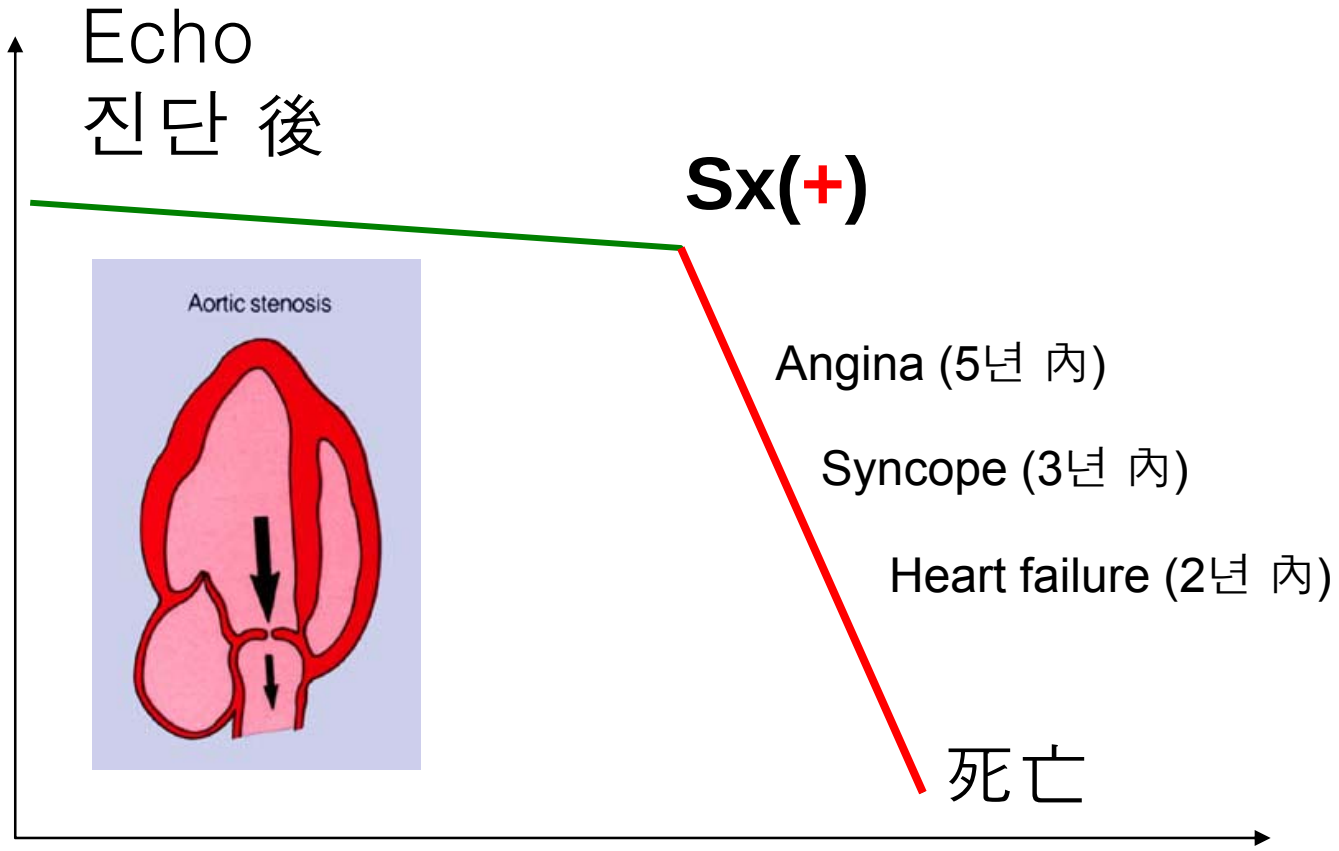
Echocardiographic Assessment of AS :

Is Traditional 2-D & Doppler Echocardiography Adequate?

동아의대

박태호

Aortic Stenosis



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II. Pitfalls

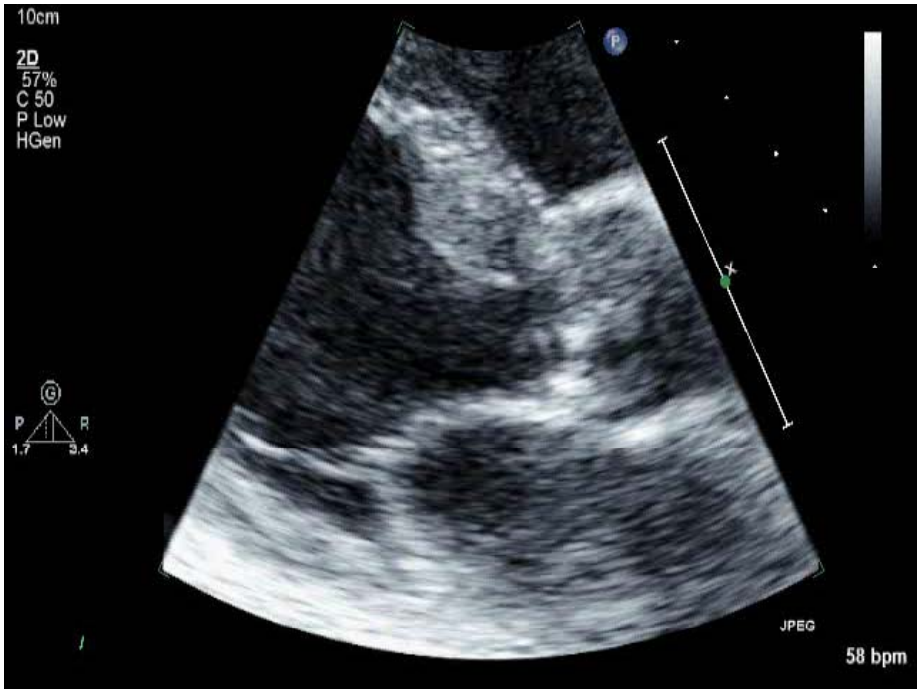
III. Other Measures

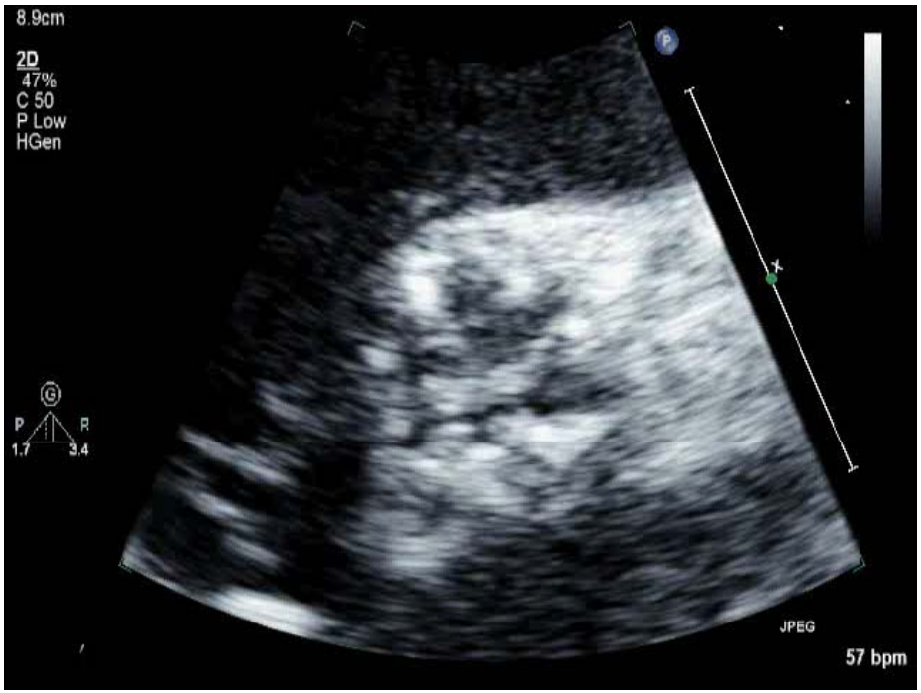
I. Standard Approach

- **Define the etiology**
  - **Calcific**
  - **Rheumatic**
  - **Bicuspid**
- **Quantify the stenosis**
- **Evaluate coexisting disease**

Define the Etiology

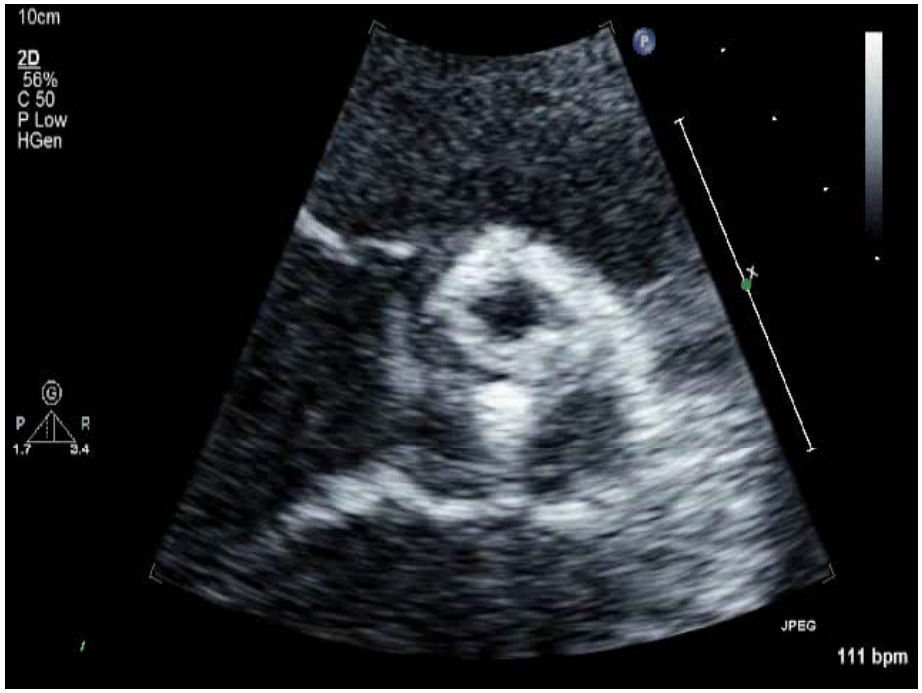
-Calcific-





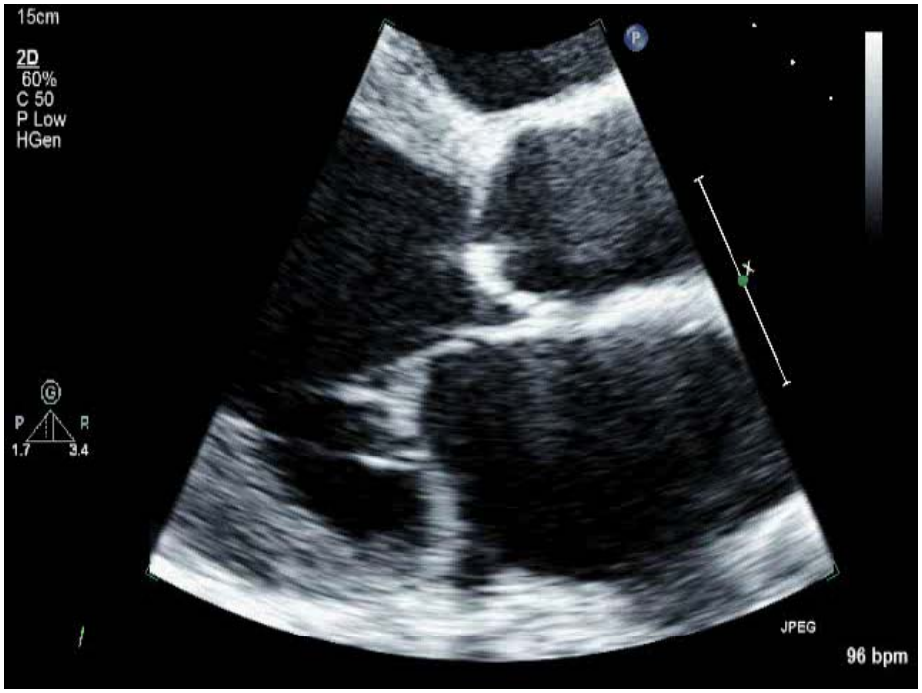
Define the Etiology

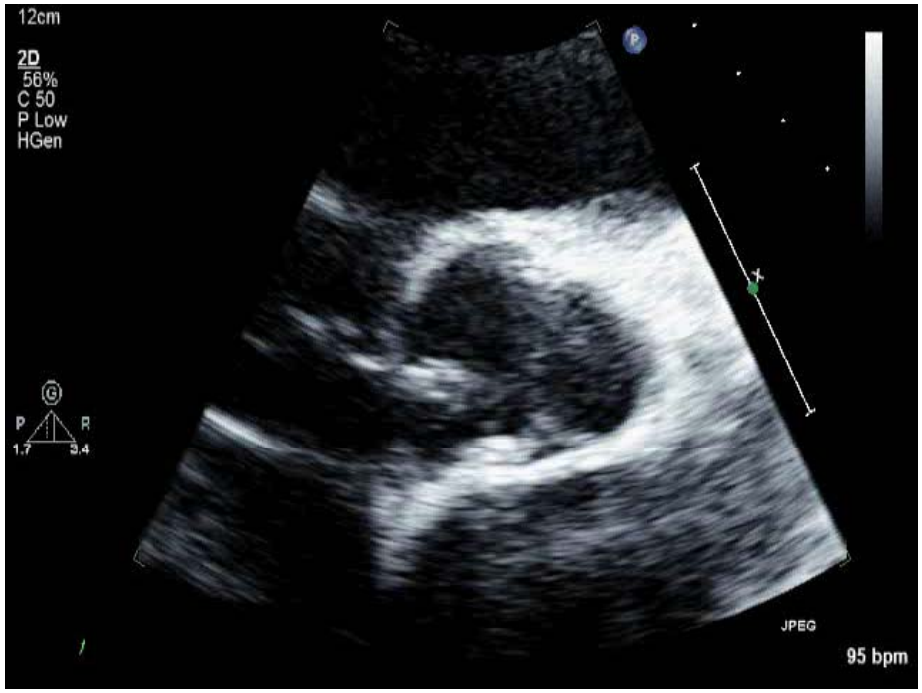
-Rheumatic-



Define the Etiology

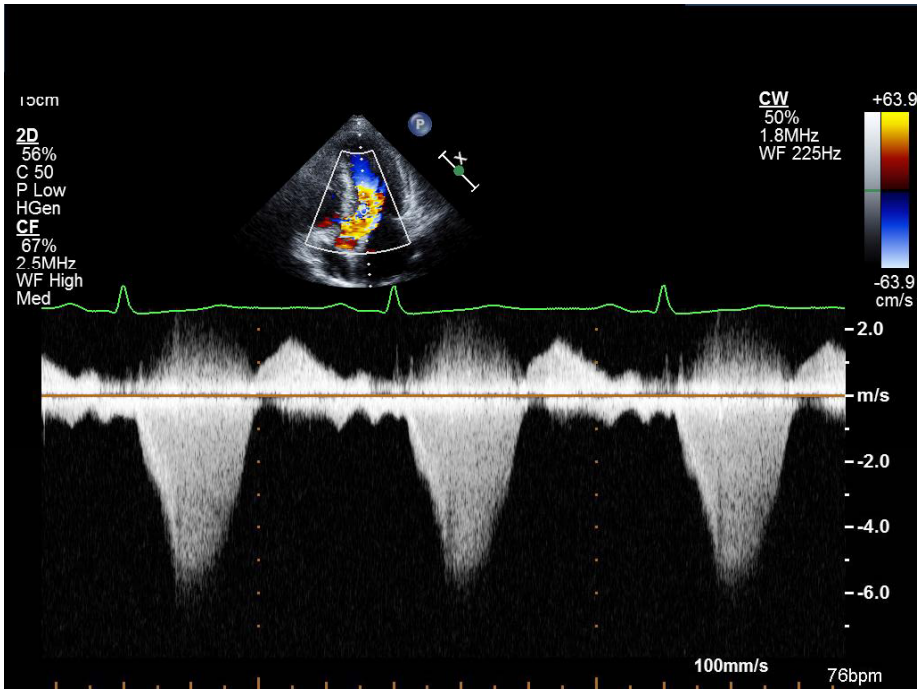
-Bicuspid-

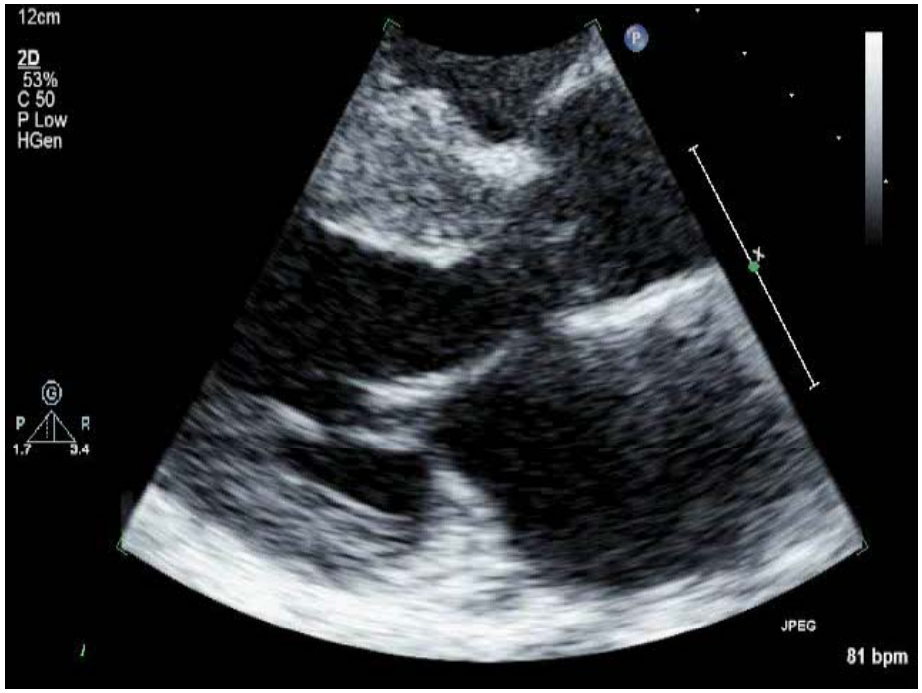




DDx from AS

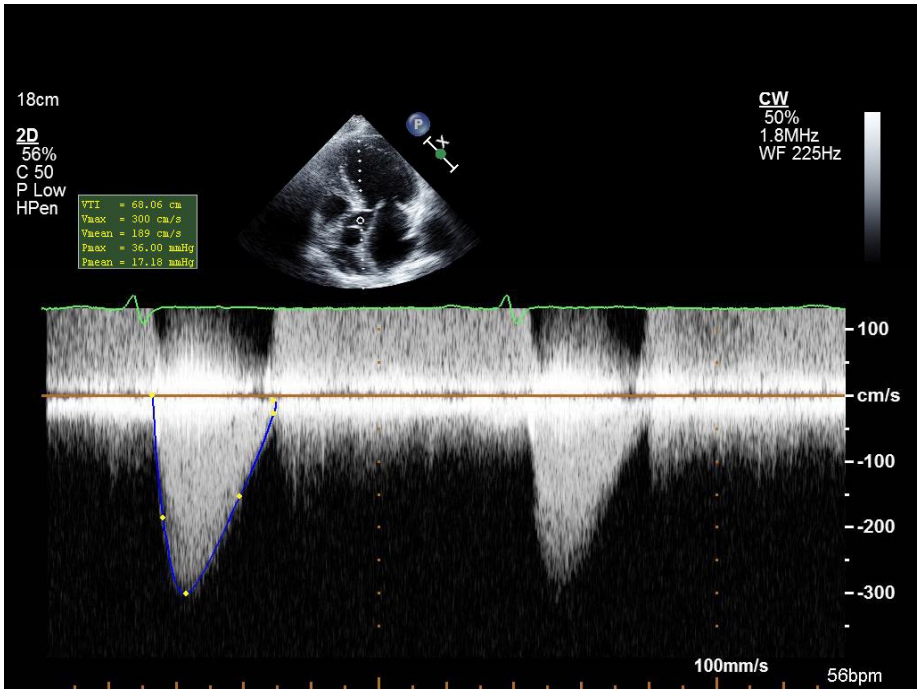
-HOCM-





DDx from AS

-Subvalvular stenosis-



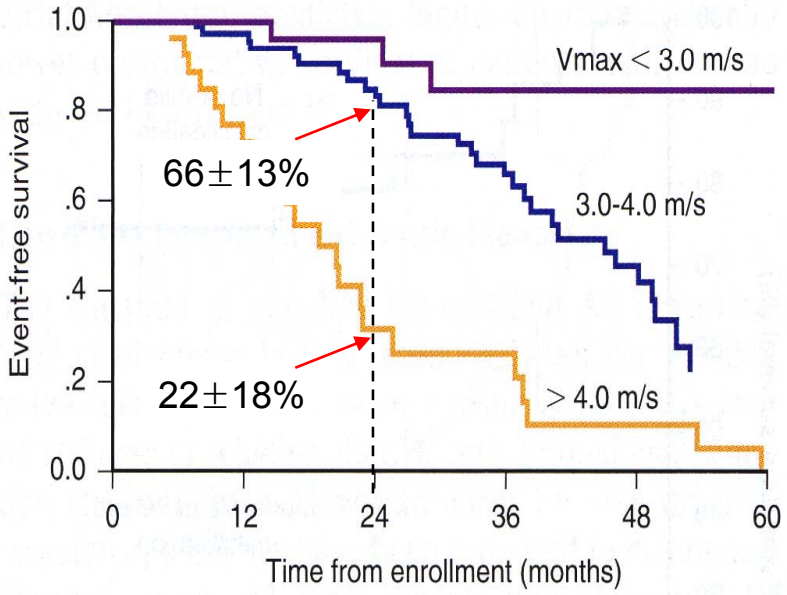
Peak V:3.0m/, Mean PG:17mmHg

Standard Approach

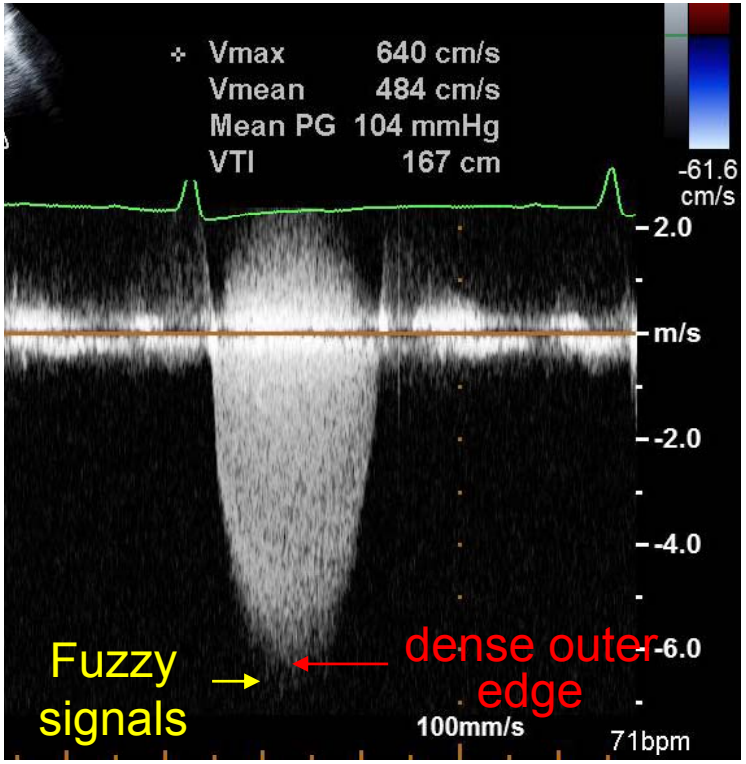
- Define the etiology
- **Quantify the stenosis**
  - **Jet velocity**
  - **PG**
  - **AVA**
- Evaluate coexisting disease

Quantification of AS

-Jet Velocity-



-Otto CM et al. ciruculation 1997-



Quantification of AS

-PG-

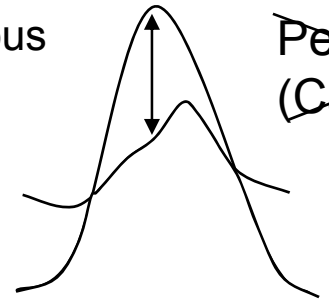
The peak PG

$\Delta P = 4V^2$

The mean PG

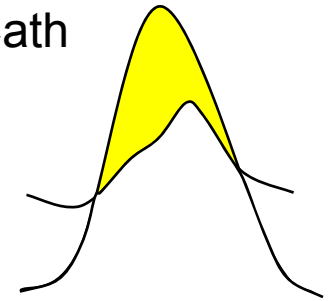
$\text{Mean } \Delta P = 2.4(Vmax)^3$

Instaneous peak Gr



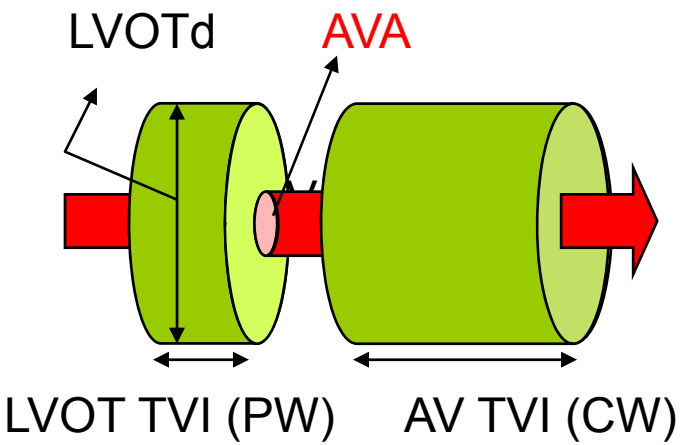
~~Peak to peak (Cath lab)~~

Mean Gr (Cath & Doppler)



Quantification of AS

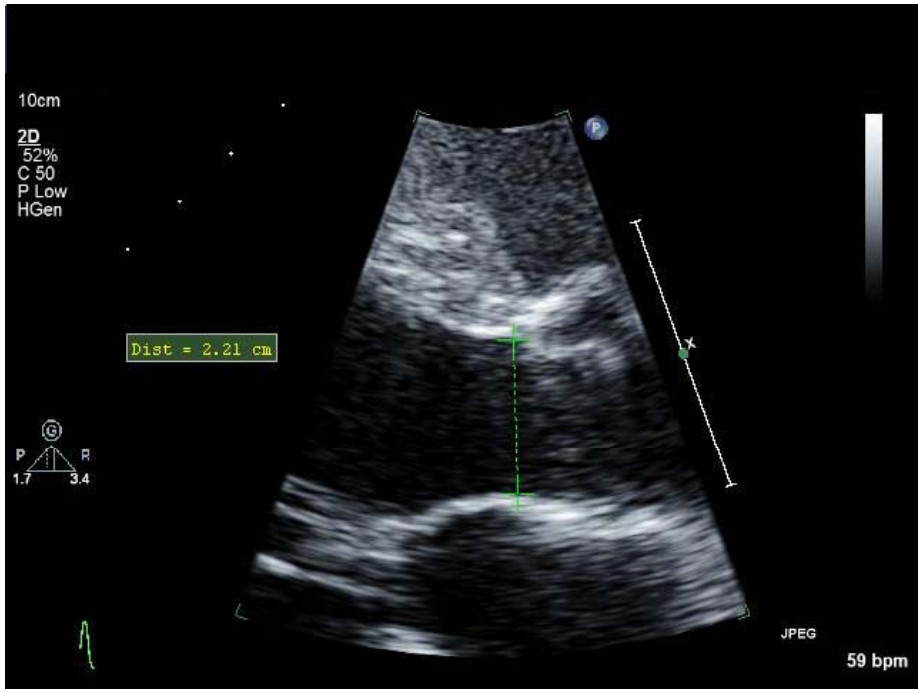
- AVA -



$$\frac{0.785 \times (\text{LVOT d})^2 \times \text{LVOT TVI}}{\text{AV TVI}}$$

Quantification of AS

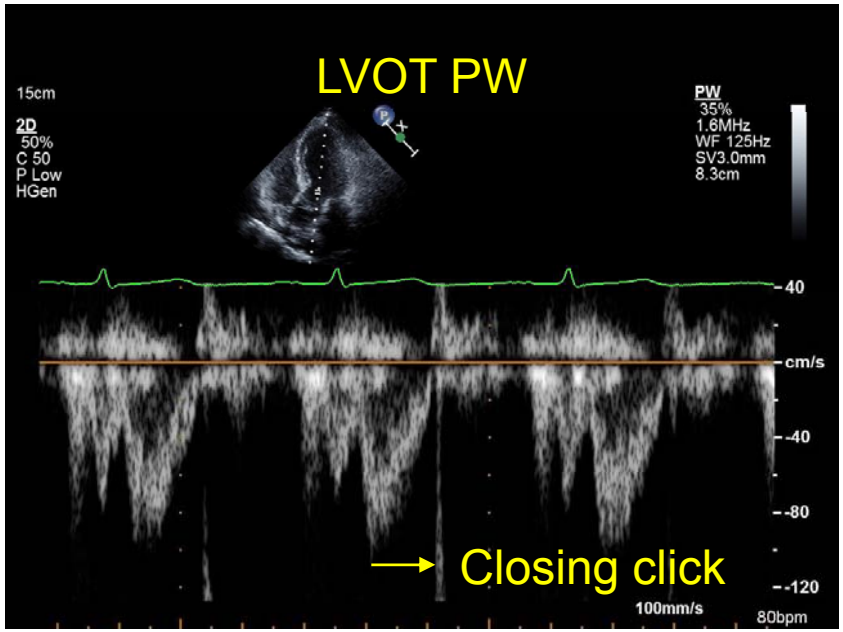
- LVOT d -

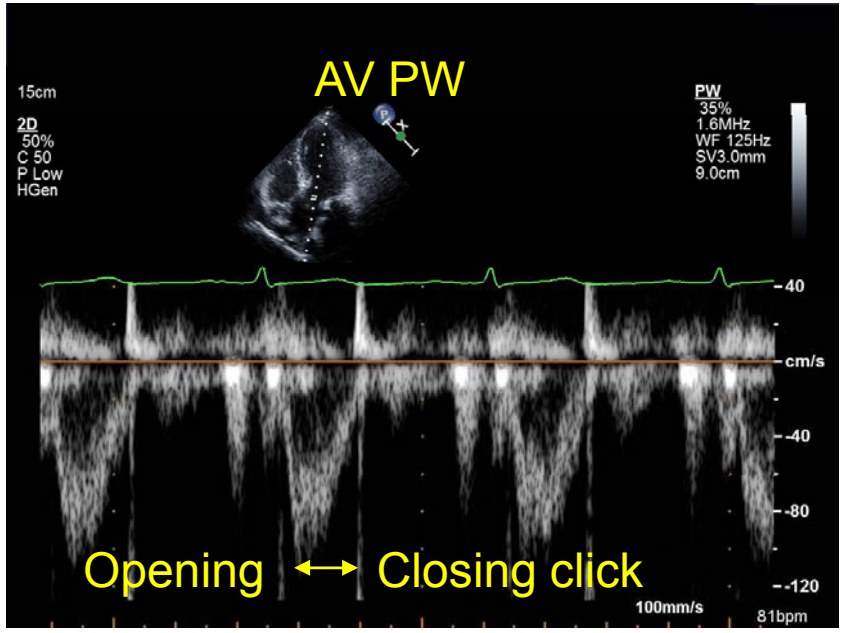


From inner edge to inner edge

Quantification of AS

- LVOT TVI -





Just apical from flow acceleration

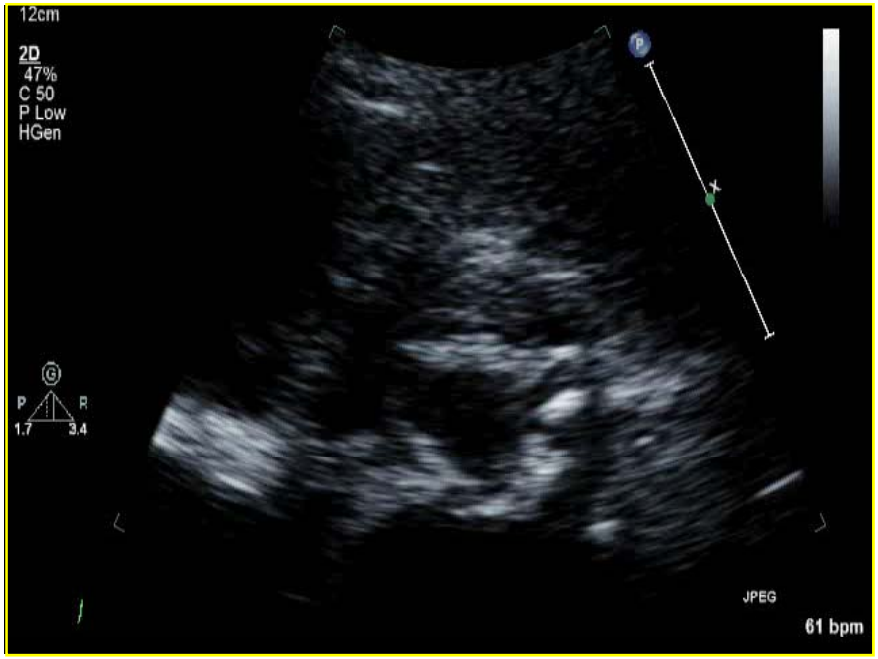
Quantification of AS

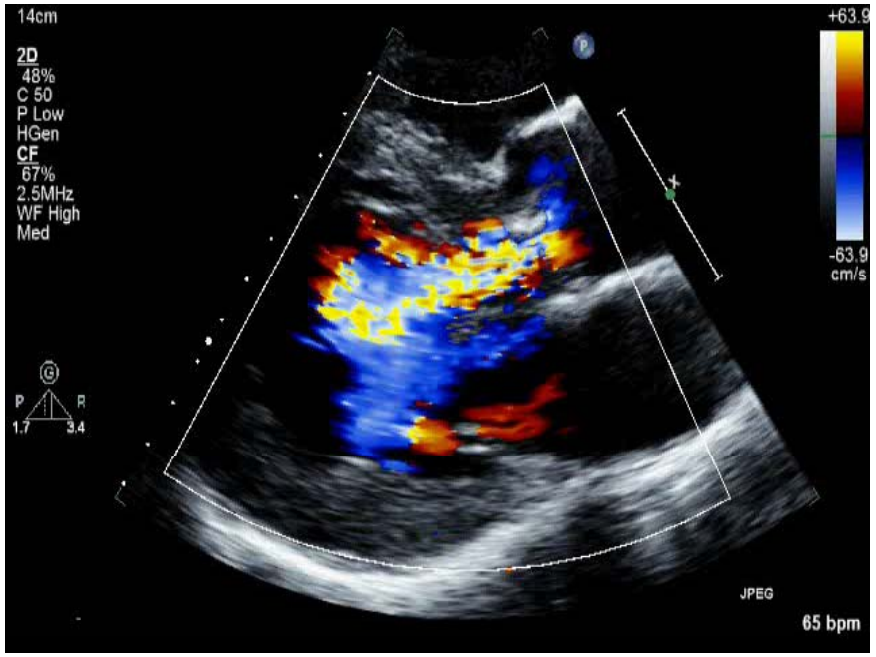
- Definition of severe AS -

- A specific AVA (or AVA index)
- 4 m/s, 0.8 -1 cm^2
- 1 cm^2, MG 40 (ACC/AHA), 50 mmHg(ESC)
- 0.75 cm^2, 50 mmHg (Echo Manual)

Evaluate coexisting conditions

- AR -



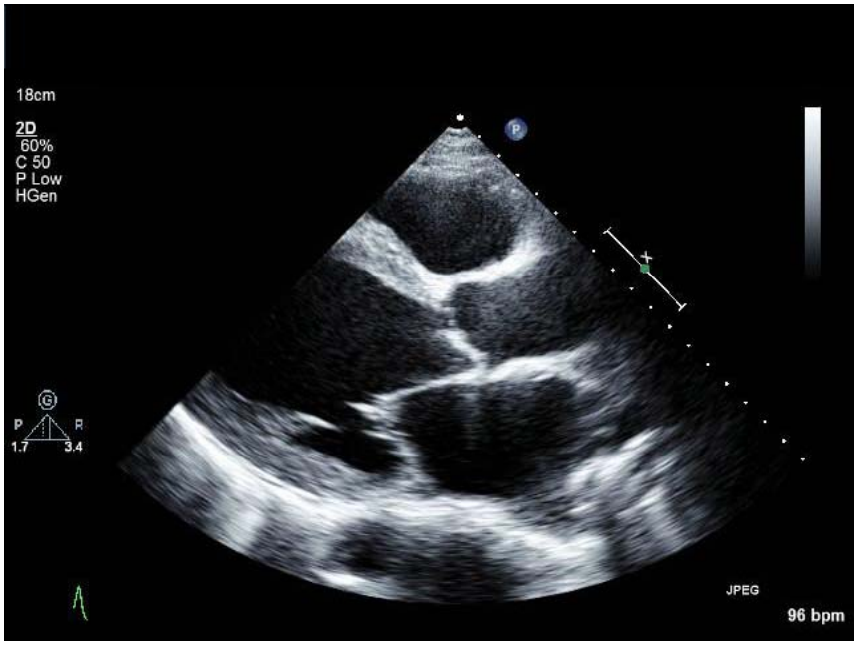


Significant AR → overestimate the AS severity

AVA (CE) =1.0 cm^2 ⟶ Peak V: 4.5 m/s, MG 50mmHg

Evaluate coexisting conditions

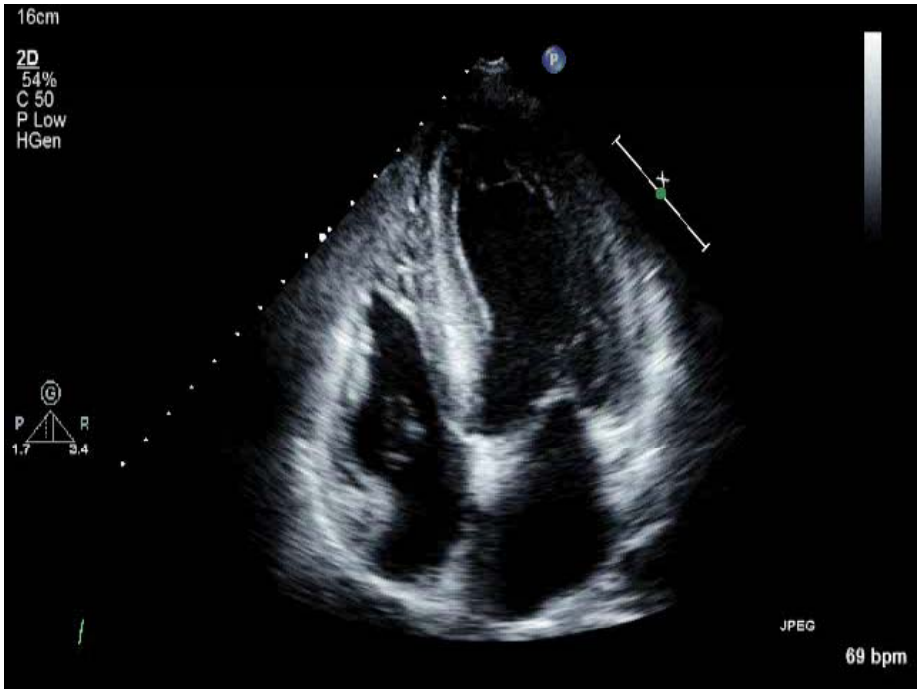
- Ascending aorta -

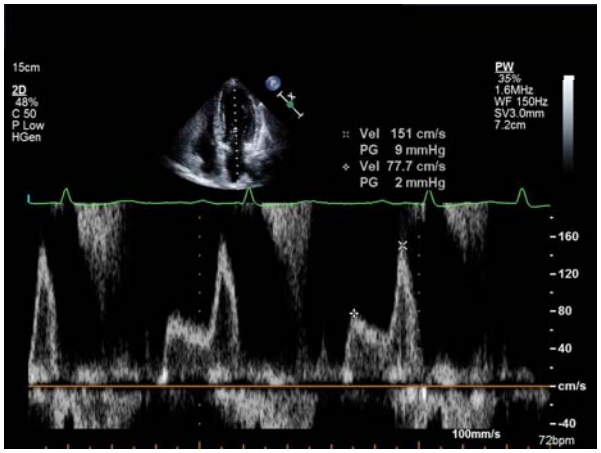


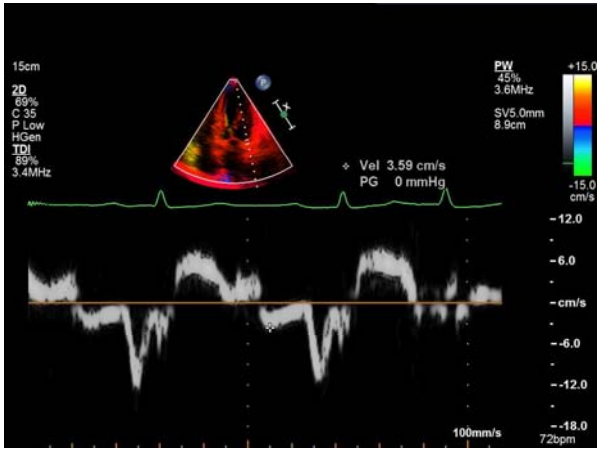
EOA → ELCo

Evaluate coexisting conditions

- LV size, function, and wall thickness -







Contents

I. Standard Approach

II. Pitfalls

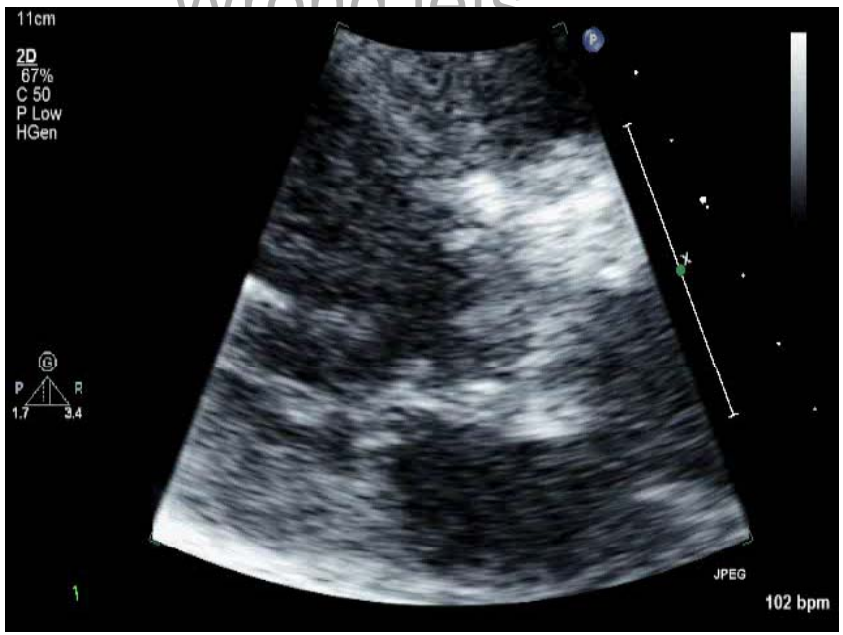
III. Other Measures

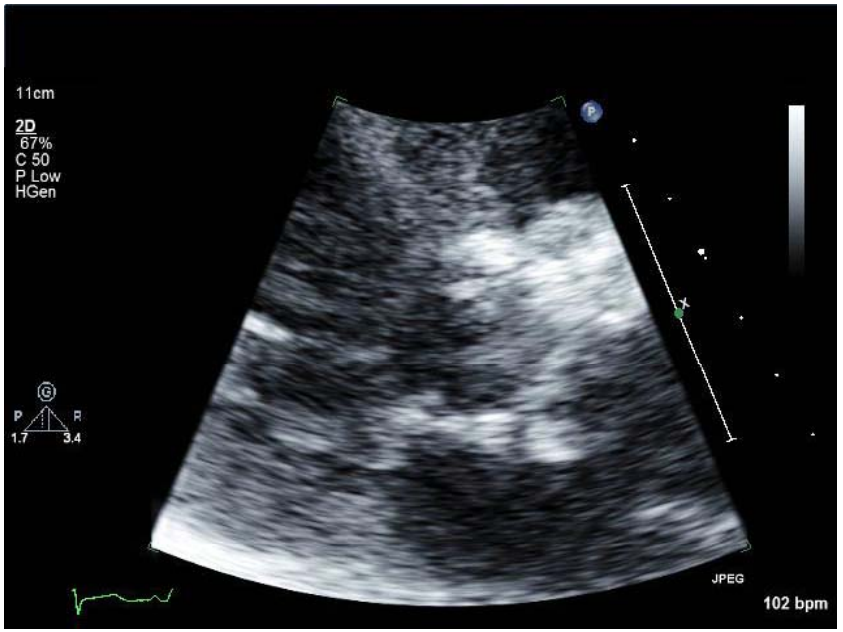
Pitfalls

- Technical
- Pressure recovery
- Flow dependence

Pitfalls

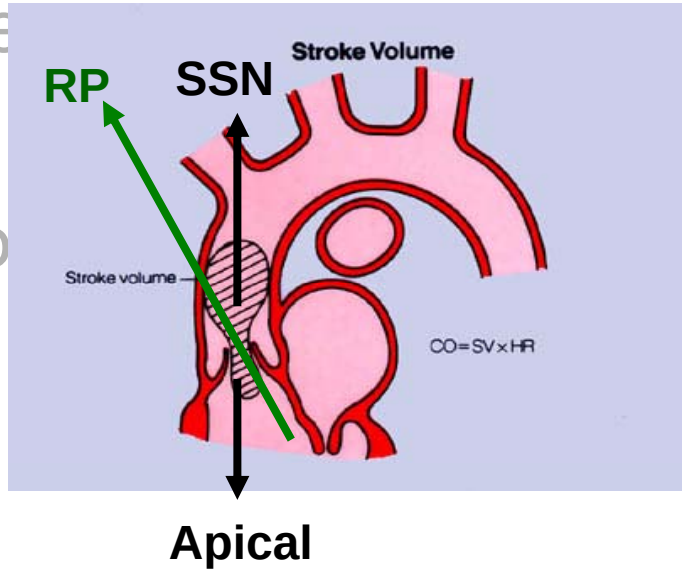
- Technical
  - ~~LVOTd measurement~~ → V_{LVOT}/V_{AV}
  - Poor angle → RVOT SV
  - Wrong jets

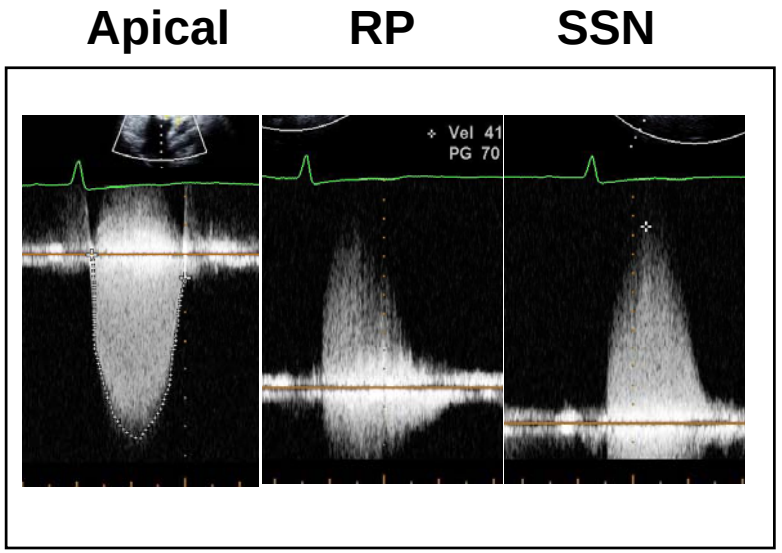




Pitfalls

- Technical
  - LVOTd measurement
  - ~~Poor angle~~ → Multiple windows
  - Wrong jets
- Pre
- Flo





Pitfalls

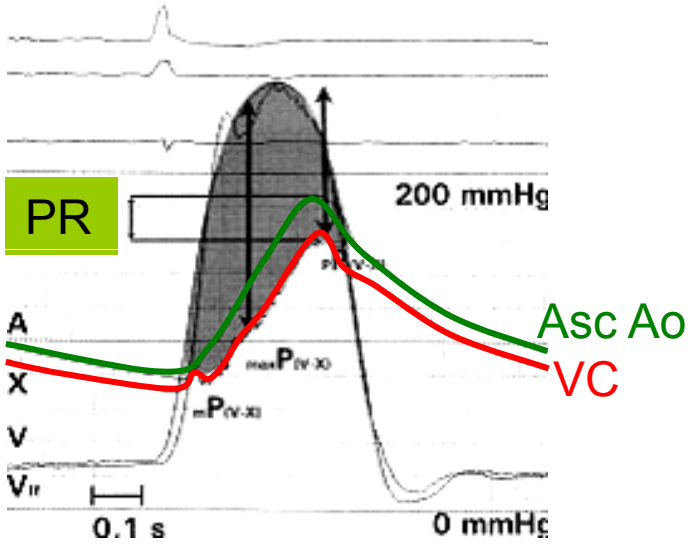
- Technical
  - LVOTd measurement
  - Poor angle
  - ~~Wrong jets~~ → MR, TR
- Pressure recovery
- Flow dependence

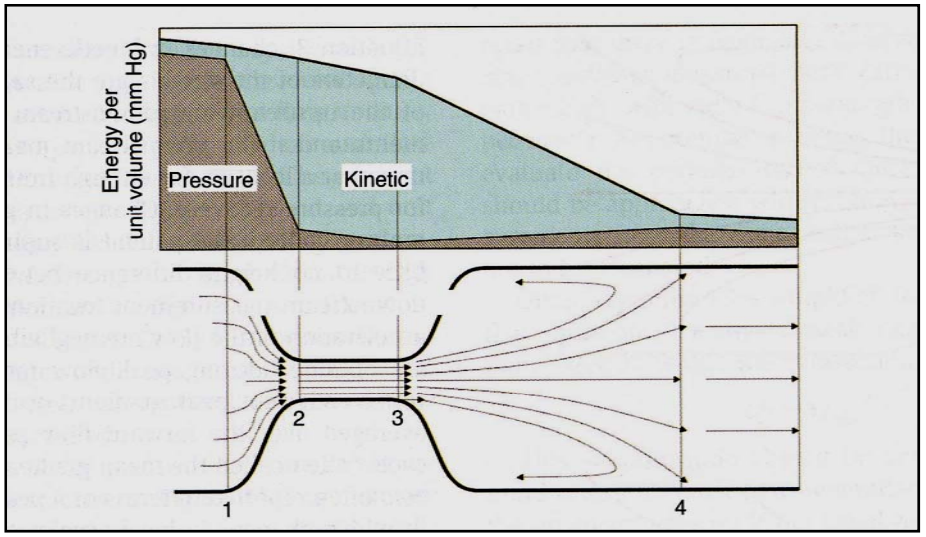
Pitfalls

- Technical
  - LVOTd measurement
  - Poor angle
  - Wrong jets
- Pressure recovery

- Flow dependence

Pressure recovery (PR)





Distal to VC, JET expands and decelerates

Contents

I. Standard Approach

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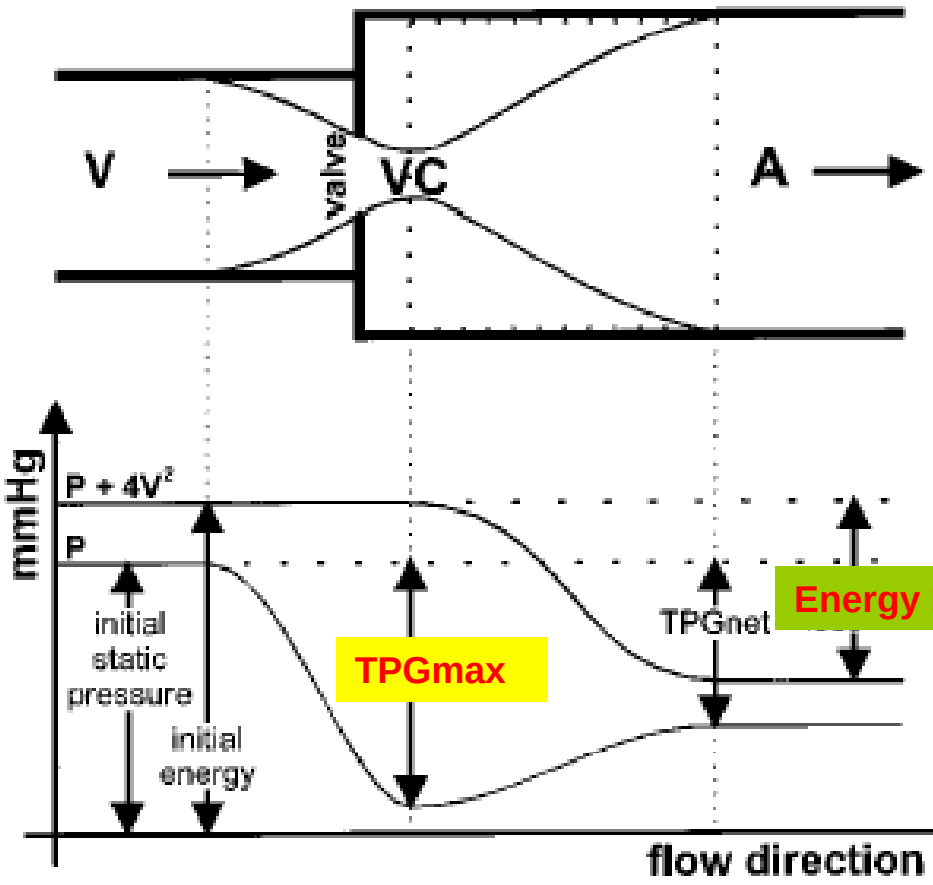
Other Measures of Severity

- **Energy loss (EL)**
- **Systemic areterial compliance (SAC)**
- **LV wall stress**
- **Planimetry**
- **3DE**

ELCo

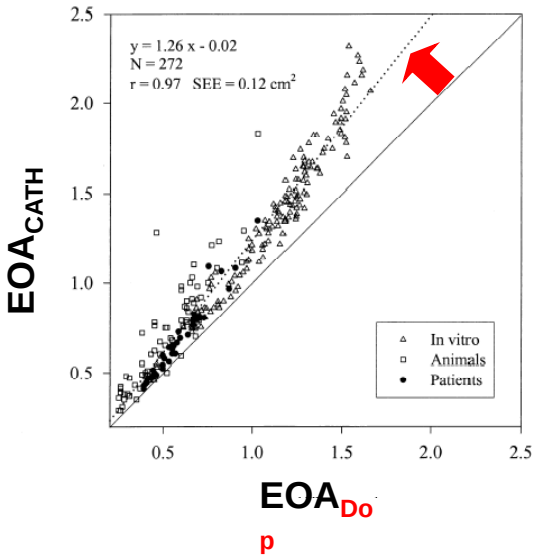


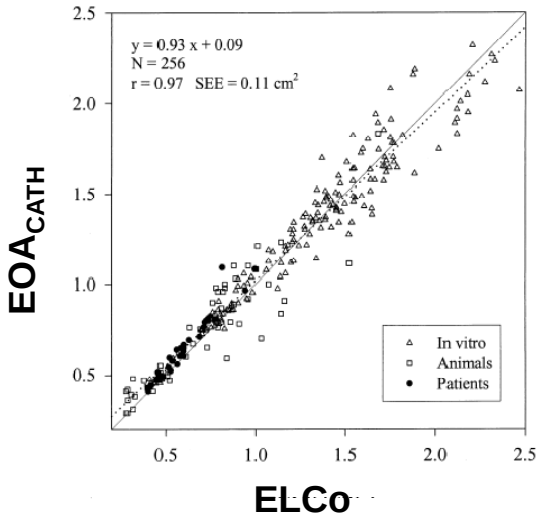
$$\text{Energy Loss} = \frac{\text{Doppler EOA} \times A_A}{A_A - \text{Doppler EOA}}$$

-Garcia D et al. Ciruculation 2000-

ELCo

- New (+A_A)
- Better (>$EOA_{Doppler}$)
- Equivalent (=EOA_{CATH})



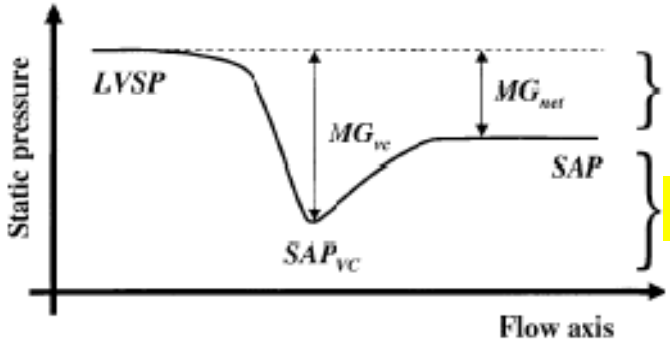


-Garcia D et al. JACC 2003-

Other Measures of severity

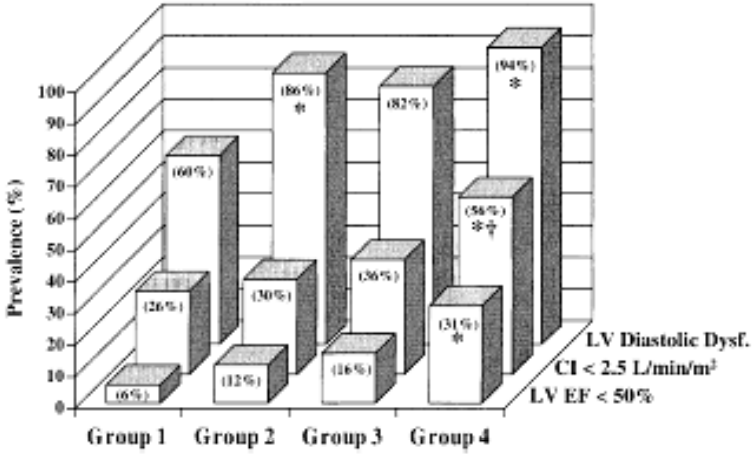
- Energy loss (EL)
- **Systemic arterial compliance (SAC)**
- LV wall stress
- Planimetry
- 3DE

Systemic Arterial Compliance (SAC)



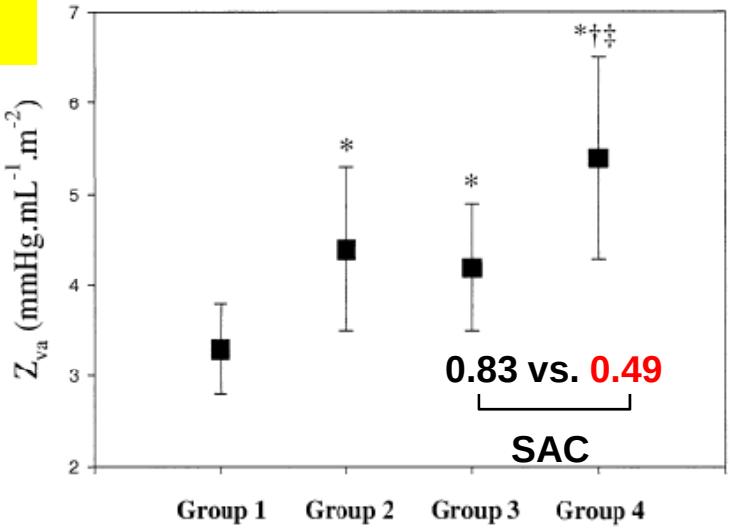
Valvular load

Arterial load



Zva = (ΔPnet+SAP)/SVi

The strongest predictor of LV dysfunction



-JACC 2005-

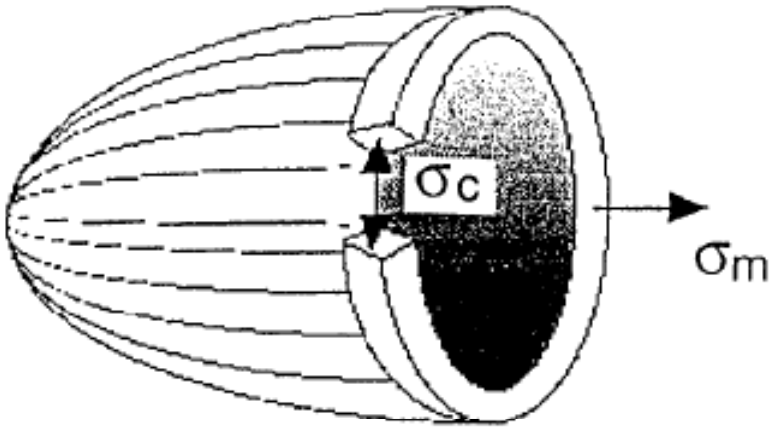
Other Measures of severity

- Energy loss (EL)
- Systemic arterial compliance (SAC)
- **LV wall stress**
- Planimetry
- 3DE

LV wall stress

- ESS(meridional)(σ_m): P•LVID/[4 •Th(1+LVID/Th)]

- ESS(circumferential)(σ_c): (1.35P x r/Th)(1-{$2r^2/L^2$})

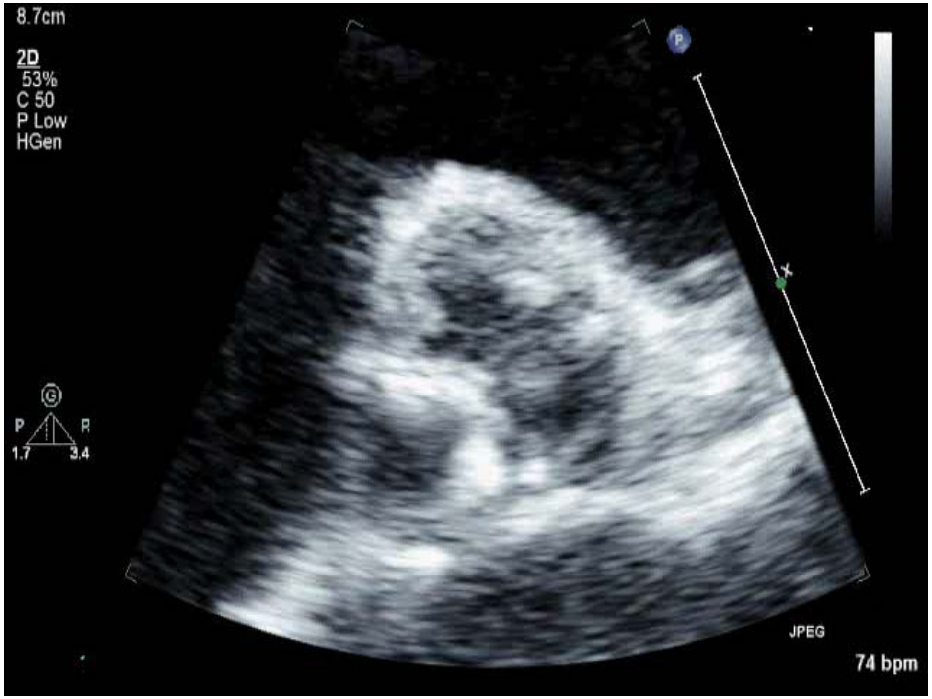


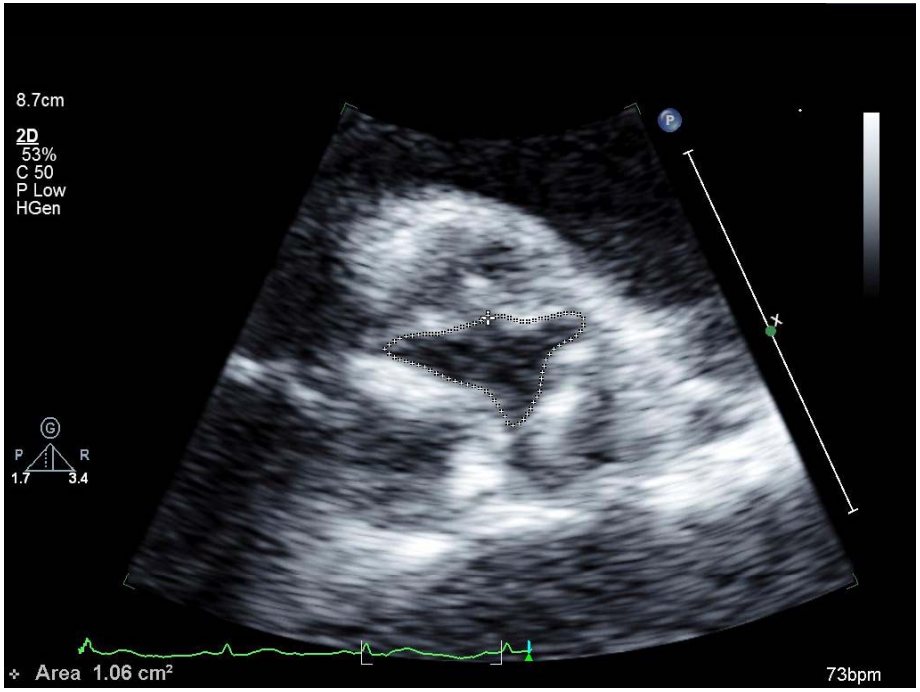
Other Measures of severity

- Energy loss (EL)
- Systemic arterial compliance (SAC)
- LV wall stress
- **Planimetry (2D)**
- 3DE

Planimetry (2D)

- The opening surface of a stenotic AV represents a complex 3D structure that cannot be reliably assessed with a planar 2D image.





Planimetry (2D)

Planimetry of aortic valve area using multiplane transoesophageal echocardiography is not a reliable method for assessing severity of aortic stenosis.

Table 1 Values of aortic valve area determined by the different methods

Variable	*No of patients*	*Mean (SD) (cm²)*	*Range (cm²)*
TOE planimetry	37	0·88 (0·35)	0·30 to 1·66
Continuity equation	37	0·70 (0·26)	0·33 to 1·52
CE TOE	22	0·70 (0·24)	0·38 to 1·37
Catheterisation	37	0·79 (0·24)	0·43 to 1·48

Heart 1997;78:68-73

0.88

0.70

0.70

0.79

Sensitivity 45%, specificity 60% for severe AS(AVA<0.75cm^2)

- The approach is only needed in a small subset of patients, mostly when TTE imaging quality is poor.

Other Measures of severity

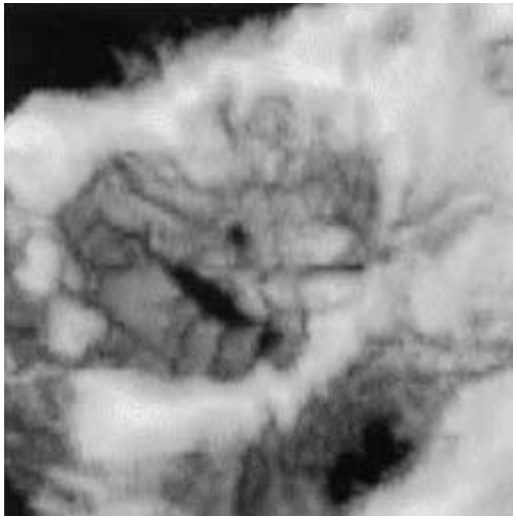
- Energy loss (EL)
- Systemic arterial compliance (SAC)
- LV wall stress
- Planimetry
- **3DE**

3DE

2D

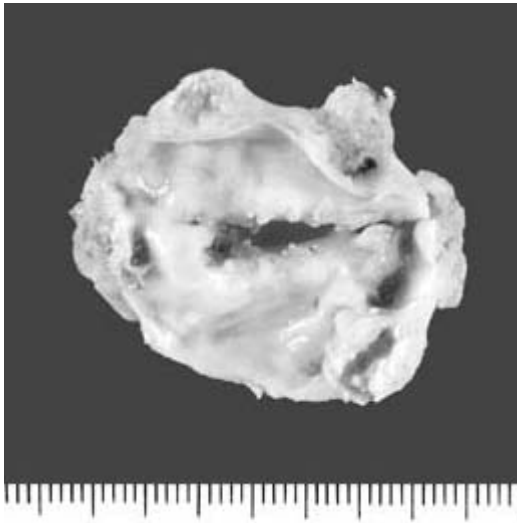
CSA 1.4 cm^2

3D



CSA 0.9 cm^2

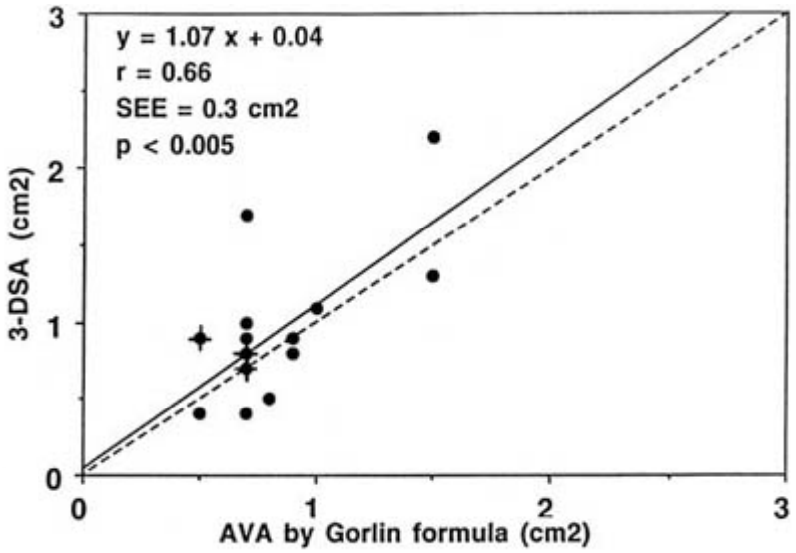
Excised valve

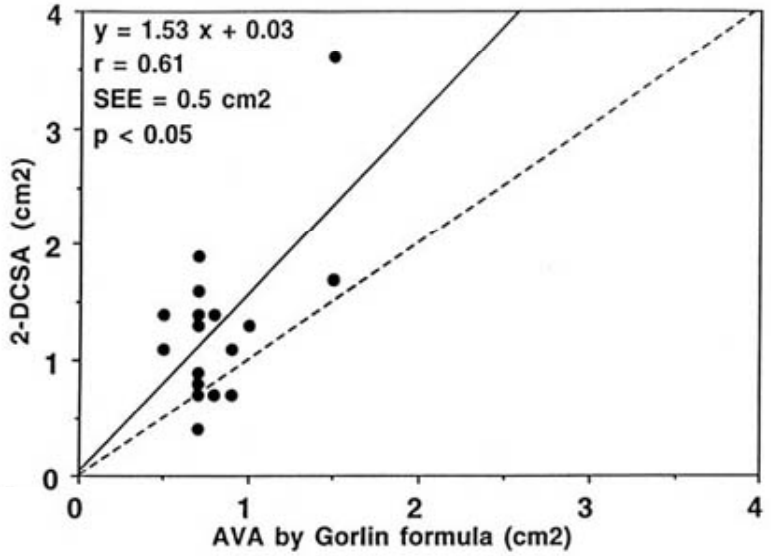


AVA (CE) 0.8 cm^2

Am Heart J 1998;136:1042-50

3DE

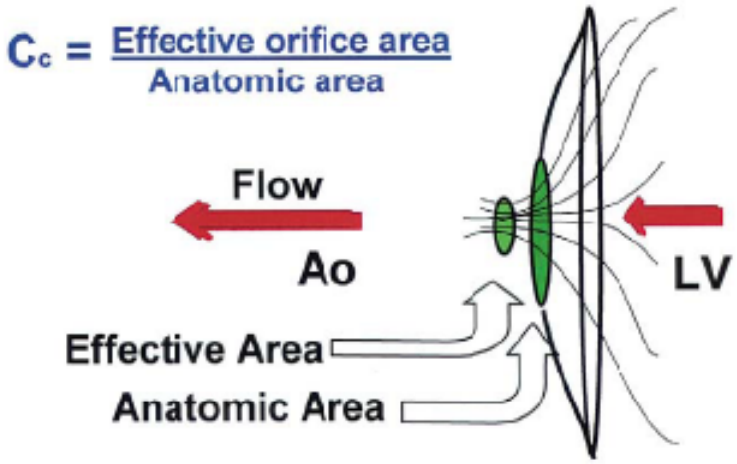




Am Heart J 1998;136:1042-50

3DE

- 3D geometry -



	Domed	Intermediate	Flattened
Anatomic area			
1.0 cm²	0.9	0.85	0.76
0.75 cm²	0.86	0.83	0.74
0.5 cm²	0.85	0.81	0.71

	Domed	Flattened
AVA	0.95±0.25cm²	0.96±0.24cm²
EOA	0.86±0.13cm²	0.69±0.17cm²

JACC 2002;40:1479-86

3DE

- Nevertheless, 3DE is not an accepted standard for the quantification of AS

Conclusion

Traditional 2D & Doppler (V, MG, AVA)

AS severity

New index (ELCo, CAP, ECC, 3DE,…)

LV dysfunction

Symptom onset

Optimal AVR timing

경청해 주셔서 감사합니다!!