Sténose aortique à Bas Débit et Bas Gradient

Philippe Pibarot, DVM, PhD, FACC, FAHA, FESC, FASE
Canada Research Chair in Valvular Heart Diseases
Doctorate Honoris Causa, Université de Liège

Institut Universitaire de Cardiologie et de Pneumologie de Québec / Québec Heart & Lung Institute
Université Laval
Disclosure: Philippe Pibarot

Financial relationship with industry:

- Edwards Lifesciences: Echo CoreLab for PARTNER 2–SAPIEN 3, PARTNER 3, TAVR-UNLOAD, EARLY-TAVR trials
- V-Wave Ltd: Echo CoreLab for FIM Study
- Cardiac Phoenix: Echo CoreLab for BACE FIM Study

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- Research and Heart & Stroke Foundation of Quebec

Off label Use: None
Low Gradient AS

$\text{AVA} \leq 1.0 \text{ cm}^2 \quad \text{MG} < 40 \text{ mmHg}$

$<50\% \quad \text{LVEF} \quad >50\%$

$<35 \text{ mL/m}^2 \quad \text{SVi} \quad >35 \text{ mL/m}^2$

«CLASSICAL» LOW-FLOW LOW-GRADIENT (HFrEF) D2 Stage

«PARADOXICAL» LOW-FLOW LOW-GRADIENT (HFpEF) D3 Stage

NORMAL-FLOW LOW-GRADIENT D? Stage
“Classical” Low-Flow, Low-Gradient AS with Reduced LVEF (D2 Stage)

HFrEF Form of AS  5-10% of AS population
Classical Low-Flow, Low-Gradient AS
LVEF<50%, AVA≤1.0, ΔP<40

Low-Dose Dobutamine-Stress Echo

↑ SV ≥ 20 %

Contractile (Flow) Reserve

ΔP≥40 AVA≤1.0

True-Severe AS
SAVR ± CABG
TAVR ± PCI

ΔP<40 AVA>1.0

Pseudo-Severe AS
HF Therapy

↑ SV < 20 %

No Contractile (Flow) Reserve

AS Severity: Indeterminate

MSCT: AoV Ca Score
♀ >1200
♂ >2000

No

Yes

True-Severe AS
SAVR (High Op. Risk)
TAVR preferred?
Case #1

Resting Echo

LVEF = 40%  
SV = 53 ml  
ΔP = 49 / 29 mmHg  
AVA = 0.77 cm²

DSE

LVEF = 50%  
SV = 73 ml  
ΔP = 92 / 52 mmHg  
AVA = 0.75 cm²
**Risk Stratification using Flow Reserve**

- **Group I =** flow reserve \(\Delta SV \geq 20\%\) under DSE
- **Group II =** no flow reserve

126 Patients

- **Group I, Valve Replacement** *
- **Group II, Valve Replacement** §
- **Group I, Medical Treatment**
- **Group II, Medical Treatment**

\* \(p = 0.001\ vs\ medical\)

§ \(p = 0.07\ vs\ medical\)

Monin et al, Circulation 2003;108:319-324
1-Year Survival in Classical LF-LG AS according to Contractile/Flow Reserve: TOPAS-TAVI Registry

Log rank: p=0.607

Ribeiro et al. JACC In press
### Guidelines Indications for AVR in Classical Low-Flow, Low-Gradient AS

**Definition:** AVA \( \leq 1.0 \text{ cm}^2 \), Mean gradient \(< 40 \text{ mmHg, LVEF} < 50\% \)

**Stage:** D2

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Recommendation for AVR</th>
<th>Class</th>
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<tbody>
<tr>
<td>ACC-AHA 2014-2017</td>
<td>AVR is reasonable in symptomatic patients with low LVEF, low-flow/low-gradient severe AS *with a DSE that shows a mean gradient ( \geq 40 \text{ mm Hg} ) with an AVA ( \leq 1.0 \text{ cm}^2 ) at any dobutamine dose</td>
<td>IIa</td>
</tr>
<tr>
<td>ESC-EACTS 2017</td>
<td>AVR should be considered in symptomatic patients with low LVEF, low-flow/low-gradient severe AS <em>with flow reserve on DSE</em></td>
<td>I</td>
</tr>
<tr>
<td>ESC-EACTS 2017</td>
<td>AVR may be considered in symptomatic patients with low LVEF, low-flow/low-gradient severe AS <em>without flow reserve on DSE, particularly when CT calcium scoring confirms severe AS</em></td>
<td>IIa</td>
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Case #2

**Rest**

- SV = 36 ml
- $Q_{\text{mean}} = 139$ ml/s
- LVEF = 20%
- $\Delta P = 35 / 22$ mmHg
- AVA = 0.85 cm²

**DSE**

- SV = 55 ml
- $Q_{\text{mean}} = 243$ ml/s
- LVEF = 30%
- $\Delta P = 63 / 32$ mmHg
- AVA = 1.1 cm²
Outcome of Patients with Moderate AS and Low LVEF

Retrospective 3-center study of 305 patients with moderate AS and LVEF < 50%

What is moderate AS for a good ventricle may be severe for a depressed ventricle!
**TAVR UNLOAD Trial**

**Study Design**

*(600 patients, 1:1 Randomized)*

- **TAVR UNLOAD Trial**
  - International Multicenter Randomized

- Heart Failure
  - LVEF < 50%
  - NYHA ≥ 2
  - Optimal HF therapy (OHFT)
  - Moderate AS

- **Primary Endpoint**
  - Hierarchical occurrence of:
    - All-cause death
    - Disabling stroke
    - Hospitalizations for HF, aortic valve disease
    - Change in KCCQ

- **Follow-up**: 1 month, 6 months, 1 year

- **Clinical endpoints**
  - Symptoms
  - Echo QoL

- **OHFT Alone**

- **TAVR + OHFT**

- Reduced AFTERLOAD
  - Improved LV systolic and diastolic function
Case #3

**Rest**

LVEF = 25%
SV = 45 ml  Q = 163 ml/s
ΔP = 46 / 27 mmHg
AVA = 0.8 cm²

**DSE**

LVEF = 30%
SV = 46 ml  Q = 169 ml/s
ΔP = 52 / 30 mmHg
AVA = 0.8 cm²
Calcification is defined as four adjacent pixels with density $>130$ Hounsfield units.

Modified Agatston method

Clavel et al. European Heart Journal (2016) 37, 2645–2657
AoV Ca Scoring by MDCT to Differentiate True vs. Pseudo-Severe Stenosis in LF-LGAS

Pseudo-Severe

AVC score: 1034 AU
AVC density: 220 AU/cm²

True-Severe

AVC score: 3682 AU
AVC density: 980 AU/cm²

AVC Score: >2000 AU in ♂
>1200 AU in ♀

AVC Density: >500 AU/cm² in ♂
>300 AU/cm² in ♀

Clavel et al. JACC 2013
“Paradoxical” Low-Flow, Low-Gradient AS with Preserved LVEF (Stage D3)

HFpEF Form of AS 5-15% of AS population

Age
Women
Hypertension
MetS – Diabetes

Hachicha Z et al., Circulation, 2007
Dumesnil et al. Eur Heart J, 2009
Pibarot & Dumesnil JACC, in press, 2012
Case #4: Paradoxical Low-Flow, Low-Gradient

- 82 y.o. woman
- Hypertension treated with ACEI
- No CAD
- NYHA III, HF hospitalization
- LVEF: 65%
- Global long. strain: 13%
- Grade II Diastolic Dysf.
- AS severity on echo:
  - AVA: 0.64 cm²; iAVA: 0.36 cm²/m²
  - Doppler velocity index: 0.19
  - Peak/mean gradient: 44/26 mmHg
  - SV index: 29 ml/m²
### Guidelines on Management of VHD: Indications for AVR in Paradoxical Low-Flow, Low-Gradient AS

**Definition:** AVA ≤ 1.0 cm², Indexed AVA ≤ 0.6 cm²/m²
Mean gradient < 40 mmHg,
LVEF ≥ 50%, SVi < 35 mL/m²

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<td>ESC-EACTS 2017</td>
<td>AVR should be considered in <strong>symptomatic</strong> patients with low flow, low gradient (&lt;40 mmHg) AS with normal EF after careful <strong>confirmation of severe AS</strong>.</td>
<td>IIa</td>
</tr>
<tr>
<td>ACC-AHA 2014/2017</td>
<td>AVR is reasonable in <strong>symptomatic</strong> patients who have low-flow, low-gradient <strong>severe</strong> AS who are <strong>normotensive</strong> and have an LVEF ≥ 50% if clinical, hemodynamic, and anatomic data support valve obstruction as the most likely cause of symptoms</td>
<td>IIa</td>
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</table>

**Stage:** D3

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*Vahanian et al. EHJ 2012*  
*Nishimura, Otto et al. JACC 2014*
Valve morphology by echocardiography suspicious of AS

Assess velocity/gradient

LOW-GRADIENT AS
V_{\text{max}} < 4 \text{ m/s}, \Delta P_{\text{m}} < 40 \text{ mmHg}

Assess AVA
AVA ≤ 1.0 cm²
AVA > 1.0 cm²
Moderate AS

Exclude measurement errors that may cause underestimation of gradient / flow / AVA

Define flow status (SVi)
Low flow (SVi ≤ 35 mL/m²)
Normal flow (SVi > 35 mL/m²)
Severe AS unlikely

Assess LVEF
LVEF < 50%
Dobutamine echo
Flow reserve present
Pseudosevere AS or true severe AS

LVEF ≥ 50%
Integrated approach (Table 6)
No flow reserve
Calcium score by CT (see Table 6)

HIGH-GRADIENT AS
V_{\text{max}} ≥ 4 \text{ m/s}, \Delta P_{\text{m}} ≥ 40 \text{ mmHg}

High flow status excluded
No
Yes
Severe high-gradient AS (normal flow/low flow) (normal EF / low EF)

Define whether high flow status is reversible?
Not reversible
Reversible
Severe AS
Re-assess at restored normal flow

2017 ESC-EACTS Guidelines

Baumgartner et al.
EHJ 2017
### Criteria that increase the likelihood of severe AS in patients with Low Gradient AS and Preserved LVEF

<table>
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<tr>
<th>Criteria</th>
<th>Details</th>
</tr>
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</table>
| **Clinical criteria**                         | • Typical symptoms without other explanation  
• Elderly patient (>70 years)                 |
| **Qualitative imaging data**                 | • LV hypertrophy (additional history of hypertension to be considered)  
• Reduced LV longitudinal function without other explanation |
| **Quantitative imaging data**                | • Mean gradient 30–40 mmHg<sup>a</sup>  
• AVA ≤0.8 cm<sup>2</sup>  
• Low flow (SVi <35 mL/m<sup>2</sup>) confirmed by techniques other than standard Doppler technique (LVOT measurement by 3D TOE or MSCT; CMR, invasive data)  
• Calcium score by MSCT<sup>b</sup>  
  - Severe aortic stenosis very likely: men ≥3000; women ≥1600  
  - Severe aortic stenosis likely: men ≥2000; women ≥1200  
  - Severe aortic stenosis unlikely: men <1600; women <800 |

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**Baumgartner et al.**  
**EHJ 20917**  
**Pseudo-Severe**  
**True-severe**
Case #4: Aortic Valve Calcium Scoring by MDCT

AVC Score: 3200 AU
Case #5: Normal-Flow, Low-Gradient AS (?
Stage)

LVEF = 65 %
LVEDD = 47 mm
LVEDV = 102 mL
Total SV (Teichholz mod.) = 66 mL

LVOT Diam. = 2.2 cm
LVOT SV = 68 mL
SVi = 38 mL/m²

MG = 32 mmHg
AVA = 0.81 cm²
AVAi = 0.45 cm²/m²
DVI = 0.24

Clavel et al.
JACC Img.
2017;10:185–202
Potential Causes of Normal-Flow, Low-Gradient AS

- Measurement errors: overestimation of stroke volume or underestimation of gradients

- Normal stroke volume index ($\geq 35 \text{ ml/m}^2$) but low mean transvalvular flow rate ($Q_{\text{mean}} = SV/LVET < 200 \text{ ml/s}$): e.g. bradychardia

- Systemic arterial hypertension and/or reduced arterial compliance

- Inconsistency in the guidelines criteria

Cote et al. JAHA 2017
In normal flow conditions:

An AVA of 1.0 cm² corresponds to a mean gradient of ~30-35 mmHg

An AVA of 0.8 cm² corresponds to a mean gradient of ~40 mmHg
Outcome and Impact of AVR in Low-Gradient AS: A Meta-Analysis

- 18 studies, 7,459 patients

Paradoxical LF-LG AS:
- Increased risk of mortality compared to moderate AS and high-gradient AS
- Outcome is improved by AVR

Normal Flow, Low-Gradient AS:
- Outcome similar to high-gradient AS but improved by AVR
Effect of Initial AVR on Prognosis of Patients with HG and LG AS: The Current Registry (n=2097)

Composite of AoV related death or HF Rehospitalization

High Gradient (AS)  Low Gradient (PLF & NF) AS

Log-rank P<0.001

Taniguchi et al Circ CV Int. 2017
Take Home Messages

In symptomatic low gradient AS, confirm:

1. Accuracy of measurements
2. Flow/LVEF Status
3. AS severity

Clavel et al. JACC Img. 2017;10:185–202
4- Select Type of AVR in Low-Gradient AS

STEP 4: SELECT TYPE OF AVR

- Consider Type of Low-gradient AS
- Assess surgical risk: comorbidities, risk scores, frailty, absence of flow reserve on dobutamine stress echocardiography

CLASSICAL LOW-FLOW LOW-GRADIENT (Stage D2)
- Transfemoral TAVR Preferred

PARADOXICAL LOW-FLOW LOW-GRADIENT (Stage D3)
- TAVR Potentially Preferred

NORMAL-FLOW LOW-GRADIENT (Stage D4?)
- SAVR or TAVR

Clavel et al. JACC Img. 2017;10:185–202
Samedi dernier à l’aéroport de Montréal
Membership

The Council on Valvular Heart Disease aims to bring together all healthcare professionals with an active interest in Valvular Heart Disease.

Council on Valvular Heart Disease Membership Benefits

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- Career enhancement
  - Access to the Council on Valvular Heart Disease member directory
  - Joining an interactive and efficient network in Valvular Heart Disease

- Rights
  - Access to Automatic ESC membership and benefits
  - Eligible to vote in Council member elections (restrictions apply*)
  - Eligible to apply for Council member positions (restrictions apply**) *Only for members of ESC member countries (country of work). ** Only for members of ESC member countries (country of work). Candidates cannot simultaneously hold a position on Nuclei/Boards of other ESC Constituent Bodies.

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https://www.escardio.org/Councils/Council-on-Valvular-Heart-Disease/Membership