Aortic Valvular Stenosis

How to Assess the Four Variables for Management

Low Flow / Low Gradient / Normal EF / Low EF

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No Disclosures
Stages of Valvular Heart Disease

Stage A
At Risk of VHD

Stage B
Progressive VHD

Stage C
Asx Severe VHD

Stage D
Sx Severe VHD

C1
Normal LV or RV

C2
Abnormal LV or RV
Stages of Chronic AS

Stage D
Sx Severe

Stage D1
HF/HG/NL EF

Stage D2
LF/LG/Low EF

Stage D3
LF/LG/NL EF

MeanΔP ≠ AVA
Low Flow Low Gradient Severe AS

LF LG AS
$SV_i < 35 \text{ mL/m}^2$
$MPG < 40 \text{ mm Hg}$

Evaluation
TTE
DSE
CT Aortic Valve
Catheterization

Low EF $< 0.50$

Pibarot P, Dumesnil JG. JACC 2012; 60:145-53
LF/LG AS with Reduced EF

Flow Reserve > 20%↑SVi

Clavel M-A et al EHJ 2016; 37:2645-57
DSE

Baseline

Vmax 3.5 m/s
Mean ΔP 32 mm Hg

Dobutamine

Vmax 4.9 m/s
Mean ΔP 56 mm Hg

Picano E et al. JACC 2009;54:2251-60
Hemodynamics

Mean Gradient 22

Mean Gradient 48

Courtesy of Rick Nishimura, MD
### AHA/ACC 2014 Guideline
**Aortic Stenosis (D2): Timing of Intervention**

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>COR</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVR is reasonable in patients with LF/LG severe AS with reduced EF (stage D2) with a dobutamine stress study that shows an aortic velocity $\geq 4$ m/s (or mean $\Delta P \geq 40$ mm Hg) with an AVA $\leq 1.0$ cm$^2$ at any dobutamine dose</td>
<td>Ila</td>
<td>B</td>
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<tr>
<td>Recommendations</td>
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<td>LOE</td>
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<td>AVR is indicated in symptomatic patients with severe LF/LG AS and reduced EF with flow reserve excluding pseudo-severe stenosis</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>AVR should be considered in symptomatic patients with LF/LG AS and reduced EF without flow reserve if CT calcium scoring confirms severe AS</td>
<td>Ila</td>
<td>C</td>
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</table>
Poor Outcomes After AVR

Classical LF/LG AS

- NYHA 3+, ↓6MWT, high STS score
- EF < 0.35; reduced GLS; lack of flow reserve; low gradient (< 20 mm Hg)
- Multi-vessel CAD
- Markedly elevated NT-BNP
- LGE
PARTNER Trial
LG/LG Severe AS with Low EF

Herrmann H et al, Circulation 2013;127:2316-2326
Courtesy of RO Bonow
PARTNER Trial
LF/LG Severe AS with low EF

Mortality Rate (%)

Time (days)

A - TAVR  \( n=56 \)
B - TAVR  \( n=17 \)
B - Std Rx  \( n=25 \)

A - Surgery  \( n=49 \)

High surgical risk
Prohibitive surgical risk

Log Rank \( P=0.001 \)

Herrmann et al, *Circulation* 2013;127:2316-2326

Courtesy of RO Bonow
Low Flow Low Gradient Severe AS

LF LG AS
SVi < 35 mL/m²
MPG < 40 mm Hg

Evaluation
TTE
DSE
CT Aortic Valve Catheterization

NL EF > 0.50

Pibarot P, Dumesnil JG. JACC 2012; 60:145-53
Development of Severe AS

Sorin V Pislaru, and Patricia A Pellikka Heart doi:10.1136/heartjnl-2015-307893
Assessment of Total LV Afterload

Valvulo-Arterial Impedance: $Z_{VA}$

$$Z_{VA} = \frac{SBP + \text{Mean } \Delta P}{SVi}$$

Hachicha Z et al. Circulation 2007;115:2856-64
LFLG Severe AS with NL EF

Aorta
LV
LA
MG 22 mmHg

AVA 0.92 cm$^2$

Pressure (mmHg)
Baseline
LV
Ao
MG 35 mmHg

Pressure (mmHg)
Nitroprusside
LV
Ao
MG 42 mmHg

Sorin V Pislaru and Patricia A Pellikka Heart doi:10.1136/heartjnl-2015-307893
LF/LG AS with Normal EF

STEP 1: Check for Measurement Errors
STEP 2: Assess Symptoms
STEP 3: Identify and Treat HTN
STEP 4: Repeat Echo, Cath
STEP 5: CT Calcium Score

STEP 6: >1200 AU (Women), >2000 AU (Men) → True Severe AS
<1200 AU (Women), <2000 AU (Men) → Pseudo-Severe AS

Adapted from Clavel M-A et al EHJ 2016; 37:2645-57
Effect of AVR on Survival
Adjusted, Propensity Analysis

AHA/ACC 2014 Guideline
Aortic Stenosis (D3): Timing of Intervention

<table>
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<td>AVR is reasonable in patients with LF/LG severe AS (stage D3) who are normotensive and have an EF ≥50% if clinical, hemodynamic, and anatomic data support valve obstruction as the most likely cause of symptoms</td>
<td>Ila</td>
<td>C</td>
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**ESC/EACT 2017 Guideline**  
**Aortic Stenosis: Timing of Intervention**

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<tr>
<td>AVR should be considered in symptomatic patients with LF/LG AS and normal EF after careful confirmation of severe AS</td>
<td>Ila</td>
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Poor Outcomes After AVR

Paradoxical LF/LG AS

- LGE
- Moderate/severe diastolic dysfunction
- Reduced GLS
- Very low SVi
LOW GRADIENT AS
AVAL ≤ 1.0 cm² and MGL < 40 mmHg

< 50% ≤ 35 ml/m²
LV EF SVI > 35 ml/m²

CLASSICAL LOW-FLOW LOW-GRADIENT
PARADOXICAL LOW-FLOW LOW-GRADIENT
NORMAL-FLOW LOW-GRADIENT

Clavel M-A et al EHJ 2016; 37:2645-57
- 82 y/o woman
- PAF, HTN
- Fatigue, dyspnea
- Grade 3 murmur
- No LVH on ECG
Mean gradient  28 mmHg
AVA          0.8 cm²
SVI          35 ml/m²
DVI          0.23
Mean gradient 17
Valve area 0.9cm²
PCWP 14
CO 3.4
Aortic BP 160/63

Mean gradient 19
Valve area 1.2cm²
PCWP 28
CO 6.7
Aortic BP 201/98

Courtesy Mayo Clinic Fellows
APPROPRIATE USE CRITERIA

ACC/AATS/AHA/ASE/EACTS/HVS/SCA/SCAI/SCCT/SCMR/STS
2017 Appropriate Use Criteria for the Treatment of Patients With Severe Aortic Stenosis


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Biomarkers in LF/LG AS

Log rank: p = 0.002

BNP<550 pg/mL and hsTnT<15 ng/L

BNP≥550 pg/mL or hsTnT≥15 ng/L

BNP≥550 pg/mL and hsTnT≥15 ng/L

Survival (%) vs Follow-Up Time (Years)

TOPAS Study JACC Imag 2017
Survival

Hachicha Z et al. Circulation 2007;115:2856-64
History

• 82 yo F
  – Progressive fatigue and dyspnea for the last year
  – Can now walk only a block before limited
  – No edema, chest pain, syncope
  – No orthopnea, PND
PMH

• Paroxysmal AF
• Borderline HTN

Home Meds

• Aspirin
Exam

- BP 119/55, HR 70, BMI 25.38
- JVP normal
- Carotid upstroke 1+ parvus and tardus
- Heart: LV impulse slightly sustained and localized
- Normal S1, single S2.
- 2/6 SEM RUSB with early to mid peak
- Lungs: Clear
- No edema
Paradoxical Low flow, low gradient severe AS

TAVR? SAVR? Observe?
DIAGNOSIS

HFpEF

Moderate AS
Stages of Chronic AS

Stage D
Sx Severe

Stage D1
NF/HG/NL EF

Stage D2
LF/LG/Low EF

Stage D3
LF/LG/NL EF

Stage D4
NF/LG/NL EF
LF/LG Severe AS with Low EF

Pibarot P, Dumesnil JG. JACC 2012; 60:145-53
Baseline

- Mean gradient 22 mmHg
- SVI 23 mL/m²
- AVA 0.7 cm²

Nitroprusside

- Mean gradient 26 mmHg
- SVI 34 mL/m²
- AVA 1.0 cm²
Anatomic/Doppler Assessment of AS

Lindman BR et al. Nat Rev Dis Prim 2016