

# *Low Gradient AS: Multi-Imaging Modalities*

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# *Disclosure*

## *Philippe Pibarot*

### **Financial relationship with industry:**

- **Edwards Lifesciences**
- **V-Wave**

### **Other financial disclosure:**

- **Research Grants from Canadian Institutes of Health**
- **Research and Heart & Stroke Foundation of Quebec**

**Off label Use: None**

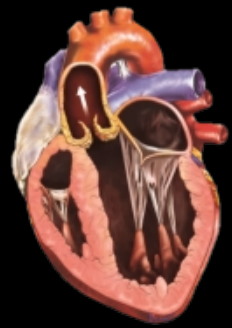
**LOW GRADIENT AS**  
**AVA<1.0 cm<sup>2</sup> MG<40 mmHg**

**<50%** ← **LVEF** → **>50%**

**SVi**

**<35 mL/m<sup>2</sup>**

**>35 mL/m<sup>2</sup>**



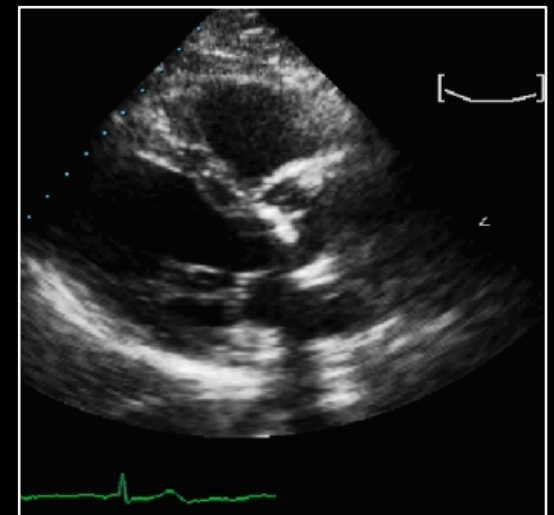
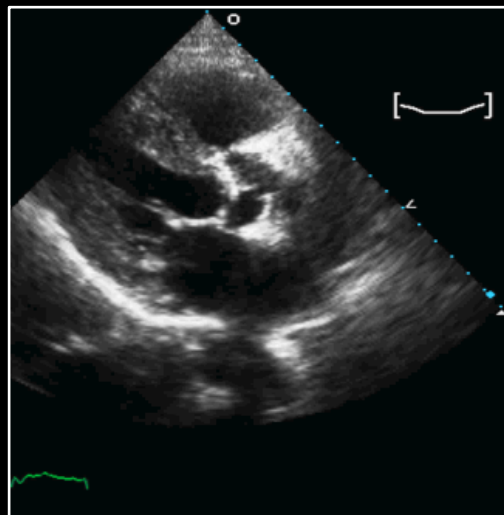
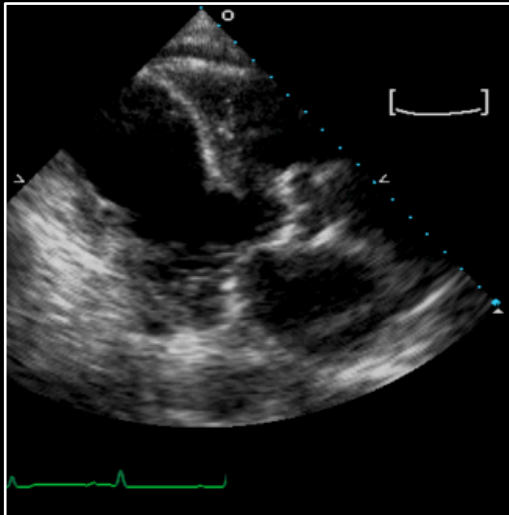
**«CLASSICAL»  
LOW-FLOW  
LOW-GRADIENT  
D2 Stage**



**«PARADOXICAL»  
LOW-FLOW  
LOW-GRADIENT  
D3 Stage**



**NORMAL  
LOW-FLOW  
LOW-GRADIENT  
D? Stage**



# *Two Different Patterns of Low-Flow, Low-Gradient AS*

**NORMAL-LVEF  
«PARADOXICAL»  
LOW-FLOW  
LOW-GRADIENT**

**10-15%**



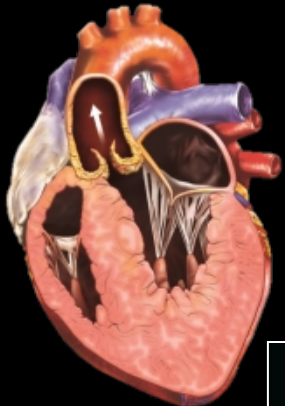
**LOW-LVEF  
«CLASSICAL»  
LOW-FLOW  
LOW-GRADIENT**

**5-10%**

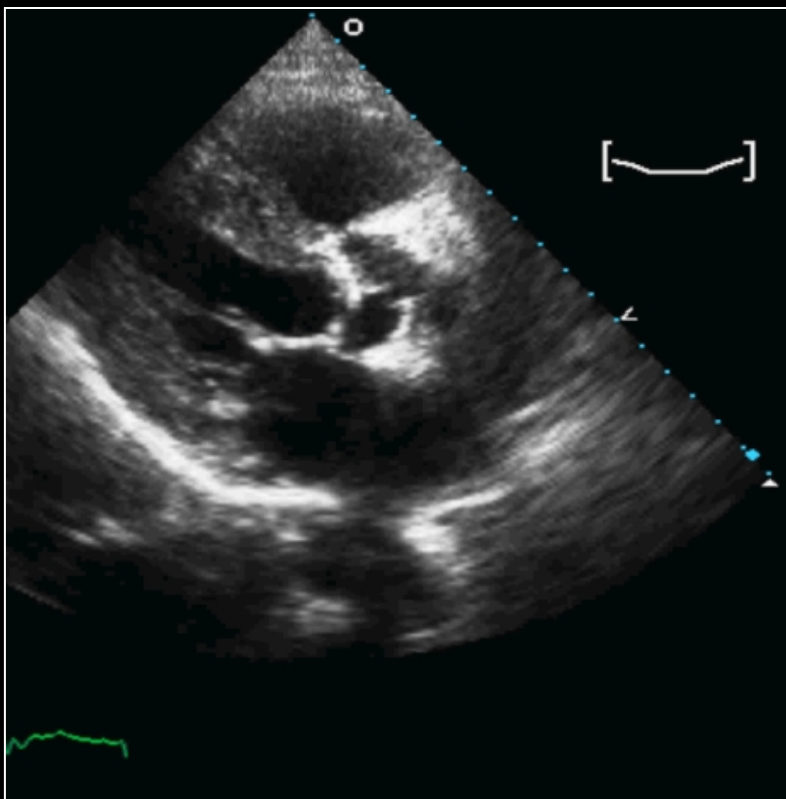


# *The Role of Multi-Modality Imaging in Low Gradient AS*

- Corroborate measurements of stroke volume / AVA and differentiate **normal-flow vs. low-flow**, low-gradient AS
- Differentiate **true vs. pseudo-severe** stenosis
- Optimize **risk stratification** and therapeutic decision making: flow reserve, myocardial fibrosis

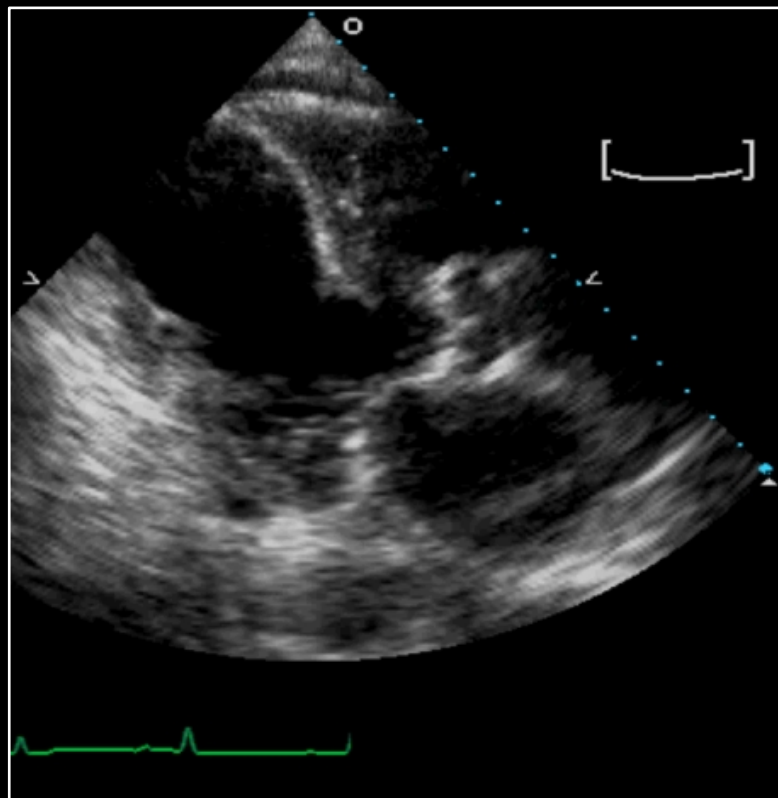


**NORMAL-LVEF**  
**«PARADOXICAL»**  
**LOW-FLOW**  
**LOW-GRADIENT**

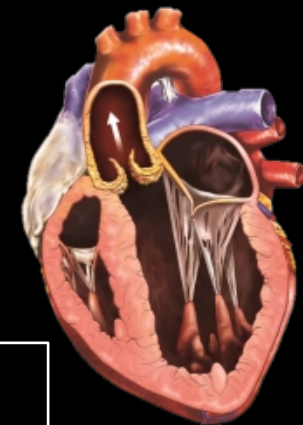


**LVEF=60%**  
**SV=46 mL**  
**MG=29 mmHg**

**LOW-LVEF**  
**«CLASSICAL»**  
**LOW-FLOW**  
**LOW-GRADIENT**

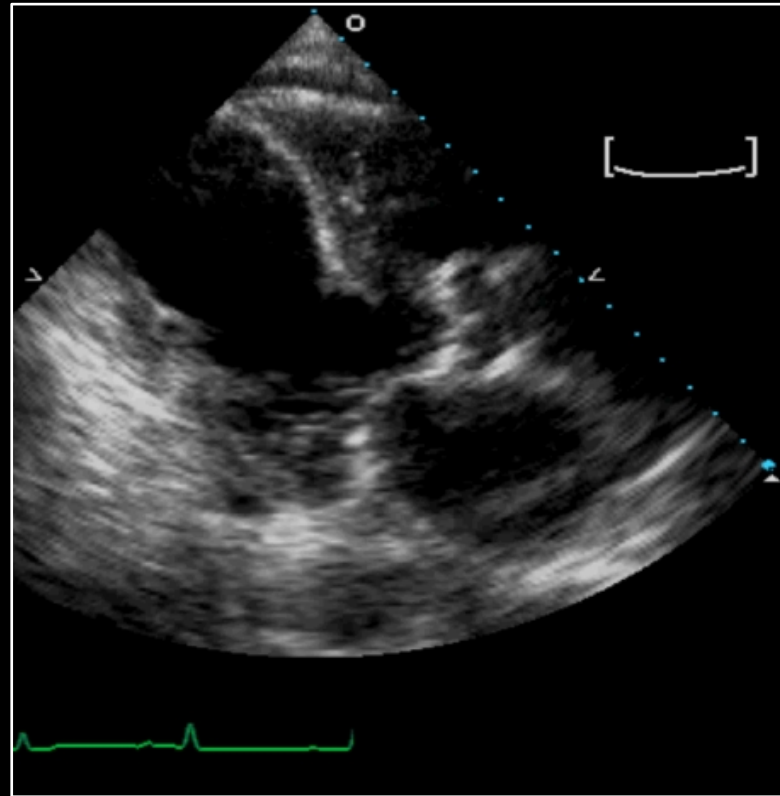
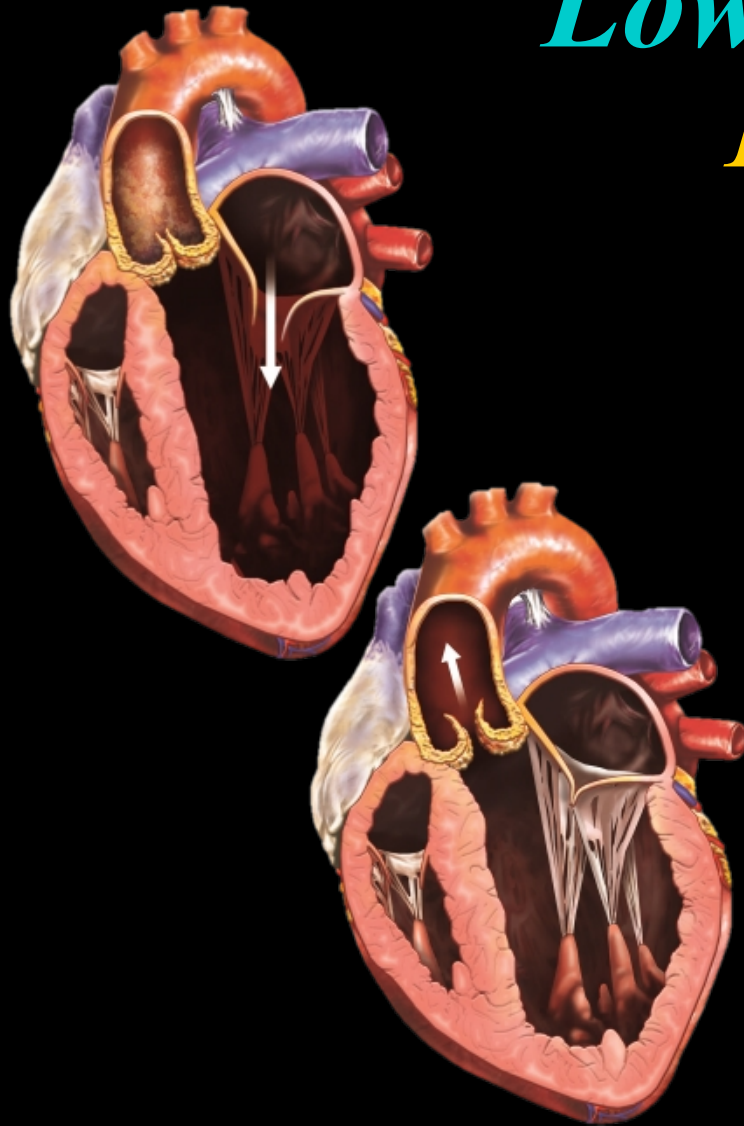


**LVEF=25%**  
**SV=42 mL**  
**MG=25 mmHg**





# *“Classical” Low-Flow, Low-Gradient AS with Reduced LVEF*

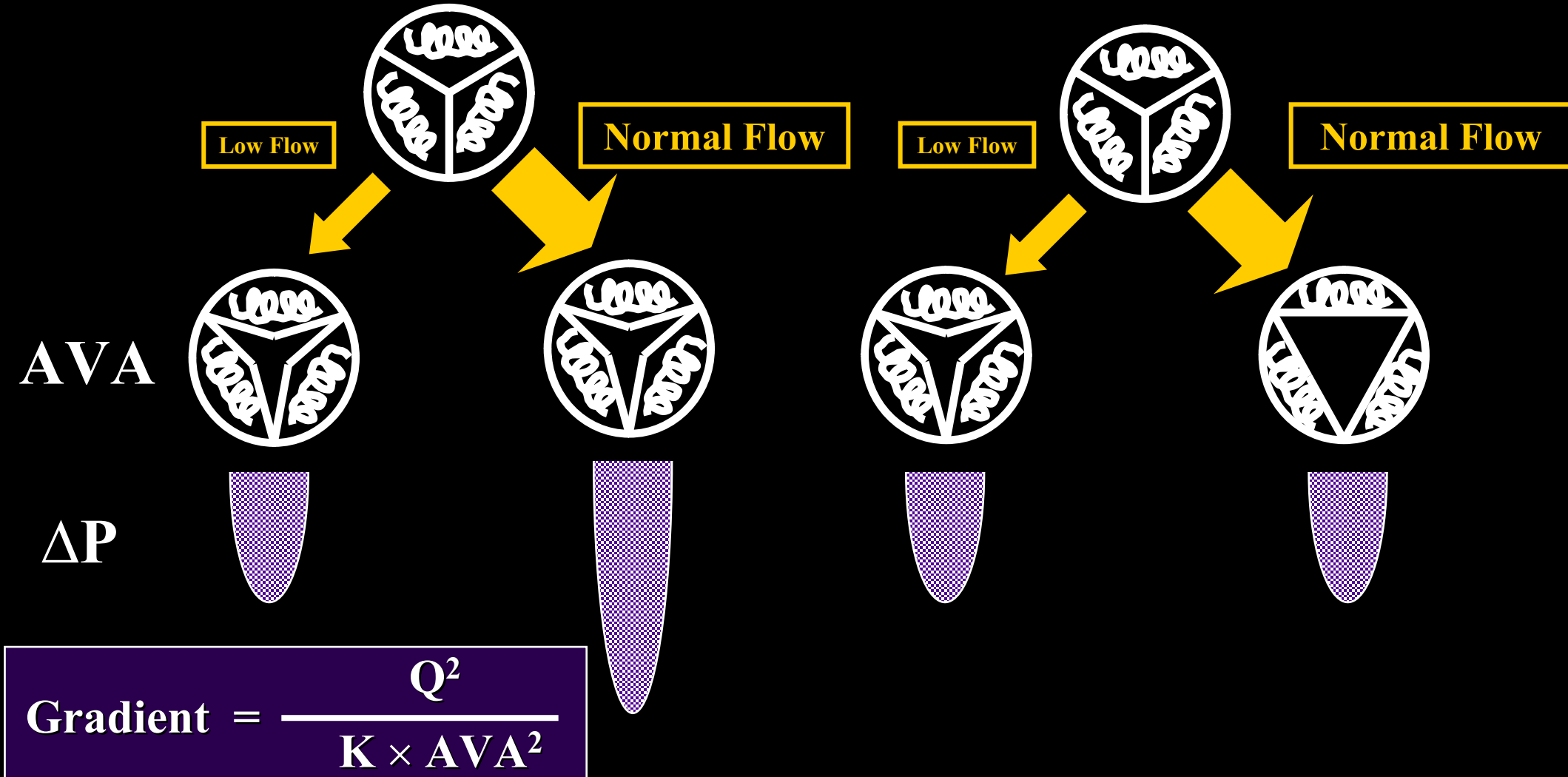


**LVEF=25%**  
**SV=42 mL**  
**MG=25 mmHg**

# *Low-Flow, Low-Gradient Severe(?) AS*

## True-Severe AS

## Pseudo-Severe AS





**LVEF ≤ 50%**  
**AVA ≤ 1.0**  
**ΔP < 40**

**Dobutamine-Stress Echo / Cath.**

**↑ SV ≥ 20 %**

**↑ SV < 20 %**

**Contractile (Flow) Reserve**

**No Contractile (Flow) Reserve**

**ΔP ≥ 40**  
**AVA ≤ 1.0**

**ΔP < 40**  
**AVA > 1.0**

**AS Severity:  
Indeterminate**

**MSCT: AoV Ca  
Score > 1200 ♀  
> 2000 ♂**

**True-Severe AS**

**Pseudo-Severe AS**

**True-Severe AS**

**SAVR ± CABG**  
**TAVR ± PCI**

**HF Therapy**

**SAVR (High Op. Risk)**  
**TAVR? BAV+TAVR?**

# *2014 ACC/AHA Guidelines on Management of VHD: Indications for AVR in AS*

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

**Stage:** **D2**

Recommendation	Class	Level
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	<b>IIa</b>	<b>B</b>

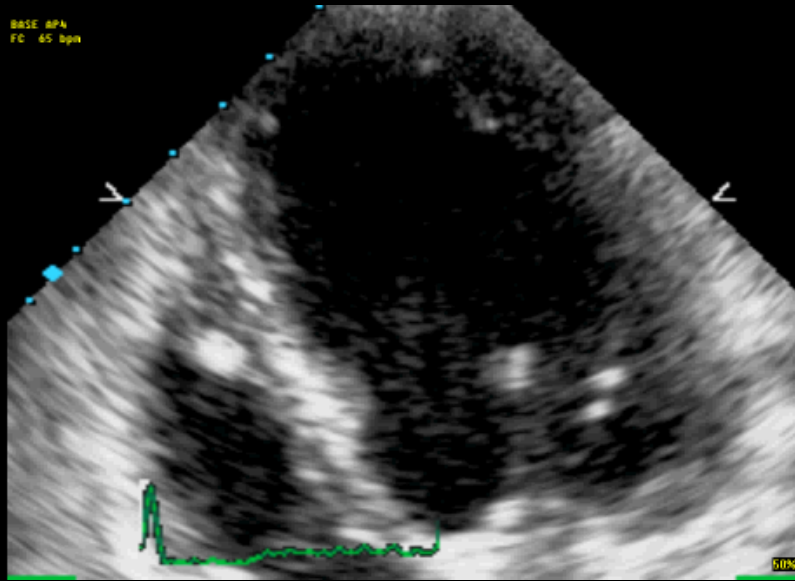
# ***2012 ESC/EACTS Guidelines on Management of VHD: Indications for AVR in AS***

**Severe AS on DSE: Increase in AVA  $<0.2 \text{ cm}^2$  with final AVA  $<1 \text{ cm}^2$ ; mean gradient  $>40 \text{ mmHg}$ )**

**Flow reserve:  $>20\%$  increase in stroke volume**

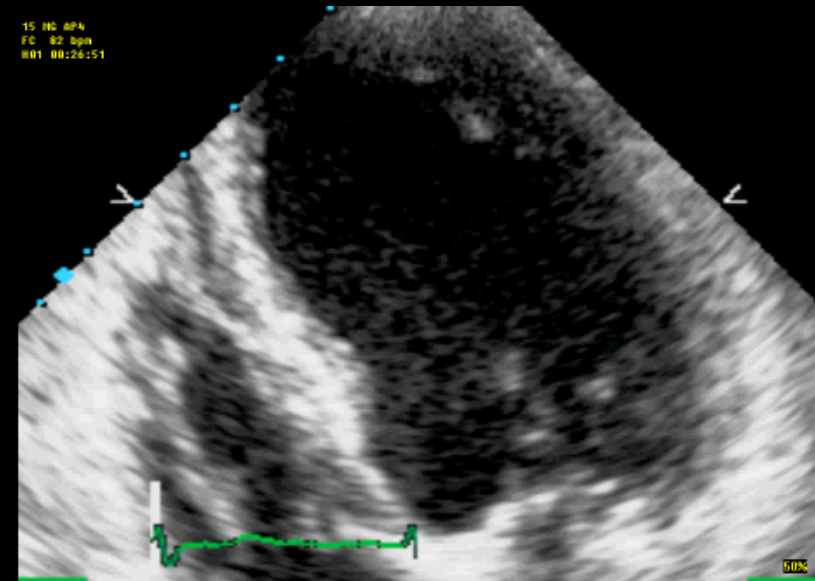
# Case #1

## Resting Echo

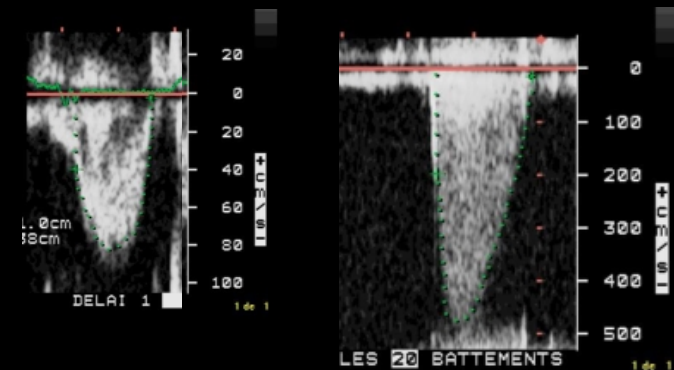
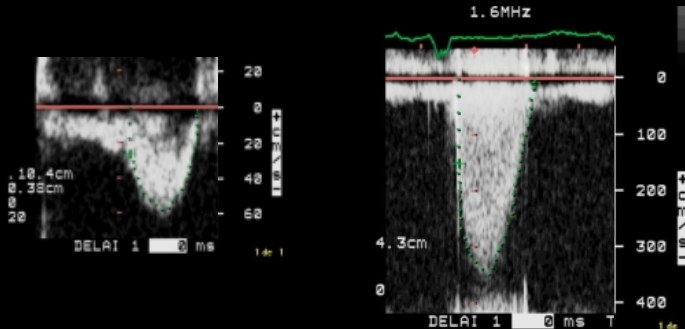


**LVEF=40%    SV= 53 ml**  
**AVA= 0.77 cm<sup>2</sup>**  
 **$\Delta P= 49 / 29$  mmHg**

## DSE



**LVEF=50%    SV= 73 ml**  
**AVA= 0.75 cm<sup>2</sup>**  
 **$\Delta P= 92 / 52$  mmHg**



## *Case #1:*

➤ *Contractile/flow reserve: Yes*

➤ *Stenosis severity: True-severe*

# Case #2

## *Resting Echo*

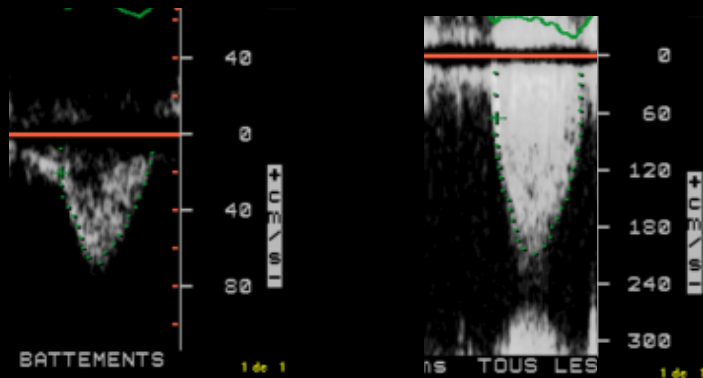
**SV= 34 ml**

**LVEF=15%**

**Peak  $\Delta P$ = 18 mmHg**

**Mean  $\Delta P$ = 12 mmHg**

**AVA= 0.85 cm<sup>2</sup>**



## *DSE*

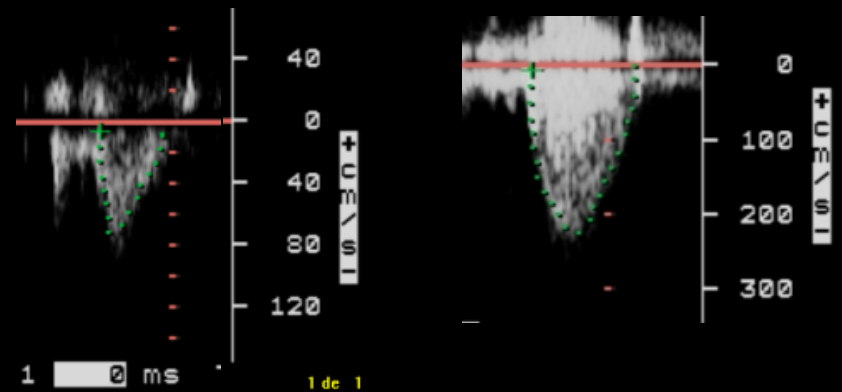
**SV= 46 ml**

**LVEF=25%**

**Peak  $\Delta P$ = 21 mmHg**

**Mean  $\Delta P$ = 13 mmHg**

**AVA= 1.2 cm<sup>2</sup>**





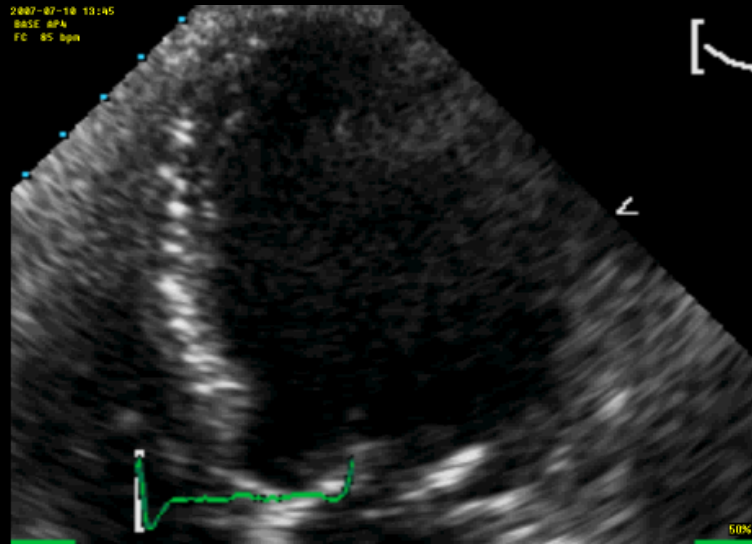
## *Case Study #2:*

➤ *Contractile/flow reserve: Yes*

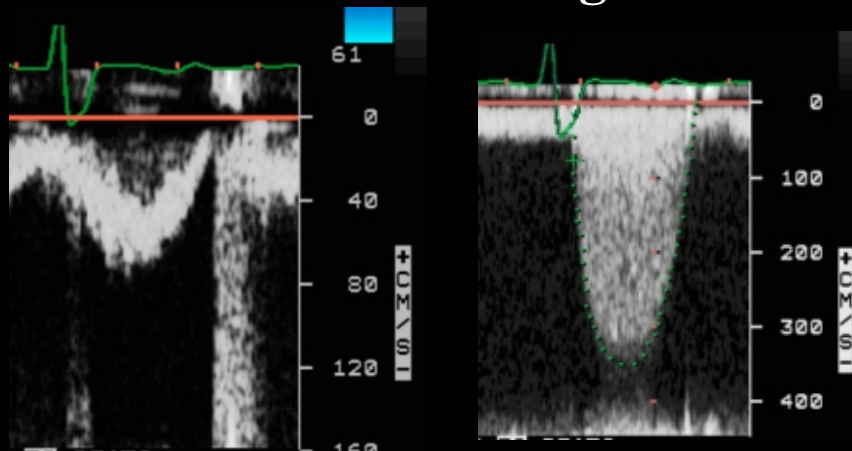
➤ *Stenosis severity: Pseudo-severe*

# Case #2

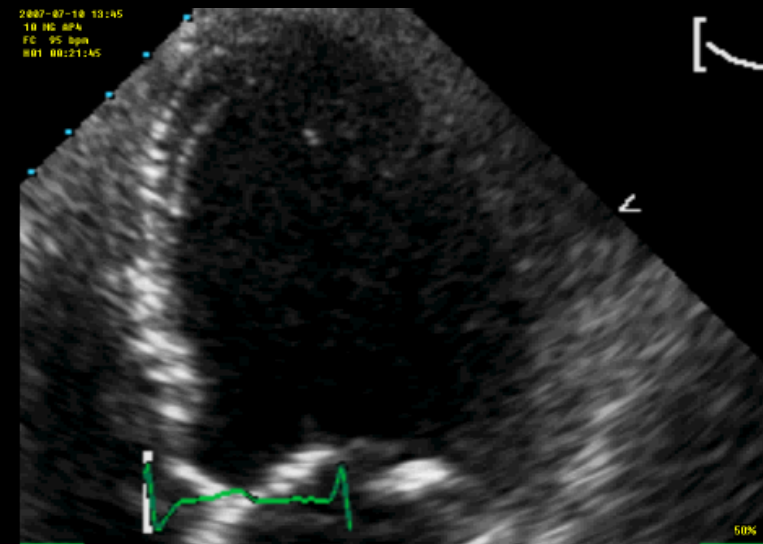
## Resting Echo



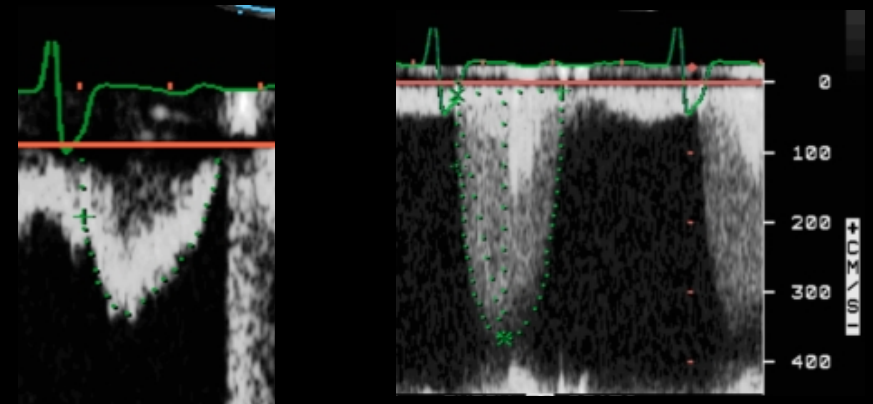
**LVEF=25%    SV= 51 ml**  
**AVA= 0.8 cm<sup>2</sup>**  
 **$\Delta P= 46 / 27$  mmHg**



## DSE



**LVEF=30%    SV= 57 ml**  
**AVA= 0.8 cm<sup>2</sup>**  
 **$\Delta P= 52 / 30$  mmHg**



## *Case #2:*

➤ *Contractile/flow reserve: No*

➤ *Stenosis severity: Indeterminate*

# *Usefulness of AoV Ca Scoring by MDCT to Differentiate True vs. Pseudo-Severe Stenosis in Low-Flow, Low-Gradient AS*

**Pseudo-Severe**



**AVC: 1034 AU**

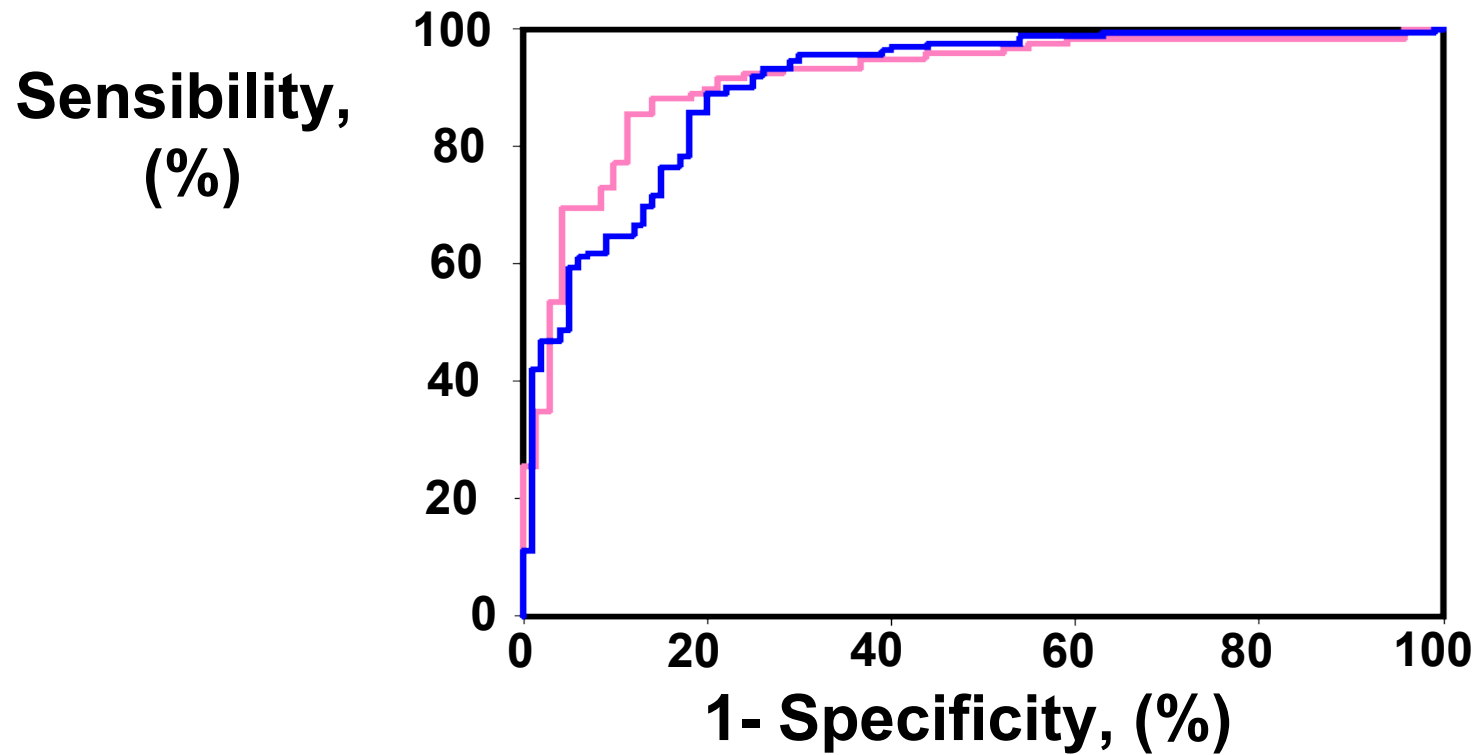
**True-Severe**



**AVC: 4682 AU**

*Clavel et al. JACC 2013: AVC Score to identify Severe AS: **>1200AU in ♀**  
**>2000 AU in ♂***

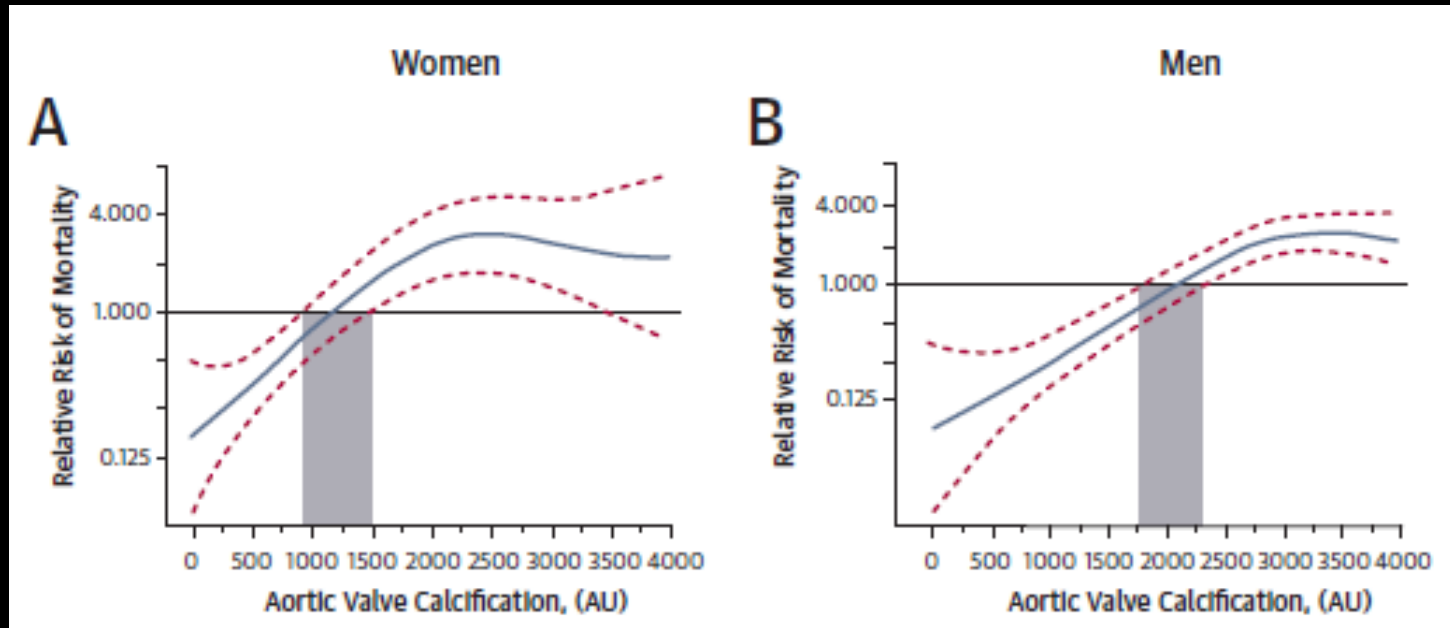
# Mayo-Québec-Bichat Collaboration: Accuracy of AVC to identify severe AS



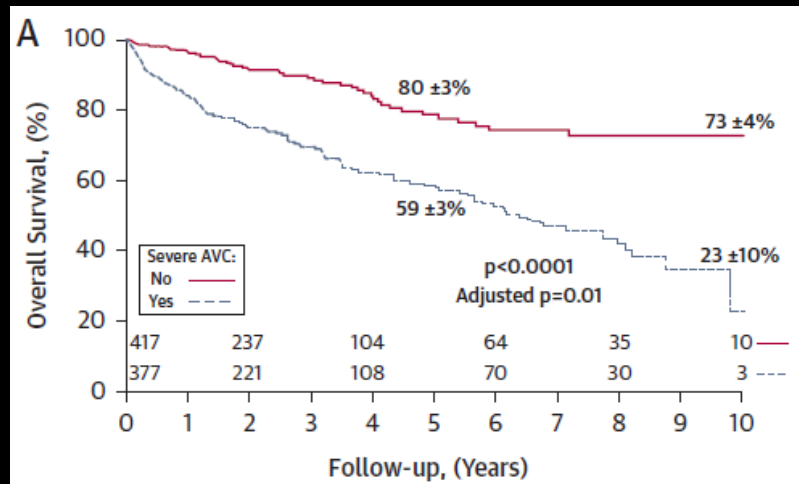
**Case #2:  
2010 AU**

Gender	Threshold	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Women	1274 AU	0.91	89	86	93	79
Men	2065 AU	0.90	89	80	88	82

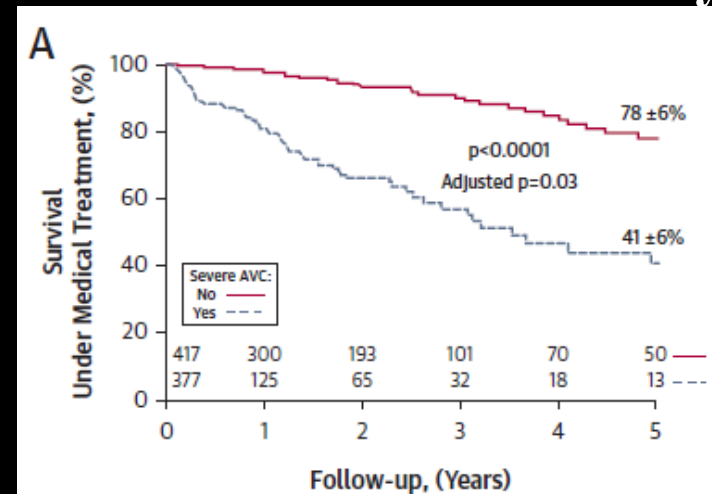
# Mayo-Québec-Bichat Collaboration: Impact of AVC on Survival In patients with AS



## Whole Cohort

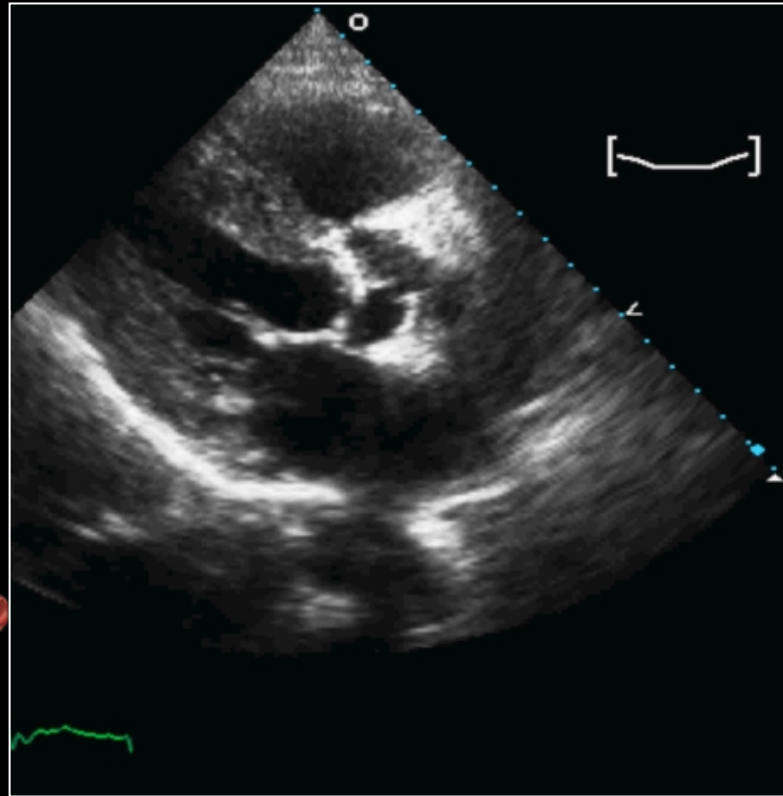
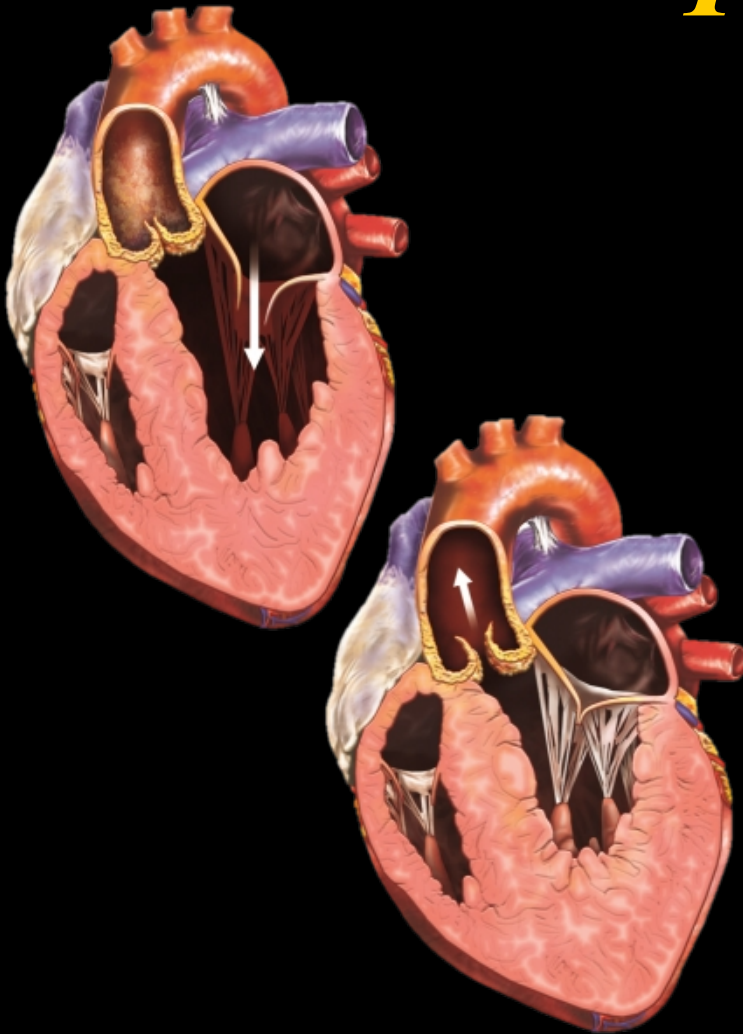


## Patients treated Medically





# ***“Paradoxical” Low-Flow, Low-Gradient AS with Preserved LVEF***

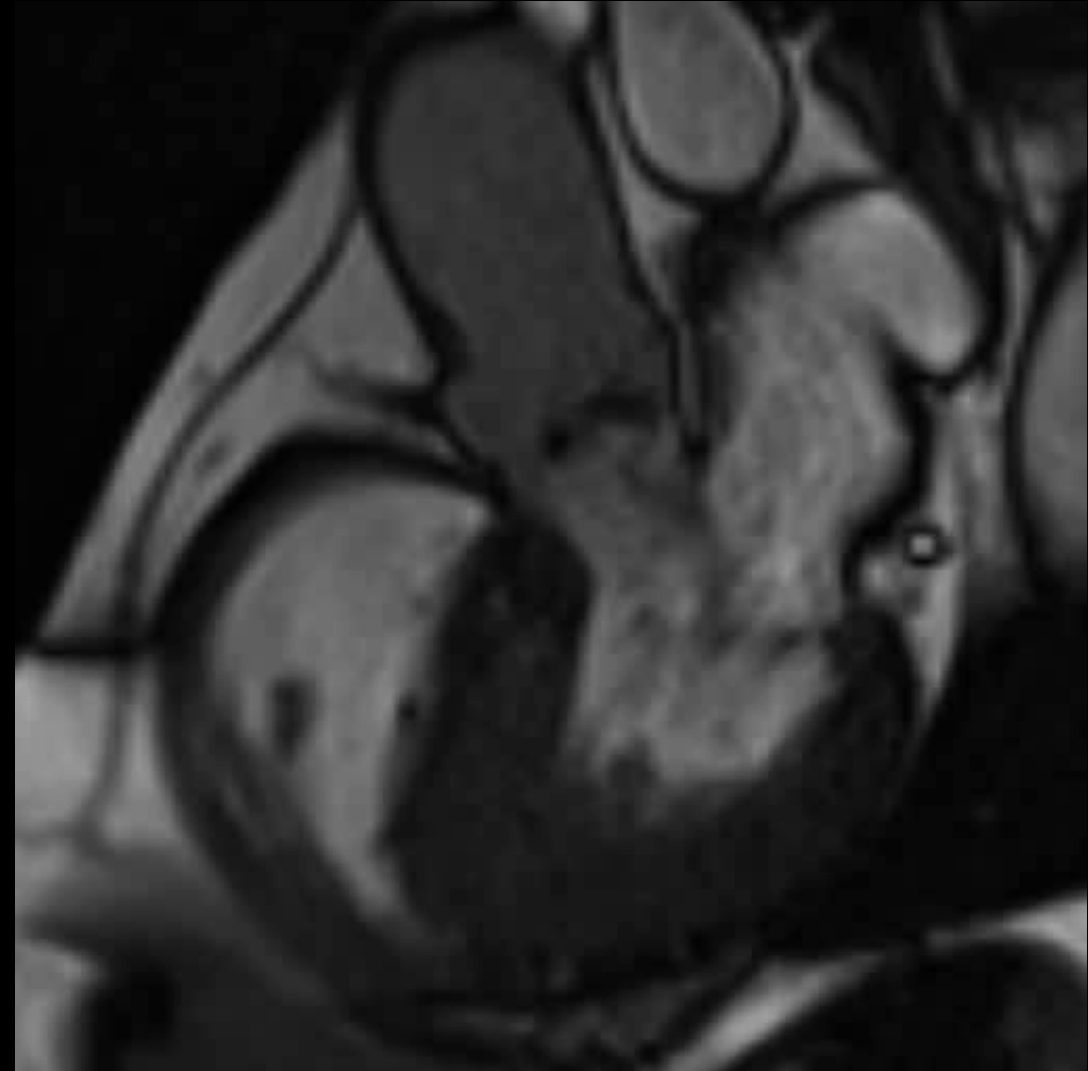


**↑ Age  
Women  
Hypertension  
MetS – Diabetes**

**LVEF=60%  
SV=46 mL  
MG=29 mmHg**

# Case #3

- 75 y.o. female
- Calcific AS
- NYHA class III
- No CAD at angio
- LVEF: 73%
- LVEDV: 38 mL/m<sup>2</sup>
- SVi: 26 mL/m<sup>2</sup>
- AS severity at catheter:
  - AVA: 0.85 cm<sup>2</sup>
  - Indexed AVA: 0.5 cm<sup>2</sup>/m<sup>2</sup>
  - Mean gradient: 32 mmHg



# Guidelines on Management of VHD: Indications for AVR in Paradoxical Low-Flow, Low-Gradient AS

**Definition:**  $AVA \leq 1.0 \text{ cm}^2$ , Indexed  $AVA \leq 0.6 \text{ cm}^2/\text{m}^2$   
Mean gradient  $< 40 \text{ mmHg}$ ,  
 $LVEF \geq 50\%$ ,  $SVi < 35 \text{ mL/m}^2$

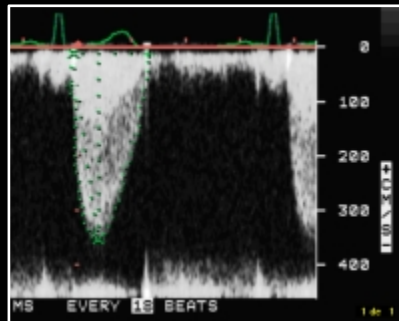
Stage: **D3**

Guidelines	Recommendation for AVR	Class
ESC-EACTS 2012	AVR should be considered in <b>symptomatic</b> patients with low flow, low gradient ( $< 40 \text{ mmHg}$ ) AS with normal EF only after careful <b>confirmation of severe AS</b> .	<b>IIa</b>
ACC-AHA 2014	AVR is reasonable in <b>symptomatic</b> patients who have low-flow, low-gradient <b>severe</b> AS who are <b>normotensive</b> and have an $LVEF \geq 50\%$ if clinical, hemodynamic, and anatomic data support valve obstruction as the most likely cause of symptoms	<b>IIa</b>

# Usefulness of Stress-Echocardiography to Differentiate True vs. Pseudo-Severe Stenosis in Paradoxical, Low-Flow, Low-Gradient AS

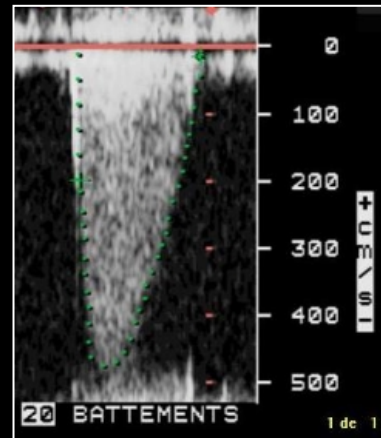
**51 patients with PLF-LG**

**REST**



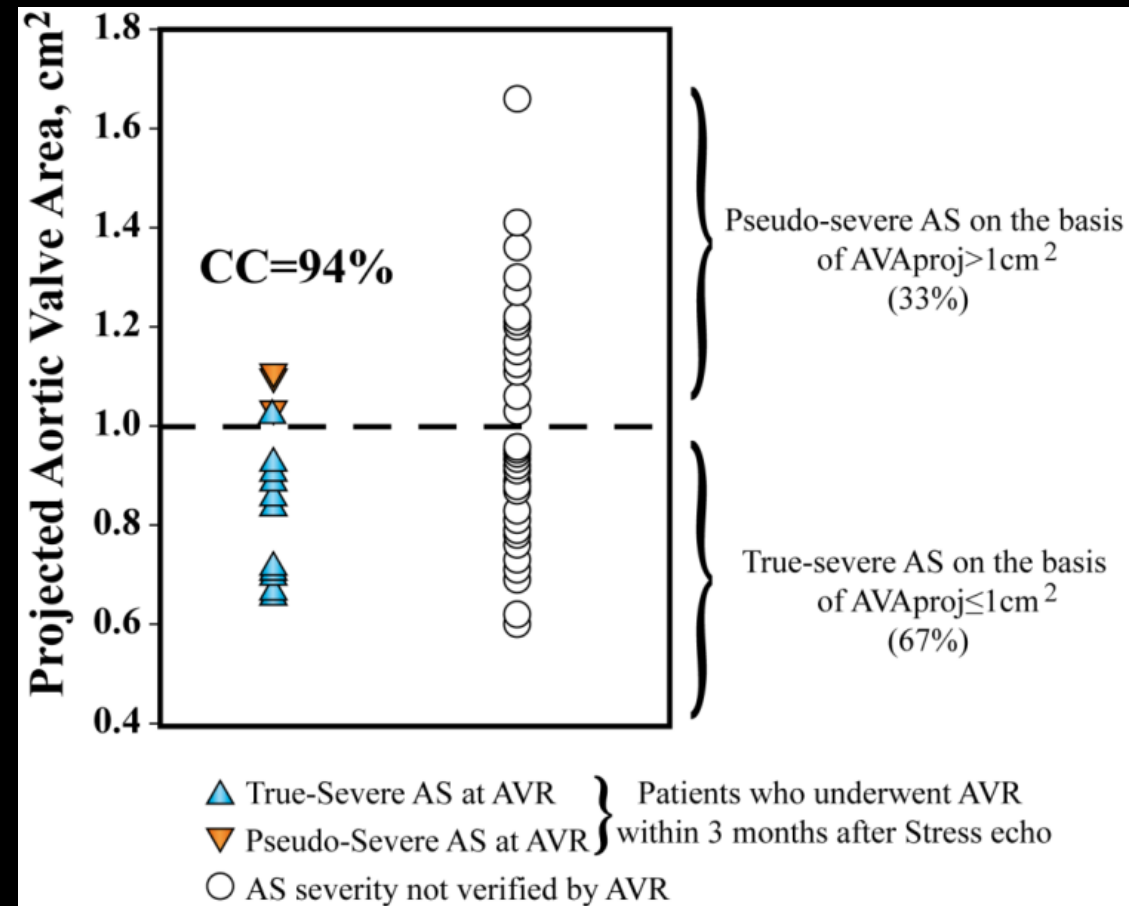
**DSE**

**15  $\mu\text{g/kg/min}$**



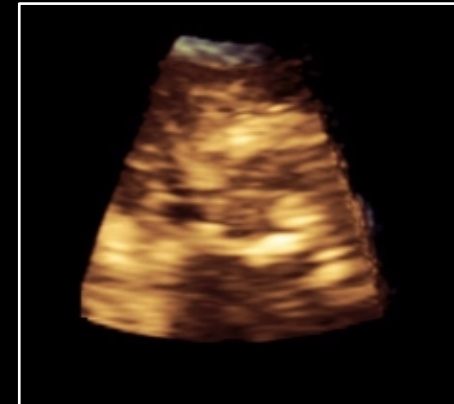
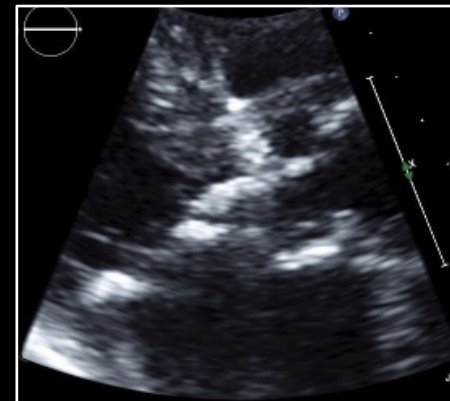
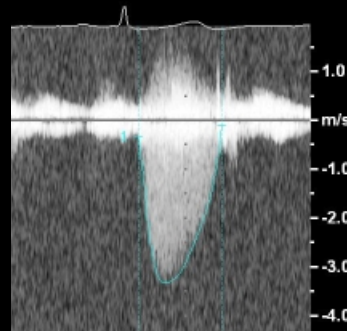
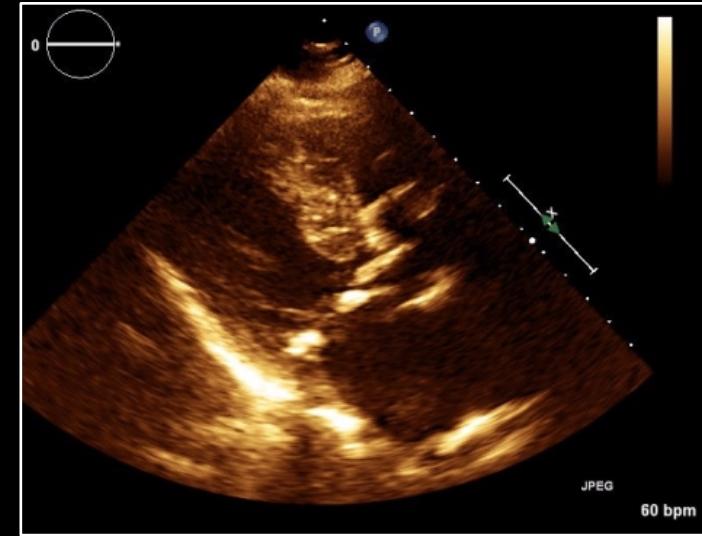
**Peak  $\Delta\text{P}$ : 51**  
**Mean  $\Delta\text{P}$ : 29**  
**AVA: 0.70**  
**LVEF: 60**

**94 mmHg**  
**57 mmHg**  
**0.75  $\text{cm}^2$**   
**65%**



# Case #4

- 82 y.o. woman
- Hypertension treated with ACEI
- No CAD
- NYHA III, hospitalization for HF
- LVEF: 65%
- Moderate-Severe Diastolic Dysf.
- AS severity on echo:
  - AVA:  $0.64 \text{ cm}^2$ ; indexed AVA:  $0.36 \text{ cm}^2/\text{m}^2$
  - Peak/mean gradient: **44/26 mmHg**





# *Usefulness of AoV Ca Scoring by MDCT to Differentiate True vs. Pseudo-Severe Stenosis in Low-Flow, Low-Gradient AS*

**Pseudo-Severe**



**AVC: 1034 AU**

**True-Severe**

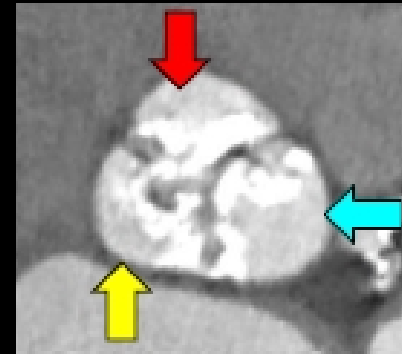
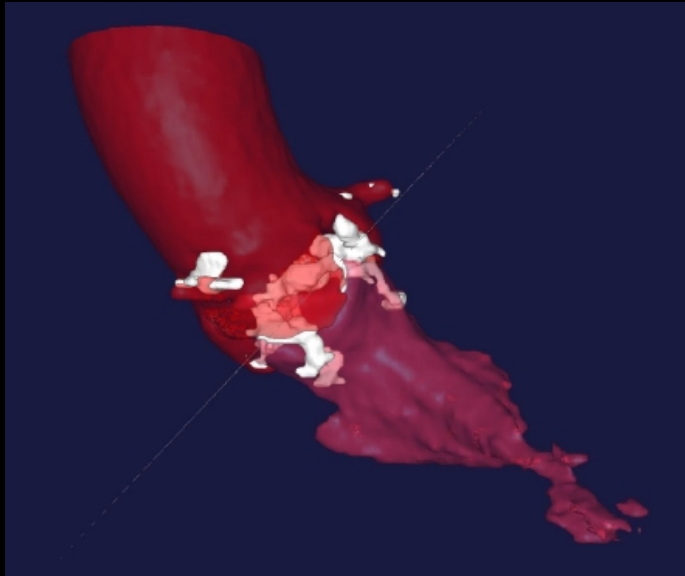


**AVC: 4682 AU**

*Clavel et al. JACC 2013: AVC Score to identify Severe AS: **>1200AU** in ♀  
**>2000 AU** in ♂*



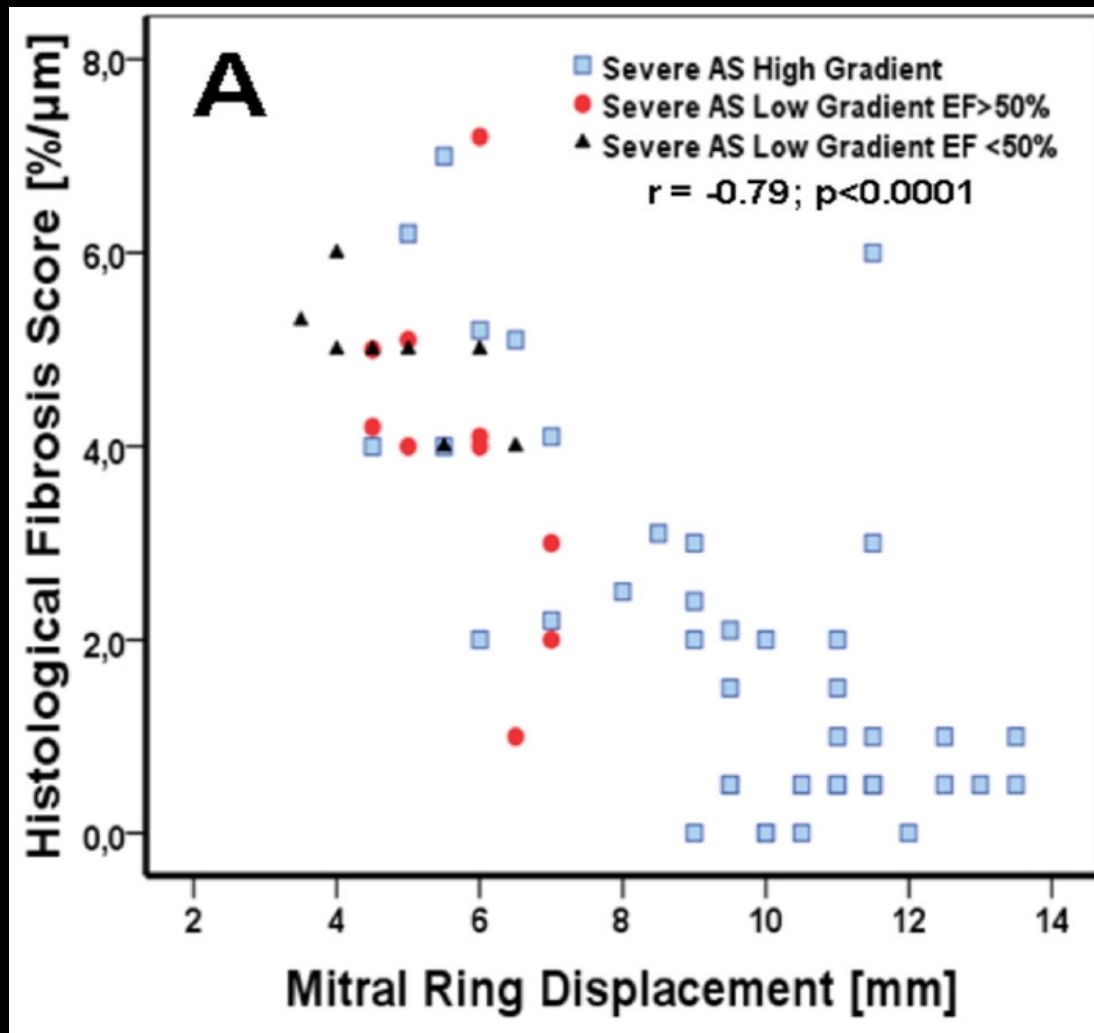
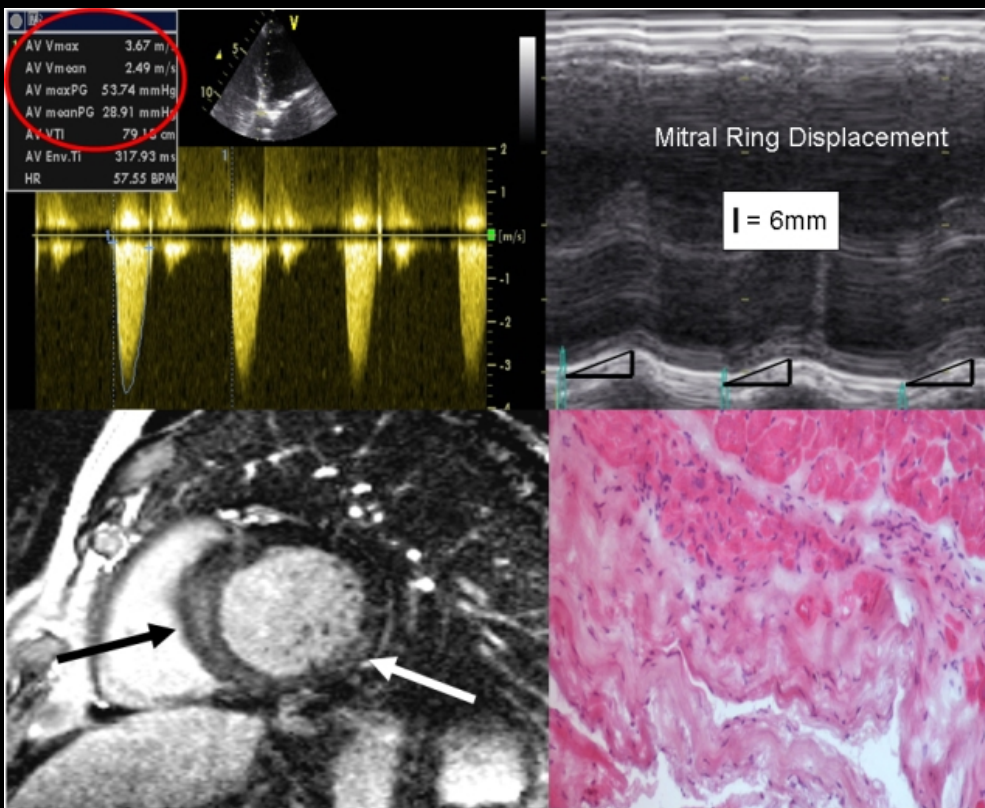
# *Case #4: Computed Tomography*



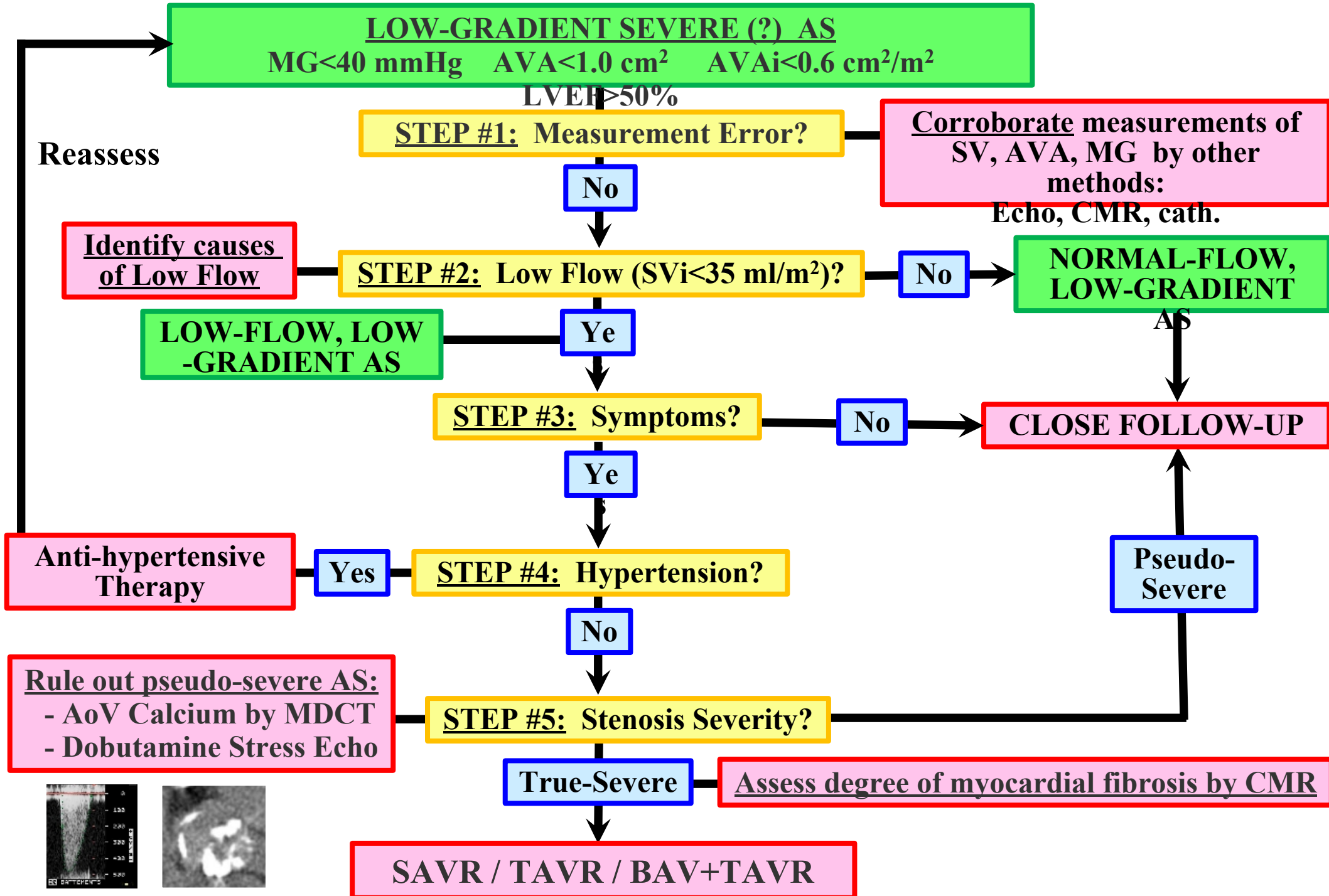
**AVC Score:  
3200 AU**

# *Patients with low-flow, low-gradient AS have more myocardial fibrosis*

## *Paradoxical Low-Flow, Low-Gradient Preserved LVEF*



*Hermann et al. JACC 2011;58;402-412*





# *Usefulness of NTP Stress-Catheterization to Differentiate True vs. Pseudo-Severe Stenosis in Paradoxical, Low-Flow, Low-Gradient AS*

