Clinical Significance of Valvulo-Arterial Impedance in Aortic Valve Stenosis

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Sart Tilman Liège, BELGIUM
Conflict of Interest Disclosure

None
**Valvulo-Arterial Impedance (Zva): Definition**

**Mechanical Impedance:** a measure of how much a structure resists motion when subjected to a given force.

**In Aortic stenosis:** Zva represents the cost in mmHg for each systemic mL of blood indexed for body size pumped by the left ventricle during systole.

**Zva** provides an estimate of the global LV hemodynamic load that results from the summation of the valvular and vascular loads:

- stenosis severity
- volume flow rate
- body size
- systemic vascular resistance
Left Ventricular Afterload in Aortic Stenosis = Valvular Load + Arterial Load

Valvulo-Arterial Impedance

\[ Z_{va} = \frac{LVSP}{SVi} = \frac{MG + SAP}{SVi} \]

>3.5: Moderate
>4.5: Severe

Courtesy from Dr Philippe Pibarot, Quebec Heart and Lung Institute, Qc, Canada.
Impact of Hypertension on AS Severity

Mascherbauer et al.; Eur Heart J; 2008

Little et al. Heart, 93:848-55. 2007
Impact of Hypertension on the Timing of Symptom Onset in AS

- 193 patients with symptomatic AS
- 32% had concomitant HTN
- Symptoms of AS develop at lower degree of stenosis severity in hypertensive patients, probably because of the additional overload due to hypertension.

AS and Reduced Systemic Arterial Compliance: Impact on LV Afterload

Valvulo-Arterial Impedance (Global LV Afterload)

\[ Z_{va} = \frac{SAP + MG}{SVi} \]

SAC = \frac{PP}{SVi}

Low SAC: ≤ 0.6

Groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moderate AS</td>
<td>Moderate AS</td>
<td>Severe AS</td>
<td>Severe AS</td>
</tr>
<tr>
<td></td>
<td>Normal SAC</td>
<td>Low SAC</td>
<td>Normal SAC</td>
<td>Low SAC</td>
</tr>
<tr>
<td></td>
<td>(n=77, 37%)</td>
<td>(n=50, 24%)</td>
<td>(n=45, 22%)</td>
<td>(n=36, 17%)</td>
</tr>
</tbody>
</table>

Briand, JACC, 46:291-296, 2005
AS and Reduced Systemic Arterial Compliance: Impact on LV Function

LV Diast. dysfunction
Zva ≥ 4.5
OR = 5.4, p < 0.0001

LV Syst. dysfunction
Zva ≥ 4.5
OR = 4.2, p = 0.001

Briand, JACC, 46:291-296, 2005
Asymptomatic patients with \( \geq \)moderate AS (peak Ao jet velocity \( \geq 2.5 \text{m.s}^{-1} \)) and LVEF\( >50\% : n=544 \)

**Low:** \( Z_{va} \leq 3.5 \text{mmHg.mL}^{-1}.\text{m}^2 \)
\( n=172, 32\% \)

**Medium:** 3.5-4.5 \( \text{mmHg.mL}^{-1}.\text{m}^2 \)
\( n=192, 35\% \)

**High:** \( \geq 4.5 \text{mmHg.mL}^{-1}.\text{m}^2 \)
\( n=180, 33\% \)

<table>
<thead>
<tr>
<th>Group</th>
<th>Low  ( Z_{va} ) (n = 172)</th>
<th>Medium ( Z_{va} ) (n = 192)</th>
<th>High ( Z_{va} ) (n = 180)</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs</td>
<td>66  ± 15</td>
<td>70  ± 12*</td>
<td>73  ± 13*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female sex</td>
<td>69  (40)</td>
<td>73  (38)</td>
<td>82  (46)</td>
<td>NS</td>
</tr>
<tr>
<td>Body surface area, ( \text{m}^2 )</td>
<td>1.8  ± 0.2</td>
<td>1.8  ± 0.2</td>
<td>1.8  ± 0.2</td>
<td>NS</td>
</tr>
<tr>
<td>Body mass index, ( \text{kg/m}^2 )</td>
<td>27  ± 6</td>
<td>27  ± 5</td>
<td>28  ± 5</td>
<td>NS</td>
</tr>
<tr>
<td>Obesity</td>
<td>39  (23)</td>
<td>53  (27)</td>
<td>55  (31)</td>
<td>NS</td>
</tr>
<tr>
<td>Hypertension</td>
<td>96  (56)</td>
<td>138 (72)*</td>
<td>128 (71)*</td>
<td>0.02</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>93  (54)</td>
<td>109 (57)</td>
<td>76  (42)</td>
<td>NS</td>
</tr>
<tr>
<td>Diabetes</td>
<td>39  (23)</td>
<td>40  (21)</td>
<td>34  (19)</td>
<td>NS</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>96  (56)</td>
<td>128 (67)</td>
<td>106 (59)</td>
<td>NS</td>
</tr>
</tbody>
</table>

\[ \text{Hachicha et al., JACC, 2009} \]
# Features of Patients with Elevated Zva

<table>
<thead>
<tr>
<th>Group</th>
<th>Low $Z_{\text{va}}$ (n = 172)</th>
<th>Medium $Z_{\text{va}}$ (n = 192)</th>
<th>High $Z_{\text{va}}$ (n = 180)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Valvular load</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic valve area, cm$^2$</td>
<td>1.2 ± 0.2</td>
<td>1.0 ± 0.3*</td>
<td>0.8 ± 0.2*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Aortic valve area index, cm$^2$·m$^{-2}$</td>
<td>0.66 ± 0.13</td>
<td>0.56 ± 0.15*</td>
<td>0.45 ± 0.12*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Energy loss index, cm$^2$·m$^{-2}$</td>
<td>0.78 ± 0.18</td>
<td>0.65 ± 0.23*</td>
<td>0.51 ± 0.15*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Peak gradient, mm Hg</td>
<td>44 ± 16</td>
<td>46 ± 20</td>
<td>56 ± 26*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean gradient, mm Hg</td>
<td>25 ± 10</td>
<td>27 ± 12</td>
<td>34 ± 17*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Vascular load</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic arterial pressure, mm Hg</td>
<td>122 ± 16</td>
<td>135 ± 19*</td>
<td>145 ± 23*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diastolic arterial pressure, mm Hg</td>
<td>68 ± 9</td>
<td>73 ± 10*</td>
<td>78 ± 10*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Systemic arterial compliance, ml·m$^{-2}$·mm Hg$^{-1}$</td>
<td>0.94 ± 0.24</td>
<td>0.69 ± 0.18*</td>
<td>0.57 ± 0.18*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Systemic vascular resistance, dyne·s·cm$^{-5}$</td>
<td>1,303 ± 287</td>
<td>1,605 ± 361*</td>
<td>1,824 ± 398*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Global LV hemodynamic load</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valvuloarterial impedance, mm Hg·ml$^{-1}$·m$^2$</td>
<td>3.1 ± 0.4</td>
<td>4.0 ± 0.3*</td>
<td>5.2 ± 0.9*†</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

* Hachicha et al., JACC, 2009
# Features of Patients with Elevated Zva

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<th>High $Z_{va}$ (n = 180)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LV geometry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IVSTd, mm</td>
<td></td>
<td>12 ± 3</td>
<td>12 ± 2</td>
<td>13 ± 3*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PWTd, mm</td>
<td></td>
<td>10 ± 2</td>
<td>11 ± 2</td>
<td>11 ± 2*</td>
<td>0.02</td>
</tr>
<tr>
<td>LVIDd, mm</td>
<td></td>
<td>48 ± 5</td>
<td>47 ± 5</td>
<td>45 ± 5*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LVEDV, ml</td>
<td></td>
<td>111 ± 27</td>
<td>106 ± 27</td>
<td>96 ± 25*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LVEDV index, ml·m⁻²</td>
<td></td>
<td>61 ± 13</td>
<td>58 ± 13*</td>
<td>52 ± 12*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Relative wall thickness, %</td>
<td></td>
<td>44 ± 10</td>
<td>46 ± 10*</td>
<td>49 ± 10*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>LV systolic function</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV ejection fraction, %</td>
<td></td>
<td>67 ± 7</td>
<td>66 ± 7</td>
<td>65 ± 7*</td>
<td>0.025</td>
</tr>
<tr>
<td>Stroke volume, ml</td>
<td></td>
<td>87 ± 16</td>
<td>75 ± 12*</td>
<td>65 ± 15*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stroke volume index, ml·m⁻²</td>
<td></td>
<td>48 ± 8</td>
<td>41 ± 5*</td>
<td>35 ± 7*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cardiac output, l·min⁻¹</td>
<td></td>
<td>5.5 ± 1.2</td>
<td>4.8 ± 1.0*</td>
<td>4.6 ± 1.1*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cardiac index, l·min⁻¹·m⁻²</td>
<td></td>
<td>3.1 ± 0.7</td>
<td>2.6 ± 0.5*</td>
<td>2.5 ± 0.5*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean transvalvular flow rate, ml·s⁻¹</td>
<td></td>
<td>268 ± 61</td>
<td>232 ± 49*</td>
<td>210 ± 55*†</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>LV diastolic function</strong>, %</td>
<td></td>
<td>Normal</td>
<td>20</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Abnormal</td>
<td>80</td>
<td>87</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Retrospective analysis of 544 asymptomatic pts 
≥ moderate AS (≥ 2.5 m/s), LVEF ≥ 50%; Follow-up 2.5±1.8 years

Prognostic Impact of Global Afterload

Overall Survival, (%)

Follow-up (years)

Age-Gender matched general population

P < 0.001

Multivariate Analysis
Med Zva: HR=2.3; p=0.03
High Zva: HR=2.8; p=0.01

Hachicha et al., JACC, 2009
Zva in the SEAS trial

n=1 591 asymptomatic patients with AS (67±10 yrs, 51% of hypertensive, 39% of women

Cramariuc et al. JACC CV Img, 2009

In patients with asymptomatic AS without diabetes or known CAD:

• LVEF generally preserved
• LV myocardial dysfunction: 33%

LV myocardial dysfunction:

• common in patients with increased Zva
• especially in the subgroup with low-flow AS
• more concentric LV geometry, LV hypertrophy, and male
Zva in Asymptomatic AS

Prospective study: 163 patients with asymptomatic AS and preserved LV function

Adjustment for gender, systemic arterial compliance, E-wave, E/A ratio and response to exercise (abnormal vs. normal)

- Peak aortic velocity ≥ 4.4 m.s\(^{-1}\)
- Zva ≥ 4.9 mmHg.ml\(^{-1}\).m\(^{-2}\)
- Longitudinal strain ≤ 15.9 %
- Ind. LA area ≥ 12.2 cm\(^2\)/m\(^2\)

Hazard ratio:
- HR = 1.7, p = 0.027
- HR = 1.9, p = 0.013
- HR = 2.2, p = 0.003
- HR = 2.8, p = 0.001

Lancellotti, Donal, Magne et al. Heart, 2010
Zva in LF/LG AS

n=184 patients with severe LF/LG AS included in the French study.

LVEF □

SV □ □ □ LV contractile reserve □ □ □

ex. SV □ (ΔSV>+20%)

Zva is inaccurate to differentiate TS and PS AS

<table>
<thead>
<tr>
<th>Valvuloarterial impedance (Zva) threshold (mmHg/mL/m²)</th>
<th>P-value to predict perioperative mortality (by univariate analysis)</th>
<th>Results of multivariate analysis to predict perioperative mortality</th>
<th>Results of multivariate analysis to predict 5 year mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.48</td>
<td>HR: 0.37 (0.64–2.131); P = 0.43</td>
<td>OR: 0.73 (0.27–1.98); P = 0.54</td>
</tr>
<tr>
<td>4.5</td>
<td>0.54</td>
<td>HR: 2.24 (0.34–11.91); P = 0.35</td>
<td>OR: 1.07 (0.48–2.37); P = 0.87</td>
</tr>
<tr>
<td>5</td>
<td>0.99</td>
<td>HR: 0.78 (0.14–4.38); P = 0.78</td>
<td>OR: 0.59 (0.28–1.22); P = 0.16</td>
</tr>
<tr>
<td>5.5</td>
<td>0.66</td>
<td>HR: 0.57 (0.10–3.54); P = 0.57</td>
<td>OR: 0.60 (0.28–1.29); P = 0.19</td>
</tr>
<tr>
<td>6</td>
<td>0.62</td>
<td>HR: 1.30 (0.22–7.57); P = 0.77</td>
<td>OR: 1.04 (0.50–2.14); P = 0.91</td>
</tr>
</tbody>
</table>

Lévy, Monin et al. EJ Echo, 2011
Zva in LF/LG AS

Zva vs. SV in patients with true-severe and pseudo-severe AS.

Rest

Qmean = 162ml/s
SVi = 30ml/m²

MPG = 31mmHg
Zva = 5mmHg/ml/m²

Dobutamine

Qmean = 252ml/s
SVi = 42ml/m²

MPG = 41mmHg
Zva = 3.8mmHg/ml/m²

BSA was assumed at 1.8 m², LVED vol at 120 mL, HR at 65 b.p.m., and SAP at 120 mmHg.

Lancellotti and Magne, Editorial, EJ Echo, 2011
Myocardial Function and Zva in Severe AS

Depressed LV longitudinal function, basal septal and lateral LGE, elevated myocardial fibrosis score, and high myocyte diameter

Hermann et al, JACC, 2011
Maximal Exercise Capacity and $Z_{va}$

Valvulo-Arterial Impedance ($Z_{va}$), mmHg/mL/m²

- $Z_{va} < 3.5$: $21.5 \pm 4.8$, $p=0.079$
- $Z_{va} > 3.5$: $18.8 \pm 5.8$
- $Z_{va} < 4$: $21.2 \pm 5.1$, $p=0.014$
- $Z_{va} \geq 4$: $17.6 \pm 5.7$
- $Z_{va} < 4.5$: $20.6 \pm 5.3$, $p=0.007$
- $Z_{va} \geq 4.5$: $15.6 \pm 5.3$
- $Z_{va} < 5$: $20.3 \pm 5.3$, $p=0.008$
- $Z_{va} \geq 5$: $14.0 \pm 5.9$
- $Z_{va} < 5.5$: $20.2 \pm 5.3$, $p=0.006$
- $Z_{va} \geq 5.5$: $12.3 \pm 6.0$

$\text{VO}_2\text{ max, mL/kg/min}$

Dulgheru et al. ESC meeting 2012
Conclusion

- Blood pressure should be routinely measured in the echo lab. and Zva calculated

- High Zva in AS patients is an accurate marker of advanced stage of the disease and is associated with reduced maximal exercise capacity

- High Zva is associated with poor mid- and long-term outcome, even in asymptomatic patients

- In patients with severe asymptomatic AS and high Zva, follow-up could be shorten and exercise test and/or exercise echo should be recommended
DON’T MISS

5-8 December 2012
MAICC – Athens, Greece

Abstract submission deadline
31 May

Early bird registration
30 September
Thank you for your attention.

“In these matters the only certainty is that nothing is certain.”

Pliny The Elder, 23 AD-79 AD
“Severe” AS with Low Gradient and Low LVEF

- AVA \( \leq 1.0 \text{ cm}^2 \)
- Mean gradient \( \leq 30-40 \text{ mmHg} \)
- LVEF \( \leq 40\% \)

- Approximately 5-10% of AS population

- High risk patients:
  - 3-year survival 50-60%
  - If operated (AVR): operative mortality: 8-30%
Prospective Studies: Topas/Euro Trial
Severe AS, LG, Low LVEF

Topas Study
Operative mortality: 18%
Clavel et al. Circulation, 2008

European Multicenter Study
Operative mortality: 16%
Levy et al. JACC, 51:1466-72, 2008
Usefulness of Dobutamine Stress Echo (DSE) in LF/LG AS

Low Flow, Low Gradient Severe AS
AVA <1.0 cm², $P_{\text{mean}}$ <30-40 mmHg, LV EF ≤40%

Dobutamine Stress Echocardiography

Stenosis Severity
(True vs. Pseudo Severe AS)

Contractile Reserve

Infusion protocol

Monitoring: ECG, blood pressure
True Severe AS vs. Pseudo Severe AS?

True Severe AS

Pseudo Severe AS

AVA

ΔP
Risk Stratification in LF/LG Severe AS, Low LVEF

Levy et al. JACC, 51:1466-72, 2008
Risk Stratification in LF/LG Severe AS, Low LVEF

Clavel et al. Circulation, 2008
Dobutamine Stress Echo

↑SV ≥ 20%

Contractile Reserve

ΔP>30-40
AVA≤1.0

True Severe AS

AVR ± CABG

ΔP≤30-40
AVA>1.0

Pseudo Severe AS

MEDICAL

ΔP<30-40
AVA≤1.0

Indeterminate

ΔP<30-40
AVA≤1.0

AVR? MEDICAL?
Outcome after AVR in Patients without Contractile Reserve

Whole Cohort (n=81)

- Survival: 54±7%
- p=0.0001

Matched Cohort (n=42)

- Survival: 65±11%
- p=0.019

Operative Mortality: 22%

Tribouilloy et al. JACC, 2009
Outcome after TAVI in LF/LG
Severe AS

Partner Study

LVEF ≤55%
LVEF >55%

TAVI Better
AVR Better

TAVI in LF/LG

<table>
<thead>
<tr>
<th>Patients with low-flow, low gradient aortic stenosis (n = 15)</th>
<th>Patients without low-flow, low gradient aortic stenosis (n = 152)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td>0.997</td>
</tr>
<tr>
<td>Women, n (%)</td>
<td></td>
<td>0.174</td>
</tr>
<tr>
<td>Log EuroSCORE (%)</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Aortic valve area (cm²)</td>
<td></td>
<td>0.818</td>
</tr>
<tr>
<td>Aortic mean gradient (mm Hg)</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Left ventricular ejection fraction (%)</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td>Coronary artery disease, n (%)</td>
<td></td>
<td>0.015</td>
</tr>
<tr>
<td>Prior myocardial infarction, n (%)</td>
<td></td>
<td>0.062</td>
</tr>
<tr>
<td>Prior PCI, n (%)</td>
<td></td>
<td>0.368</td>
</tr>
<tr>
<td>Prior CABG, n (%)</td>
<td></td>
<td>0.012</td>
</tr>
<tr>
<td>Atrial fibrillation, n (%)</td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td>Prior stroke, n (%)</td>
<td></td>
<td>0.140</td>
</tr>
<tr>
<td>Kidney disease, n (%)</td>
<td></td>
<td>0.458</td>
</tr>
<tr>
<td>COPD, n (%)</td>
<td></td>
<td>0.558</td>
</tr>
</tbody>
</table>

Early mortality: 33%, p=0.037

Smith et al., NEJM, 2011
Gotzmann et al., Cath CV Interv, 2011
Paradoxical Low-Flow, Low-Gradient Severe Aortic Stenosis Despite Preserved Ejection Fraction Is Associated With Higher Afterload and Reduced Survival

Zeineb Hachicha, MD; Jean G. Dumesnil, MD; Peter Bogaty, MD; Philippe Pibarot, DVM, PhD

n=512

SEVERE AS
(AVAi ≤ 0.6 cm²/m²)

PRESERVED LV FUNCTION
(LVEF ≥ 50%)

331 patients (65%)
SVI > 35ml/m²

Normal Flow (NF) Group

181 patients (35%)
SVI ≤ 35ml/m²

Paradoxical Low Flow (PLF) Group
Normal Flow AS

LVEDV: 115 ml
LVEF: 60%
SV: 70 ml
AVA: 0.7 cm²
ΔP: 45 mmHg

Paradoxical Low Flow AS

LVEDV: 85 ml
LVEF: 60%
SV: 50 ml
AVA: 0.7 cm²
ΔP: 25 mmHg

Pibarot & Dumesnil
iJACC; 2:400-3, 2009
Outcome of Patients with Paradoxical Low Flow

Hachicha Z et al., Circulation. 115:2856-2864, 2007

NF: Normal Flow: SVI>35 (65%)
PLF: Paradoxical Low Flow: SVI≤35 (35%)
Prevalence of PLF/LG Severe AS

≈ 5-15% of Severe AS
Echo Features of Paradoxical LF/LG Severe AS

The Aortic Valve:
- AVA < 1.0 cm$^2$
- AVAi < 0.6 cm$^2$/m$^2$
- Severely thickened/calcified valve
- Mean gradient < 40 mmHg
- Valvulo-arterial impedance > 4.5 mmHg.ml$^{-1}$.m$^{-2}$

The Left Ventricle
- EDD < 47 mm  EDV < 55 mL/m$^2$
- RWT ratio > 0.50
- Impaired LV filling
- LVEF > 50%
- GLS < 16%  GRS < 30%
- SVi < 35 mL/m$^2$
Advanced Echo Features of Paradoxical LF/LG Severe AS

Adda et al, Circulation CV Img, 2012
Myocardial Function in Paradoxical LF/LG Severe AS

Characterized by similar LVEF and AVA but lower MPG and LV SV

Weidemann, Hermann et al, Circ, 2009

Depressed LV longitudinal function, basal septal and lateral LGE, elevated myocardial fibrosis score, and high myocyte diameter

Hermann et al, JACC, 2011
Consider inconsistencies in guidelines criteria

Rule out pseudo-severe AS:
- Valve morphology by echo
- Exercise/dobutamine stress echo
- Calcium score by CT
- BNP

Rule out measurement errors: corroborating methods:
(Teichholz, Simpson, 3D-contrast, AV Planimetry)

Discordant Findings:
AVA < 1.0 cm² & ΔP_{mean} < 40 mmHg
LVEF > 50%

Features of paradoxical low flow:
SVi ≤ 35 mL/m² Zva > 4.5
EDD < 47 mm EDVi < 55 ml/m²
RWTR > 0.50 GLS < 16%

Present:
Consider paradoxical low flow AS

Absent:
Consider inconsistencies in guidelines criteria

Consider paradoxical low flow severe AS:
AVR

Rule out small body size:
AVAi > 0.6 cm²/m²

Present:
Consider paradoxical low flow AS

Rule out pseudo-severe AS:
- Valve morphology by echo
- Exercise/dobutamine stress echo
- Calcium score by CT
- BNP

Consider paradoxical low flow severe AS:
AVR

Features of paradoxical low flow:
SVi ≤ 35 mL/m² Zva > 4.5
EDD < 47 mm EDVi < 55 ml/m²
RWTR > 0.50 GLS < 16%
Outcome of Paradoxical LF/LG Severe AS

**SEAS trial**

\[ n=1\ 873 \]

\[ LVEF \geq 55\% \]

\[ n=1\ 525 \]

**LG Severe AS**

\[ n=435,\ 29\% \]

**Mod. AS**

\[ n=184,\ 12\% \]

**Severe AS**

\[ n=35,\ 2\% \]

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**Jander et al, Circulation, 2011**
Outcome of Paradoxical LF/LG Severe AS

Aortic Valve Events

Major CV Events

Survival, (%)

Follow-up, (month)

Survival, (%)

Follow-up, (month)

p=0.48

Moderate AS

Severe LG AS

Severe AS

Jander et al, Circulation, 2011
Outcome of Paradoxical LF/LG

Similar AS severity, similar outcome!

AVA: 0.99 vs. 1.01 cm²
AVAi: 0.54 vs 0.52 cm²/m²

SVi: 42.1 vs. 42.7 mL/m²

BSA: 1.83m² vs. 1.94m²

Jander et al, Circulation, 2011
Asymptomatic Paradoxical LF/LG Severe AS

Asymptomatic severe AS with preserved LV ejection fraction, n=150

| Clinical Outcome in Asymptomatic Severe Aortic Stenosis | JACC Vol. 59, No. 3, 2012 | Insights From the New Proposed Aortic Stenosis Grading Classification |

Patrizio Lancellotti, MD, PhD,* Julien Magne, PhD,* Erwan Donal, MD, PhD,† Laurent Davin, MD,* Kim O'Connor, MD,* Monica Rosca, MD,* Catherine Szymanski, MD,* Bernard Cosyns, MD, PhD,§ Luc A. Piérard, MD, PhD* |

<table>
<thead>
<tr>
<th></th>
<th>NF/LG (n = 48) (31%)</th>
<th>NF/HG (n = 78) (52%)</th>
<th>LF/HG (n = 15) (10%)</th>
<th>LF/LG (n = 11) (7%)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs</td>
<td>69 ± 8</td>
<td>71 ± 10</td>
<td>71 ± 8</td>
<td>65 ± 14</td>
<td>NS</td>
</tr>
<tr>
<td>Male, %</td>
<td>29 (63)</td>
<td>53 (68)</td>
<td>9 (60)</td>
<td>5 (45)</td>
<td>NS</td>
</tr>
<tr>
<td>Body surface area, m²</td>
<td>1.8 ± 0.2</td>
<td>1.8 ± 0.2</td>
<td>1.9 ± 0.2</td>
<td>1.8 ± 0.2</td>
<td>NS</td>
</tr>
<tr>
<td>AVA, cm²</td>
<td>0.85 ± 0.08</td>
<td>0.79 ± 0.1</td>
<td>0.74 ± 0.15*</td>
<td>0.80 ± 0.14</td>
<td>0.04</td>
</tr>
<tr>
<td>Indexed AVA, cm²/m²</td>
<td>0.47 ± 0.07</td>
<td>0.45 ± 0.08</td>
<td>0.39 ± 0.09*</td>
<td>0.45 ± 0.09</td>
<td>0.04</td>
</tr>
<tr>
<td>Peak aortic velocity, m/s⁻¹</td>
<td>3.5 ± 0.4</td>
<td>4.5 ± 0.6*</td>
<td>4.6 ± 0.4*</td>
<td>3.8 ± 0.5†‡</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean aortic gradient, mm Hg</td>
<td>32 ± 5</td>
<td>53 ± 12*</td>
<td>50 ± 14*</td>
<td>33 ± 5†‡</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Valvulo-arterial Impedance, mm Hg/ml/m²</td>
<td>3.7 ± 0.8</td>
<td>3.9 ± 0.9</td>
<td>5.9 ± 1.1*†</td>
<td>6.0 ± 1.1*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>LVEDV index, ml/m²</td>
<td>58 ± 14</td>
<td>61 ± 18</td>
<td>55 ± 14</td>
<td>52 ± 16</td>
<td>NS</td>
</tr>
<tr>
<td>LVESV index, ml/m²</td>
<td>21 ± 7</td>
<td>23 ± 12</td>
<td>20 ± 11</td>
<td>19 ± 12</td>
<td>NS</td>
</tr>
<tr>
<td>LV stroke volume, ml</td>
<td>74 ± 16</td>
<td>73 ± 16</td>
<td>63 ± 7†</td>
<td>59 ± 10†</td>
<td>0.003</td>
</tr>
<tr>
<td>Indexed LV stroke volume, ml/m²</td>
<td>41 ± 10</td>
<td>41 ± 11</td>
<td>33 ± 2*†</td>
<td>31 ± 2*†</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>LVEF, %</td>
<td>67 ± 8</td>
<td>67.0 ± 7.5</td>
<td>66 ± 7</td>
<td>66 ± 8</td>
<td>NS</td>
</tr>
<tr>
<td>LV longitudinal strain, %</td>
<td>16.7 ± 2.6</td>
<td>16.0 ± 2.6</td>
<td>14.8 ± 2.7*</td>
<td>13.6 ± 4.3*†</td>
<td>0.002</td>
</tr>
<tr>
<td>LA area index, cm²/m²</td>
<td>12.4 ± 4.0</td>
<td>11.9 ± 3.0</td>
<td>13.4 ± 3.0</td>
<td>13.0 ± 3.0</td>
<td>NS</td>
</tr>
<tr>
<td>BNP, pg/ml</td>
<td>34 ± 5</td>
<td>67 ± 10</td>
<td>110 ± 14†</td>
<td>95 ± 18*</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Risk score</td>
<td>12.2 ± 2.0</td>
<td>15.1 ± 2.0*</td>
<td>16.5 ± 2.0*</td>
<td>14.9 ± 2.0*</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Asymptomatic Paradoxical LF/LG
Severe AS

Adjusted incidence of cardiac events, %

Follow-up, months

p=0.009

LF/LG group
LF/HG group
NF/HG group
NF/LG group
Key Messages

- The presence of a moderately increased transvalvular gradient (<40 mmHg) does not exclude the presence of a severe AS, even in patients with preserved LVEF.

- DSE is very useful for the management of LF/LG AS.

- Paradoxical LF/LG entity is found in 5-15% of AS patients and is often associated with more advanced stage of the disease and worse prognosis, even in asymptomatic patients.

- It is important to recognize this entity so we do not deny surgery to a symptomatic patient with small AVA and LG.
Thank you for your attention.

“In these matters the only certainty is that nothing is certain.”

Pliny The Elder, 23 AD-79 AD
DON’T MISS

5-8 December 2012
MAICC – Athens, Greece

Abstract submission deadline
31 May

Early bird registration
30 September
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