement

Indexed EOA (cm²/m²)

<table>
<thead>
<tr>
<th>PPM</th>
<th>Indexed EOA (cm²/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>≤ 0.85</td>
</tr>
<tr>
<td>Severe</td>
<td>≤ 0.65</td>
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</table>

JACC 2000;36:1131
PPM Risk Factors

Mechanical valves

Stented Bioprosthesis

Small valve size (19, 21 mm)

Clinical
HT, DM, obesity, female gender, CAD, CKD

Pre-op AS

JACC 2009; 53(1):39
Freedom from CV Death

Years

%

P<0.001

NS PPM
Mod PPM
Severe PPM

JACC 2009; 53(1):39
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal</th>
<th>Possible stenosis</th>
<th>Sugg sig stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak velocity (m/s)</td>
<td>&lt; 3</td>
<td>3-4</td>
<td>&gt; 4</td>
</tr>
<tr>
<td>Mean grad (mmHg)</td>
<td>&lt; 20</td>
<td>20-35</td>
<td>&gt; 35</td>
</tr>
<tr>
<td>DVI</td>
<td>≥ 0.30</td>
<td>0.29-0.25</td>
<td>&lt; 0.25</td>
</tr>
<tr>
<td>Jet contour</td>
<td>Early peak</td>
<td>Mid peak</td>
<td>Rounded symmetric</td>
</tr>
<tr>
<td>AT (ms)</td>
<td>&lt; 80</td>
<td>80-100</td>
<td>&gt;100</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>Sensitivity</td>
<td>Specificity</td>
</tr>
<tr>
<td>----------------</td>
<td>----------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>MG (mmHg)</td>
<td>75%</td>
<td>83%</td>
<td>74%</td>
</tr>
<tr>
<td>DVI</td>
<td>75%</td>
<td>92%</td>
<td>84%</td>
</tr>
<tr>
<td>EOAi (cm²/m²)</td>
<td>67%</td>
<td>83%</td>
<td>66%</td>
</tr>
<tr>
<td>dA (cm²)</td>
<td>87%</td>
<td>92%</td>
<td>86%</td>
</tr>
<tr>
<td>AT (ms)</td>
<td>94%</td>
<td>92%</td>
<td>94%</td>
</tr>
<tr>
<td>AT/ET</td>
<td>89%</td>
<td>83%</td>
<td>90%</td>
</tr>
</tbody>
</table>
The increase of pressure downstream from the stenosis caused by a reconversion of kinetic to potential energy which can lead to an “overestimation” of gradients by Doppler in certain situations.
Aortic Size and Correlation Between Mean Doppler and Mean Catheter Gradients

Aorta, cm:
- 1.8
- 2.4
- 3.0
- 4.0
- 5.0

Mean Catheter Gradient, mmHg

Mean Doppler Gradient, mmHg

Circulation 1996;94:1934-1940