

Low flow aortic stenosis

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- Aortic stenosis is the 3rd most common CV disease after HTN and CAD (in western world)
- Prevalence is 2-7% over the age of 65 years
- Evaluation of aortic stenosis is the most challenging of all valvular heart diseases

Stewart BF, et al. J Am Coll Cardiol 1997; 29:630–634.

| Severity of Aortic Stenosis in Adults | | | |
|---------------------------------------|--------------------------------------------------|-----------------|------------------------------|
| | AVA (cm ²) | Mean TVG (mmHg) | Peak Aortic Velocity (m/sec) |
| Mild | >1.5 | <25 | <3 |
| Moderate | 1-1.5 | 25-40 | 3-4 |
| Severe | <1 or iAVA ≤ 0.6 cm ² /m ² | >40* | >4 |

Aortic Valve Area, AVA; Aortic Valve Area indexed for iAVA; Transvalvular Gradient, TVG; *ESC guideline accepts 50 mmHg as cut off to be severe.

$$\Delta PG = 4 \cdot V^2$$

GRADIENT = FLOW DEPENDENT VARIABLE

Small reduction in flow can cause great reductions in gradient

AVA=FLOW INDEPENDENT VARIABLE

AVA calculation is a standard and must be incorporated into a comprehensive evaluation of AS severity

The diagram illustrates the continuity equation for Aortic Valve Area (AVA) calculation. On the left, a cross-section of the heart shows the left ventricle (LV) and aortic valve (AV) with a Doppler probe. On the right, the continuity equation is shown: LVOT VTI (red) multiplied by LVOT CSA (red) equals AS VTI (blue) multiplied by AVA (blue).

| Aortic Stenosis | | | |
|-----------------------------------------------------|------------------|----------|------------------|
| Indicator | Mild | Moderate | Severe |
| Jet velocity (m/s) | Less than 3.0 | 3.0-4.0 | Greater than 4.0 |
| Mean gradient (mm Hg)* | Less than 25 | 25-40 | Greater than 40 |
| Valve area (cm ²) | Greater than 1.5 | 1.0-1.5 | Less than 1.0 |
| Valve area index (cm ² /m ²) | | | Less than 0.6 |

Does a mean PG > 40 mmHg **perfectly match** with a valve area < 1 cm²?

MISMATCH happens

Carabello demonstrated in 2427 patients, that
 “a mean gradient of 26 mmHg actually yields to an AVA of 1.0 cm², whereas a mean gradient >40 is corresponding with a AVA of 0.8 cm²”

N Engl J Med 2002;346:677-82

2. INACCURACY IN CALCULATION OF LVOT DIAMETER
3. WHO SAID AVA < 1.0 CORRESPONDS TO GRADIENTS > 40
???
4. LOW FLOW STATE (DEFINED SVi < 35 ml/mt²)

Case Scenarios

Case 1

. 80 yr old Male
HTN, HCV +ve
NYHA IV
Bilateral pleural effusion

- AV GRADIENTS=43/28
- LVEF= 30 %
- iAVA= 0.5 cm²


Case 2

- 75 old male
- s/p CABG
- Chest pain on mild exertion, NYHA III
- Coroanry angiogram: well functioning grafts
- AV GRADIENTS=45/30
- LVEF= 52 %
- iAVA= 0.5 cm²

LOW FLOW STATE

- LOW EF → low flow low gradient severe AS
- PRESERVED EF → paradoxical low flow low gradient severe AS

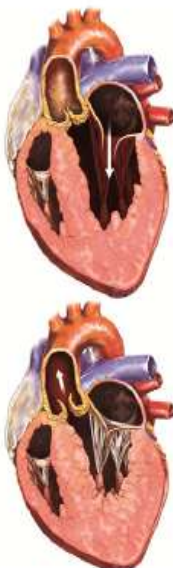
**LOW-LVEF
"CLASSICAL"
LOW-FLOW,
LOW-GRADIENT AS**



Pathophysiology

- Myocardial fibrosis
- Restrictive physiology
- Small LV cavity
- Impaired LV function yet normal EF (around 50-60%)
- Resembles heart failure with preserved EF (Diastolic Heart failure)

**NORMAL-LVEF
"PARADOXICAL"
LOW-FLOW,
LOW-GRADIENT**



Prevalence of low flow state

- **LOW EF**
5- 10 % of all patients of AVA < 1.0
- **PRESERVED EF**
10-25 % of all patients of AVA < 1.0

"IF WE DON'T CALCULATE AVA, WE WILL MISS 15-35 % OF CASES OF CRITICAL AS, MORE IMPORTANTLY WE WILL DEPRIVE THESE PATIENTS OF THE POTENTIAL BENEFIT OF AVR ON THEIR SYMPTOMS/SURVIVAL"

Pibarot P, et al. J Am Coll Cardiol 2012;60:1845–53

Diagnosis

- Proper diagnosis is hence important so as not to **MISS** these not uncommon patients

PATHOPHYSIOLOGY

- **LOW FLOW** secondary to **LOW EF**
- **LOW EF** is due to myocardial dysfunction

Causes of myocardial dysfunction :

- secondary to **AS (true severe AS)**
- secondary to other causes (e.g: ischemia, HTN)
- primary myocardial disease, needs to be **evaluated" (pseudo-stenosis)**

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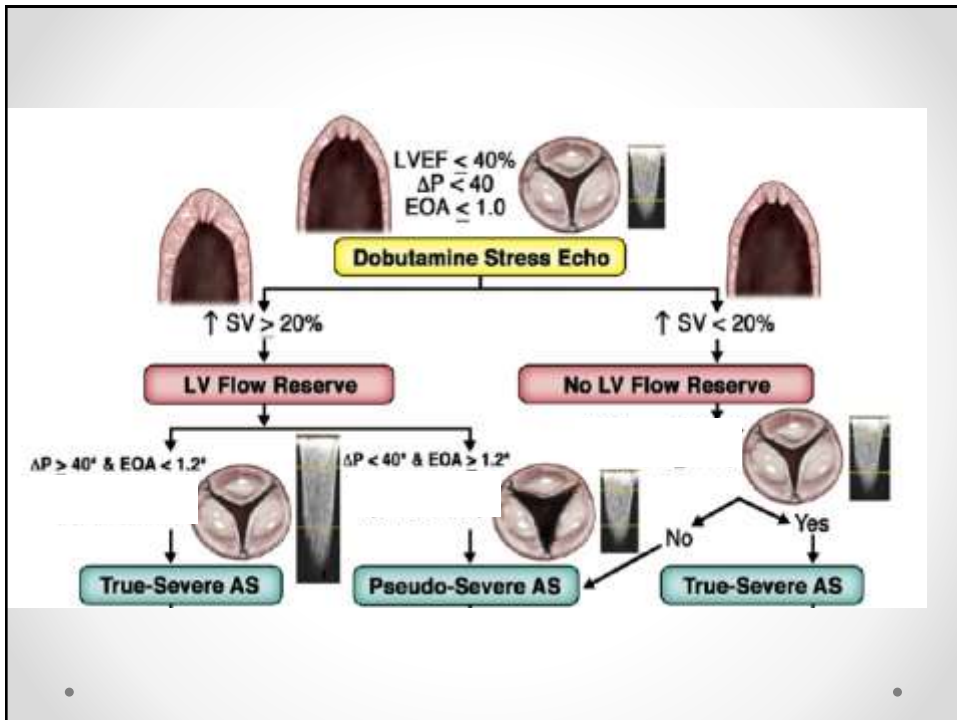


DIAGNOSIS- Low flow low EF AS

- FIRST SUSPICION → GRADIENT-AVA MISMATCH during routine echo
- GRADIENT < 40 mmhg, AVA <1.0, EF <40 %
- Dobutamine stress echo (exercise stress echo)
Class IIA recommendation

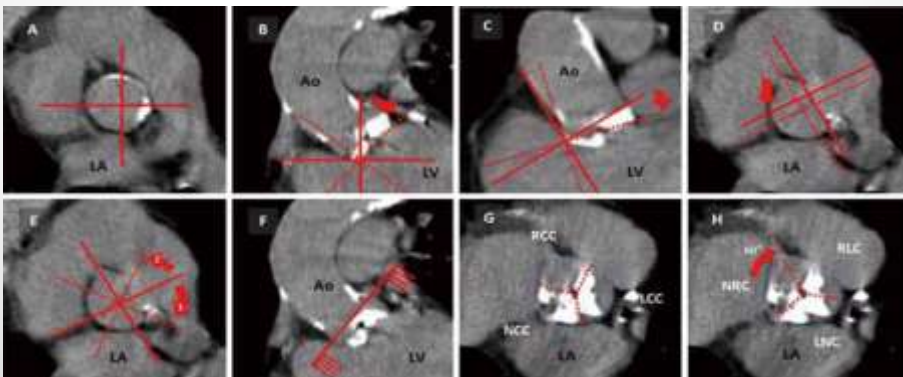
Dobutamine stress echo

- Low dose protocol upto 20 $\mu\text{g}/\text{kg}/\text{mt}$
- We look for three things:
 - Flow reserve
 - Change in EOA
 - Change in Gradient



MSCT AV CALCIUM SCORING

A score >1,650 Agatston units provides good accuracy (93 % sensitive, 75 % specific) to distinguish true severe from pseudosevere AS



Cueff et al. Heart 2011;97:721-6

DIAGNOSIS-Paradoxical LFLG severe AS

- LVEF is a late and insensitive marker for study of LV functions
- Not too far that LVEF will be replaced by other better markers of LV function

“Normal LVEF Does Not Mean normal Myocardial Function”

ALTERNATIVES TO ‘EF’

- Valvulo-Arterial Impedance (Zva) >5.5
- MPI (Tei Index) >0.42
- Mitral annular displacement (By TDI) < 12 mm
- Global LV Strain < 10%
- CT AV Calcium Scoring >1650 AU
- BNP levels >550 pg/ml

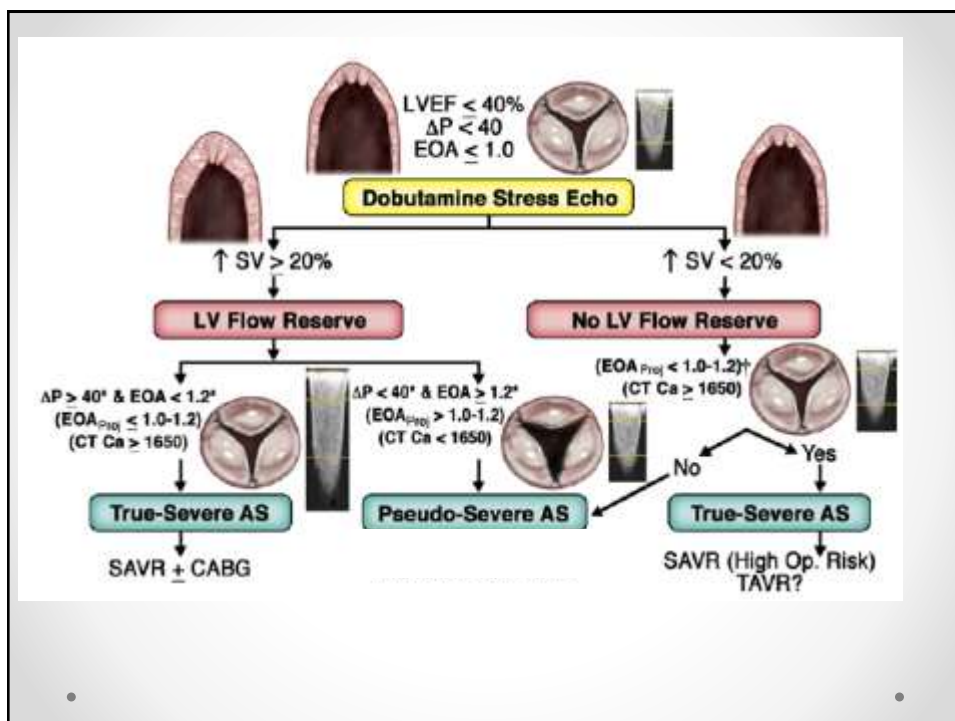
Treatment options- low flow low gradient AS

- SYMPTOM STATUS

- VALVULAR SEVERITY

“ANY SYMPTOMATIC SEVERE AS, IRRESPECTIVE OF EF AND FLOW RESERVE, HAS TO BE INTERVENED (class I)”

AVR for patients who have no symptoms and whose left ventricular ejection fraction is less than 50% (class I indication, level of evidence C)

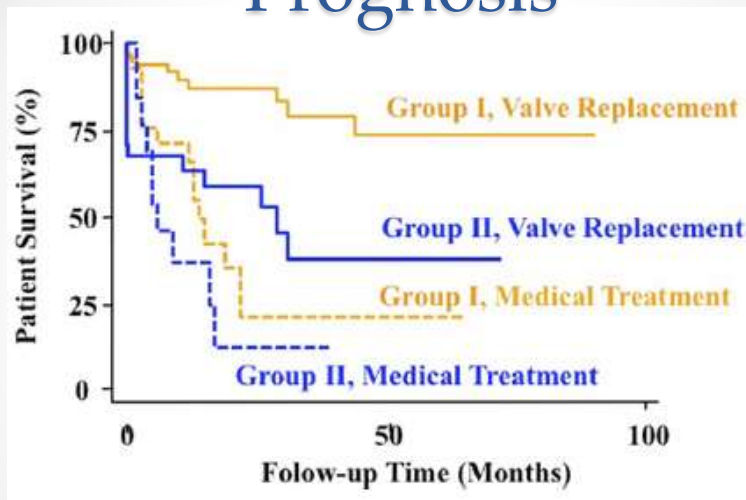


Role of TAVI

- Operative risk for open heart surgery is generally very high in absence of flow reserve
- Recent studies reported a greater and more rapid improvement of LVEF in patients treated by TAVI than those treated by surgical AVR *
- RATIONALE related to a lesser incidence of patient–prosthesis mismatch.
- In contrast, TAVR associated with a higher incidence of paravalvular regurgitation, stroke, vascular complications which may eventually have a negative impact on outcomes
- PARTNER A & B and STACCATO TRIALS

*Clavel et al. Circulation 2010;122:1928–36

Prognosis

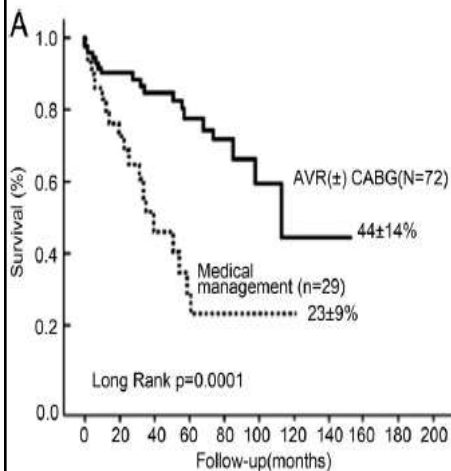


Group I= Flow reserve +

Group II= Flow reserve -

Connolly HM, et al. Circulation 2000; 101:1940–6

Treatment options-Paradoxical low flow low gradient AS



Tarantini G, Covolo E, Razzolini R, et al.
The Annals of Thoracic Surgery, Volume 91(6)

- 2012 ESC guidelines class IIa indication for AVR
- “This subgroup of patients seems to be at a more advanced stage and has a poorer prognosis if treated medically rather than surgically”
- It remains to be determined if TAVI could not be a better alternative in these patients

Take home messages

- ACCURATE AVA CALCULATION BY CONTINUITY EQUATION MUST BE A STANDARD IN EVALUATION OF AS BY ECHO
- ELSE WE ARE GOING TO MISS 30 % CASES OF SEVERE AS
- LOW FLOW AS COULD BE DUE TO BOTH NORMAL AND REDUCED EF

LOW-LVEF
"CLASSICAL"
LOW-FLOW,
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- Low Flow due to low EF
- DSE to differentiate True from Pseudo Severe AS
- CT AV Ca Score
- SAVR/TAVI irrespective of EF and Flow reserve

- Low Flow due to intrinsic myocardial dysfunction
- Better picked up by novel methods of LV function like MAD, Tei index, Strain apart from Zva, BNP levels
- AVR better than medical management

NORMAL-LVEF
"PARADOXICAL"
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A Simplified Statement

“Irrespective of AV Gradients and LVEF, symptomatic patients with iAVA $< 0.6 \text{ cm}^2$, and CT AV calcium score $> 1650 \text{ AU}$, should be referred for SAVR/TAVI”

And finally..

“**TAVI** may eventually prove to be an attractive alternative to surgical AVR in both types of LF-LG severe AS, but this remains to be confirmed by future randomized studies”



DAY 1 post TAVI 😊

Case Scenarios

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- HTN, HCV +ve
- NYHA IV
- Bilateral mitral regurgitation

- CoreValve 29
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Thanks for attention