Aortic Stenosis

Bicuspid Aortic Valve
Dilated Aortic Root

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03/10/2005

DISCLOSURE

Relevant Financial Relationship(s)

None

Off Label Usage

None

Pre Questions (1)

- The Difference between Doppler MIG and catheterization PPG
  A. Is due to pressure recovery
  B. Is due to different measurement timing of the LV and aortic pressures
  C. Occurs only in patients with small aortas
  D. Is used to calculate aortic valve area

Pre Questions (2)

- The Difference between Doppler MIG and catheterization PPG
  A. Is due to pressure recovery
  B. Is due to difference in the timing of the aortic pressure measurement between cath and echo
  C. Is due to difference in the timing of the LV pressure measurement between cath and echo
  D. Is related to the severity of aortic stenosis

Pre Questions (3)

- Catheter-Doppler Discordance maybe due to
  A. Pressure recovery
  B. Eccentric jet
  C. Very severe aortic stenosis
  D. HOCM

Pre Questions (4)

- The most common form of bicuspid aortic valve is
  - A. Fusion of the LCC/RCC
  - B. Fusion of the LCC/NCC
  - C. Fusion of the RCC/NCC
  - D. Equal distribution of cusp fusion

Severity of Aortic Stenosis

Severe Aortic Stenosis

Area Gradient Match

	Mean Gradient (mmHg)	Valve Area (cm^2)	Valve Velocity (m/sec)
Mild	<25	>1.5	2-2.9
Moderate	25- 40	1.0-1.5	3-3.9
Severe	>40	<1.0	> 4.0

iAVA < 0.6 cm/m^2

Nishimura, et al. Circulation, 2014
Bonow RO, et al. Circulation, 2008

Severe Aortic Stenosis
Severity of Aortic Stenosis
Area Gradient Mismatch

	Mean Gradient (mmHg)	Valve Area (cm^2)	Valve Velocity (m/sec)
Mild	<20	>1.5	2 - 2.9
Moderate	20- 39	1.0-1.5	3 - 3.9
Severe	>40	<1.0	> 4.0

iAVA < 0.6 cm/m^2

Nishimura, et al. Circulation, 2014
Bonow RO, et al. Circulation, 2008

Severe Aortic Stenosis
Severity of Aortic Stenosis
Reverse Area Gradient Mismatch

	Mean Gradient (mmHg)	Valve Area (cm^2)	Valve Velocity (cm/sec)
Mild	<20	>1.5	2 – 2.9
Moderate	20-39	1.0-1.5	3 – 3.9
Severe	>40	< 1.0	> 4.0

Nishimura, et al., Circulation 2014

Bonow RO, et al. Circulation, 2008

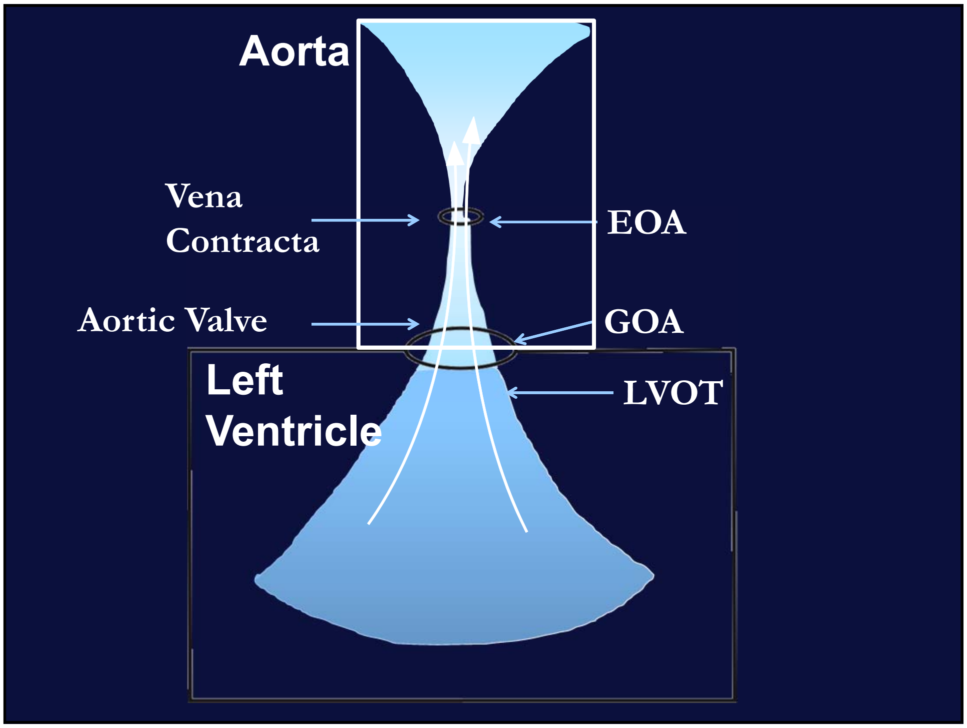
Aortic Stenosis

Determining the "True" Severity

Measurement Errors Must be Excluded

Topics of Discussions

- GOA Vs. EOA
- Doppler Vs. Catheter
- Factors affecting Gradient
- Area/Gradient Mismatch
- Reverse Area Gradient Mismatch

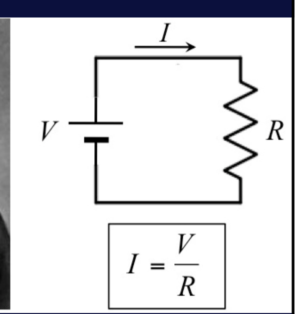


Evangelista Torricelli

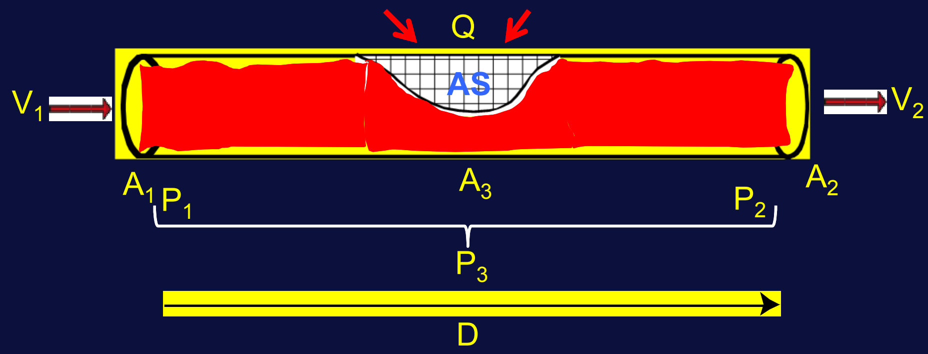
1608-1647

Georg Simon Ohm

1789-1854



Aortic Stenosis



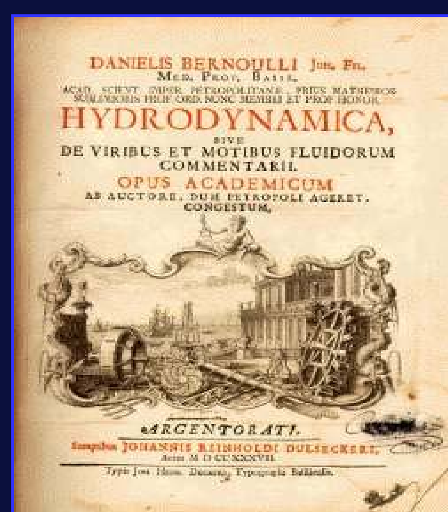
$V_{1,2\&3}$ Velocity
$A_{1,2\&3}$ Area
Q Flow
R Resistance
$P_{1,2\&3}$ Pressure
D Distance

Catheterization: Flow Q = $\frac{\Delta \text{ Pressure}\uparrow}{\text{Resistance}\uparrow}$

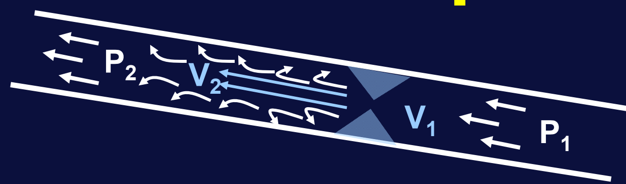
Doppler: Flow Q = Area$\downarrow$ x Velocity$\uparrow$

Daniel Bernoulli

1700-1782



Bernoulli Equation



$$P1-P2 = \mathbf{1/2\rho(V_2^2-V_1^2)}$$ *Convective acceleration*

+

$$\rho \int^{max} (dv/dt) * ds$$ *Flow acceleration*

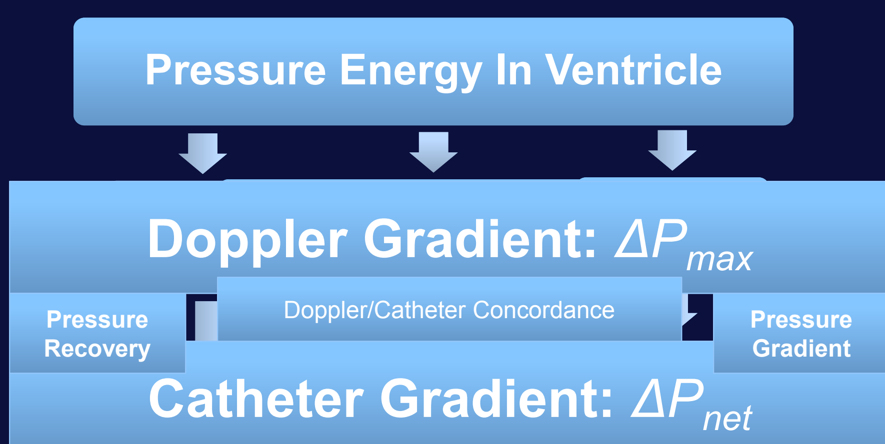
+

$$R(\mu)$$ *Viscous Friction*

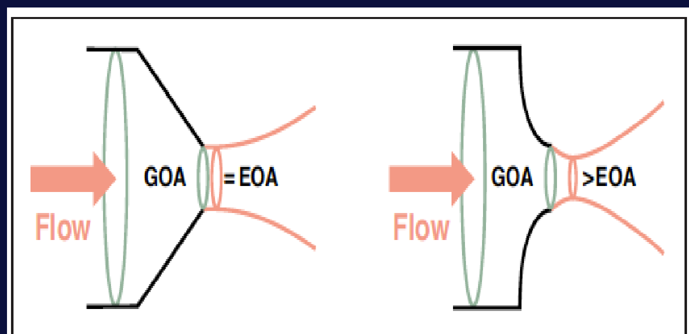
Short Tube
Non-Laminar
Acceleration

P1&V1= proximal to obstruction
P2&V2= distal to obstruction
ρ=mass density of blood
R=viscous resistance
μ = viscosity

Pressure Recovery



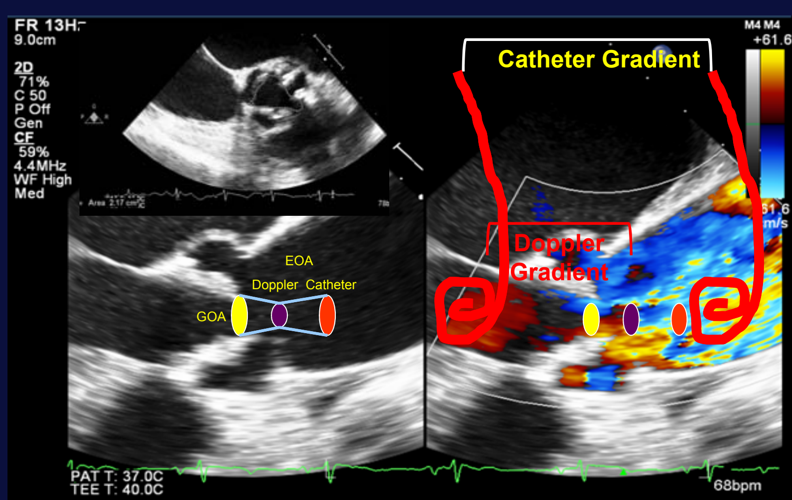
GOA Versus EOA



B

GOA: Planimetry
EOA: Continuity Equation
Coefficient of Contraction: EOA/GOA

Doppler versus Catheter Area and Gradient Assessment



Area Recovery

- *Difference between Doppler and Catheter Effective Orifice Area*
- *50% of EOA < 1 cm^2 with Doppler was > 1 cm^2 by Catheter*

Upcoming Concepts

- **For a given AV GOA**

  The Gradient can be variable

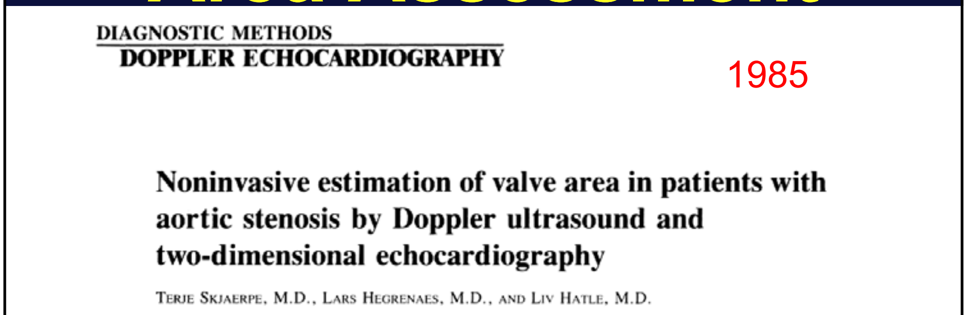
  The EOA can be variable

  (Derived from gradient)

  The Area and Gradient may not match

  The Doppler and Catheter measures may not match

Doppler Aortic Valve Area Assessment



DIAGNOSTIC METHODS
DOPPLER ECHOCARDIOGRAPHY

Noninvasive estimation of valve area in patients with aortic stenosis by Doppler ultrasound and two-dimensional echocardiography

TERJE SKJAERPE, M.D., LARS HEGRENAES, M.D., AND LIV HATLE, M.D.

1985

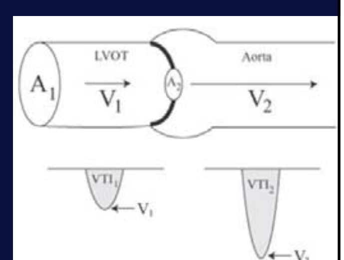
- Described in 30 subjects; 14 had significant AR
- Compared only to Fick and single plane CO angiography

Doppler Aortic Valve Area Assessment

- Continuity Equation
- A1 x V1 = A2 x V2

$$A_2\,(AV) = \frac{A_1 \times V_1}{V_2}$$

B



- Also, $A_2/A_1 = V_1/V_2$

B

- The ratio of velocities is the inverse of the ratio of areas
- Dimensionless index = $V_1/V_2 < 0.25$

Doppler Aortic Valve Area Assessment

LVOT Diameter = 2 cm
LVOT Area = 0.785 x $(2)^2$
LVOT Area = 3.14 cm^2

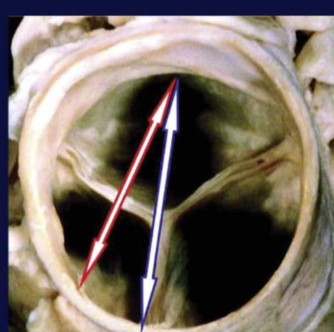
- LVOT diameter
- Measure in systole
- At Leaflet insertion
- Error squared!!

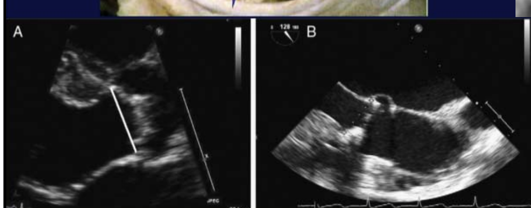
LVOT assumed as a circle = Πr^2
LVOT Area = Π (LVOT radius) ^{2}
LVOT Area = 3.14 x $(\text{LVOT diameter}/2)^2$
LVOT Area = 0.785 x $(\text{LVOT diameter})^2$

B

Measurement Errors

20% > Echo

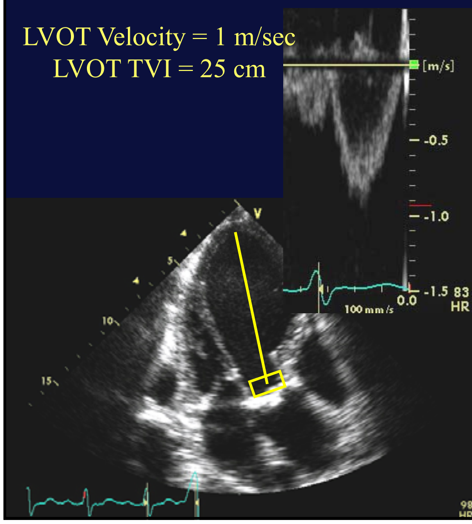




Discrepancy is worse with AS

Doppler Aortic Valve Area Assessment

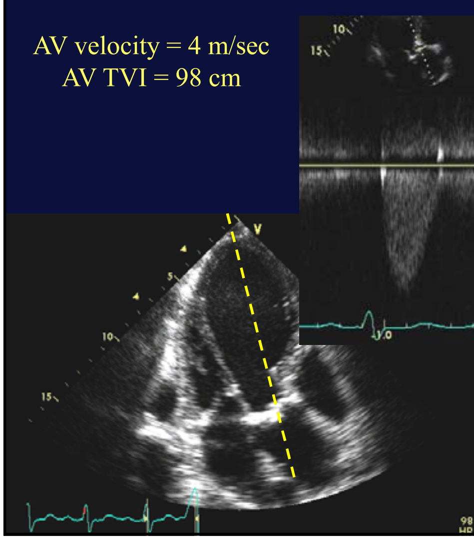
LVOT Velocity = 1 m/sec
LVOT TVI = 25 cm



- PW: LVOT
- Use proper cursor alignment parallel to blood flow to obtain optimum signal

Doppler Aortic Valve Area Assessment

AV velocity = 4 m/sec
AV TVI = 98 cm



- CW: AV
- Multiple windows
- Use proper cursor alignment parallel to blood flow to obtain optimum

Doppler Gradient Assessment

British Heart Journal, 1978, **40**, 131-140

Noninvasive assessment of pressure drop in mitral stenosis by Doppler ultrasound

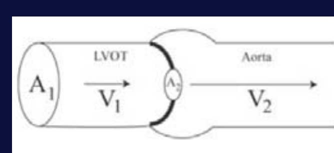
L. HATLE, A. BRUBAKK, A. TROMSDAL, AND B. ANGELSEN

From Section of Cardiology, Medical Department, University Hospital, 7000 Trondheim; and Division of Engineering Cybernetics, The Norwegian Institute of Technology and Division of Automatic Control at the Foundation of Scientific and Industrial Control at the University of Trondheim, 7000 Trondheim, Norway

- Described in 10 subjects
- Extrapolated to aortic valve

Doppler Aortic Valve Gradient Assessment

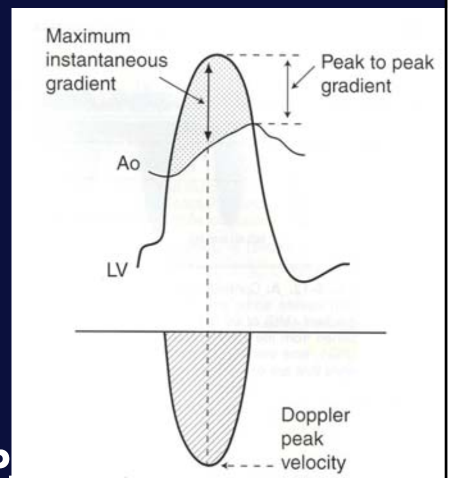
- Doppler
  - MIG = $4V_2^2 - 4V_1^2$
  - MIG = $4V_2^2$
- Use MIG = $4V_2^2 - 4V_1^2$
  - $V_1 > 1.5$ m/second
  - $V_2 < 3$ m/second



B

Doppler versus Catheter Gradient Assessment

- Catheterization
  - Peak to Peak
  - $P_{mean\ Catheter}$
- Doppler
  - MIG ($4V_2^2 - 4V_1^2$)
  - $P_{mean\ Doppler}$
- MIG always > PPG
- $P_{mean\ Doppler} - P_{mean\ Catheter} = P_{rec}$



B

Not Pressure Recovery

- LV Pressure: Peak 200 mmHg
- Aortic Pressure: Peak 150 mmHg
- Cath Peak to Peak: 50 mmHg
- Doppler Velocity: 4.5 m/second
- Doppler Maximum Instantaneous Gradient: Peak: 81
- Doppler-Cath difference: 31 mmHg

Pressure Recovery

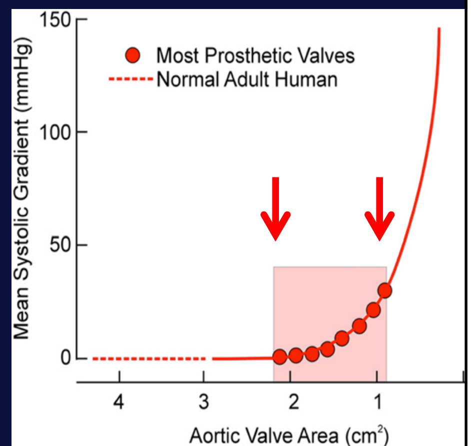
- Catheterization Gradient = Mean 40 mmHg
- Doppler Mean Gradient = 50 mmHg
- Pressure Recovery = 10 mmHg

Gradient Determinants

- Area
- Flow
- Jet Eccentricity
- Aortic root diameter
- Global LV afterload

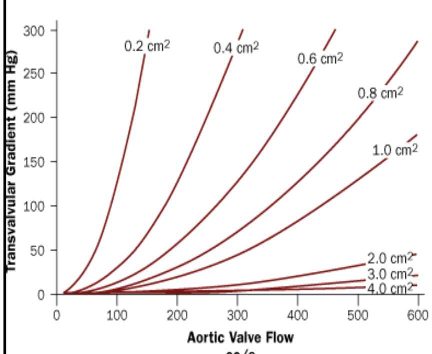
Gradient Determinants

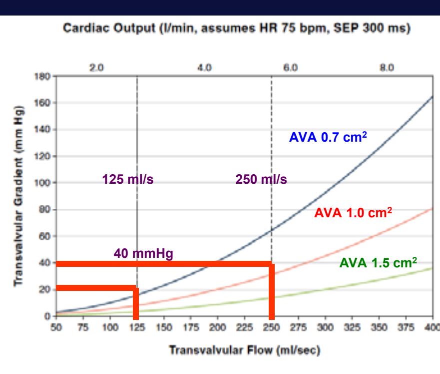
- Area: There is an ***inverse*** quadratic relationship
- $\Delta P = Q^2/(K \times EOA^2)$

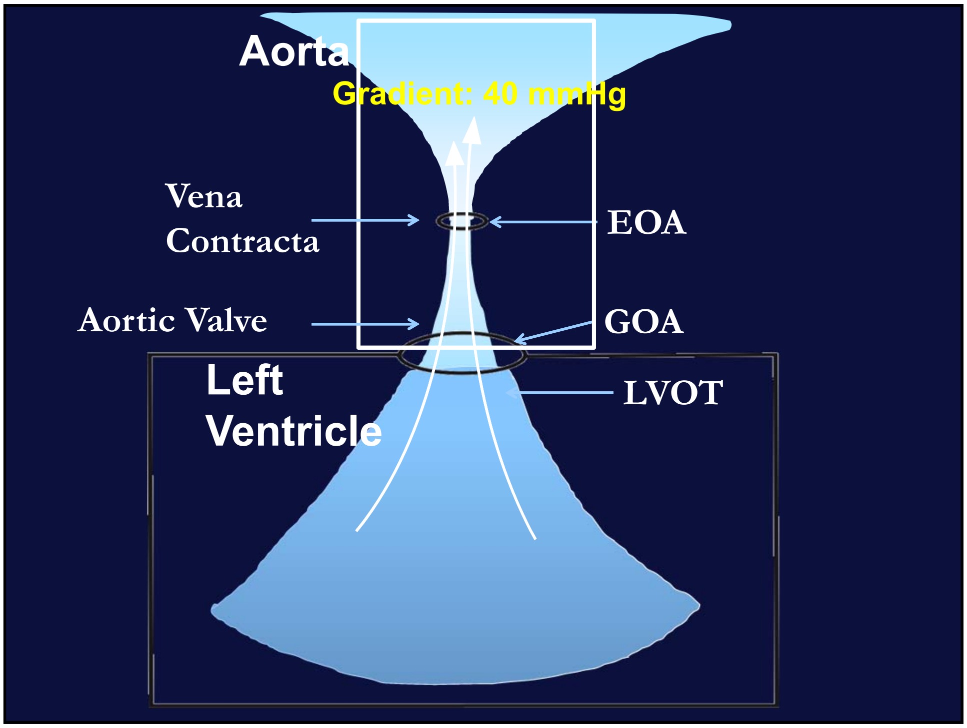


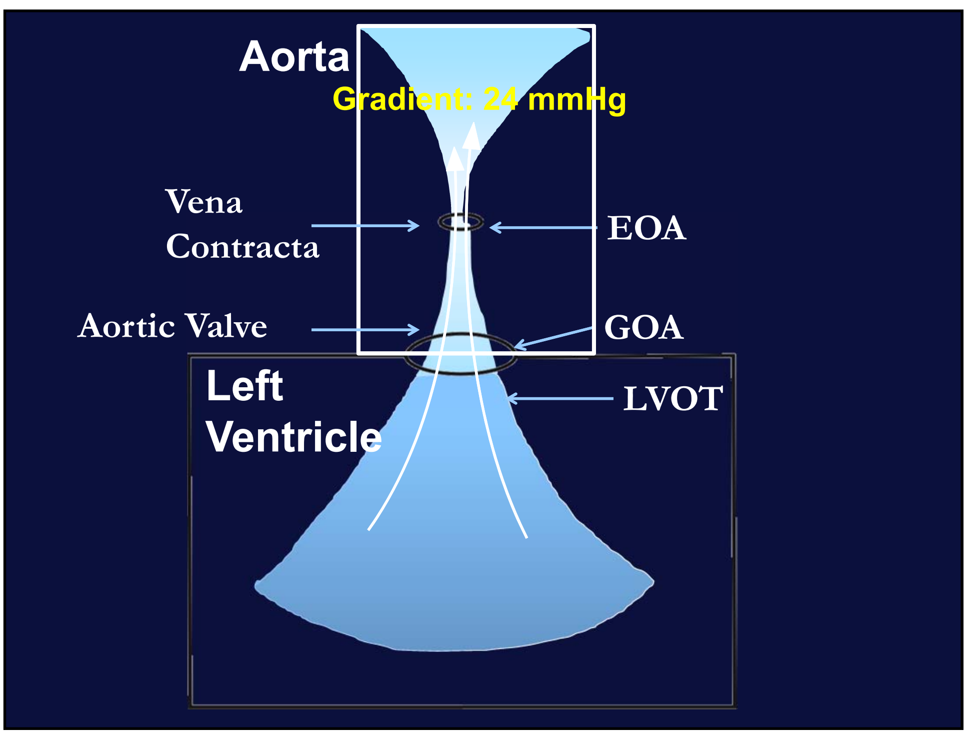
Gradient Determinants

- Flow: There is a ***direct*** quadratic relationship
- Low Flow: SVI < 35ml/m²





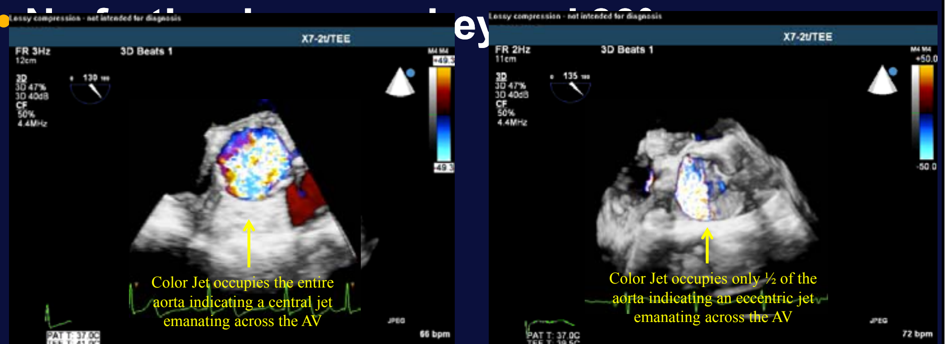

Aorta
Gradient: 40 mmHg
Vena Contracta
EOA
Aortic Valve
GOA
Left Ventricle
LVOT


Aorta
Gradient: 24 mmHg
Vena Contracta
EOA
Aortic Valve
GOA
Left Ventricle
LVOT

Gradient Determinants

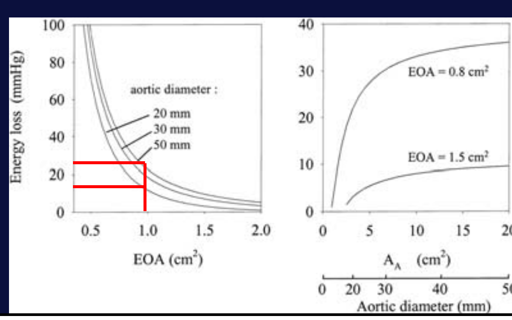
- **Jet Eccentricity**
- **For the Same GOA, an Eccentric Jet leads to a Higher Gradient**

⑩ **↑Vel 0.7 m/s, ↑MG 23 mmHg, ↓ EOA 0.2**

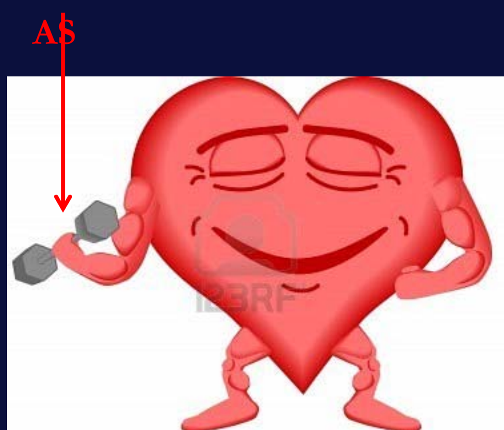


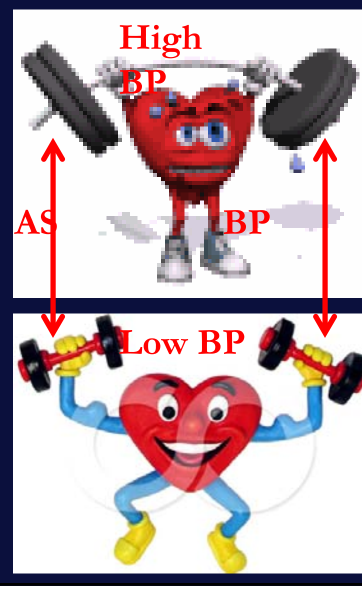
Gradient Determinants

- **Aortic root diameter**
- **The smaller the aortic root, the less energy loss, the more the pressure recovery, the lower the catheter gradient. This effect plateaus at a diameter of 30 mm (area 7 cm^2)**



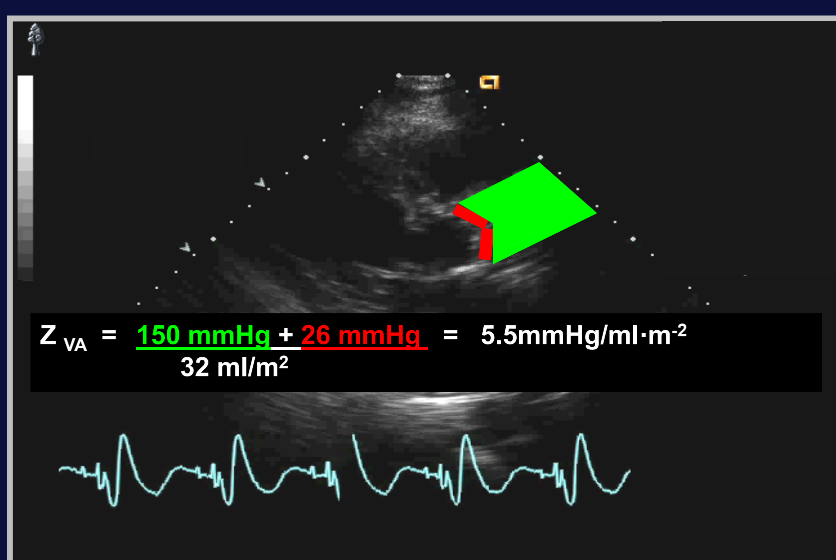
Global Left Ventricular Afterload



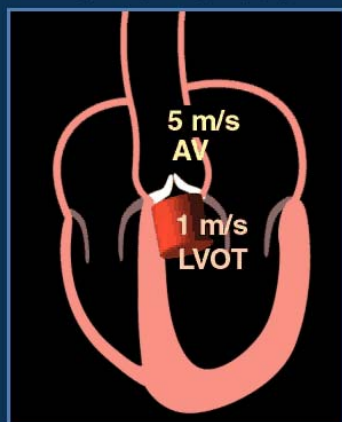


Moderate AS and low compliance =
Severe AS and normal compliance

Global Left Ventricular Afterload



Severe Aortic Stenosis with Normal Function



Area Gradient Match

Normal Ejection Fraction

Normal Cardiac Output

AVA<1cm^2
ΔP_{mean}>40mmHg

Courtesy Heidi Connolly

Aortic Stenosis
Area/Gradient Mismatch

Aortic Stenosis
Area Gradient Mismatch

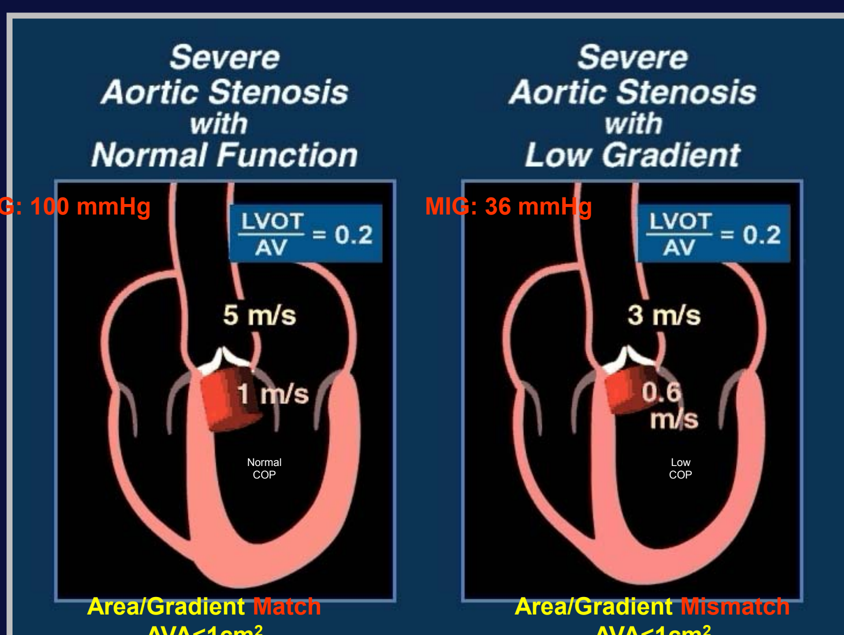
Low flow (normal or reduced LVEF)
Mean Gradient <30-40mmHg
AVA <1.0cm^2

True, Severe AS

Mild-Mod AS Low Flow (pseudo AS)

MIG: 100 mmHg

MIG: 36 mmHg



Area/Gradient Match
AVA<1cm^2
ΔP_{mean}>40mmHg

Area/Gradient Mismatch
AVA<1cm^2
ΔP_{mean}<40mmHg

Low EF Area Gradient Mismatch

Risk Stratify

Dobutamine Stress

Dobutamine Echocardiography

Baseline Doppler hemodynamics

Dobu...

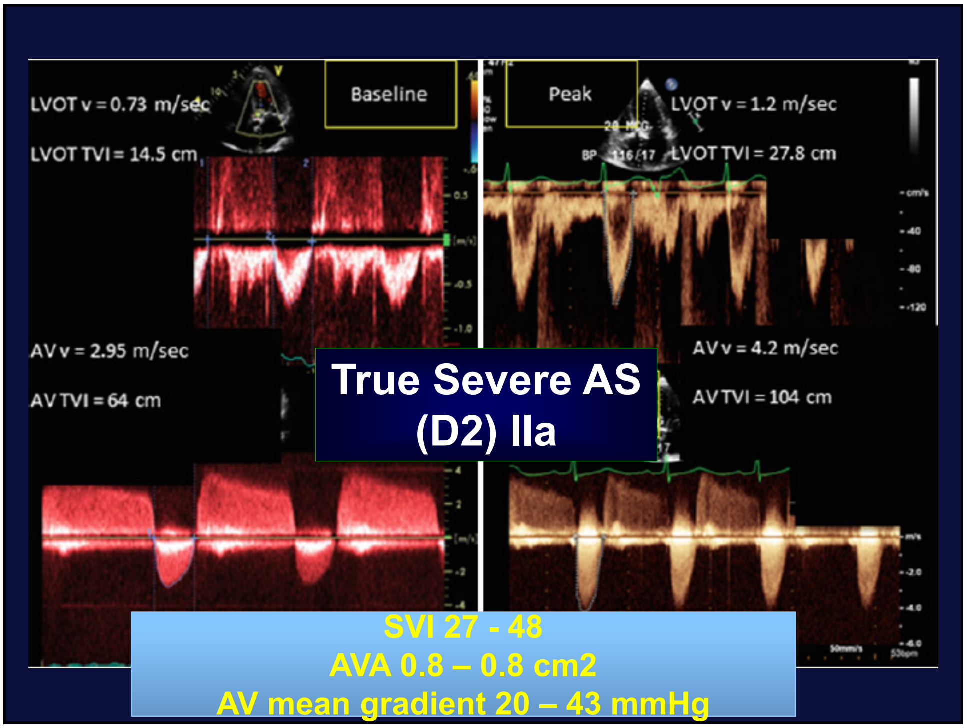
Vm... cm²

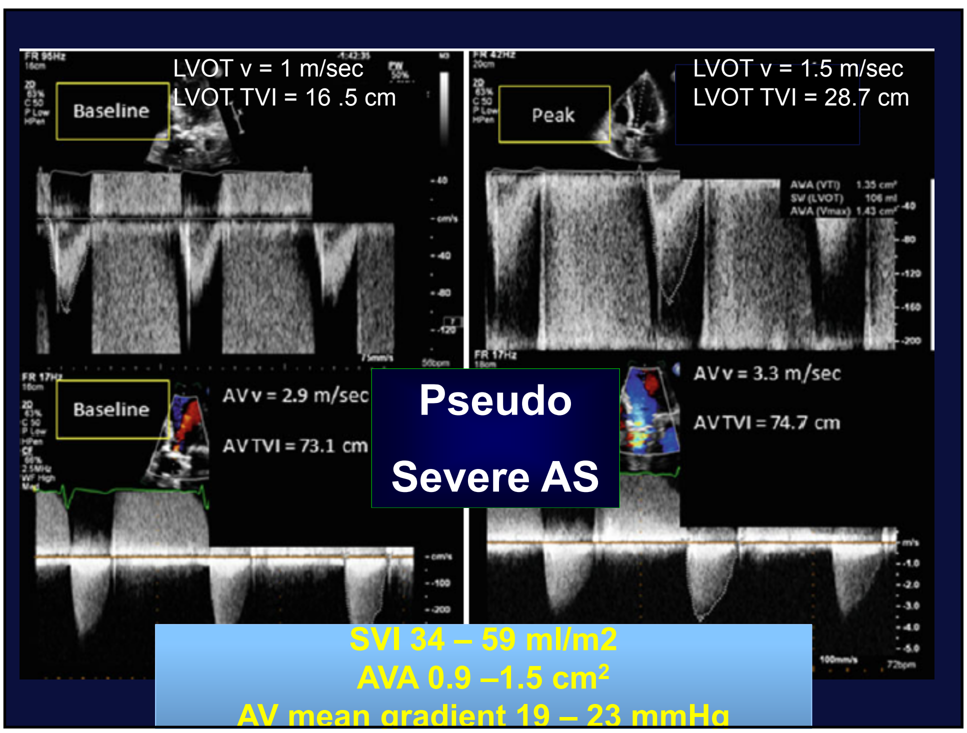
↑ Mean gradient
↑ AV Area

True Severe AS (D2) IIa

Pseudo Severe AS

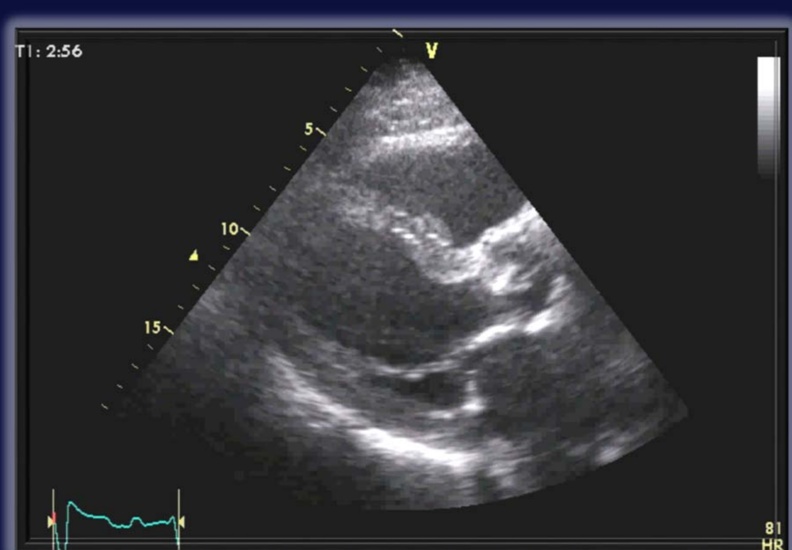
Flow Reserve? ≥ 20% SV

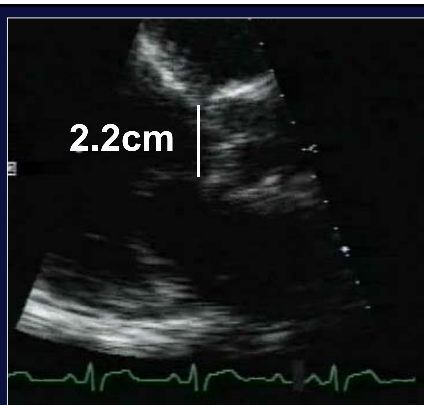

Baseline
Peak
LVOT v = 0.73 m/sec
LVOT TVI = 14.5 cm
LVOT v = 1.2 m/sec
LVOT TVI = 27.8 cm
AV v = 2.95 m/sec
AV TVI = 64 cm
AV v = 4.2 m/sec
AV TVI = 104 cm
True Severe AS
(D2) IIa
SVI 27 - 48
AVA 0.8 – 0.8 cm2
AV mean gradient 20 – 43 mmHg

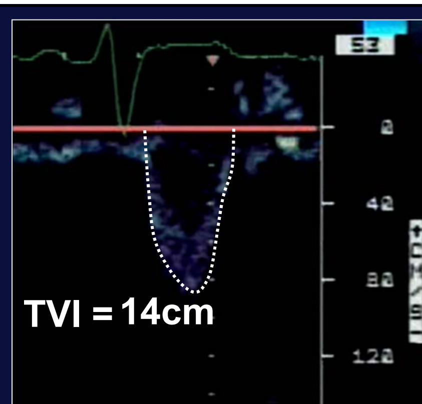

Baseline
LVOT v = 1 m/sec
LVOT TVI = 16 .5 cm
Peak
LVOT v = 1.5 m/sec
LVOT TVI = 28.7 cm
Baseline
AV v = 2.9 m/sec
AV TVI = 73.1 cm
AV v = 3.3 m/sec
AV TVI = 74.7 cm
Pseudo
Severe AS
SVI 34 – 59 ml/m2
AVA 0.9 –1.5 cm²
AV mean gradient 19 – 23 mmHg

Case

- 62 y/o male
- STEMI and subsequent CABG five years ago
- Recurrent heart failure x 3 months





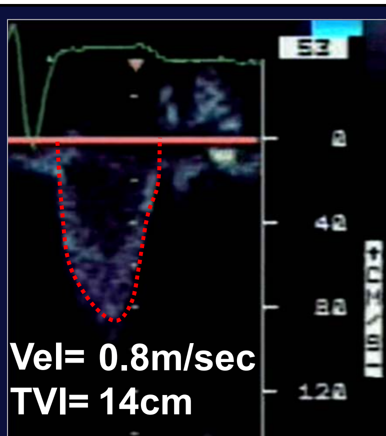


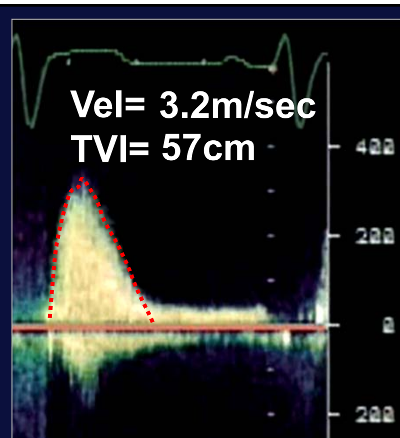
Stroke Volume = CSA x TVI

= 0.785 ( )^2 x

= 53cm^3

LVSVI = 53cm^3 / 2.3 m^2 = 23 cm^3/ m^2 (< 35ml/m^2)





$$\text{Area}_{AV} = \frac{0.785\ (2.2\text{cm})^2 \times (\quad)}{}$$

= 0.9 cm^2; MG 24mmHg

Dobutamine Stress

LV Stroke Volume Index
$26ml/m^2 – 40ml/m^2$

Mean AV Gradient
24 – 52mmHg

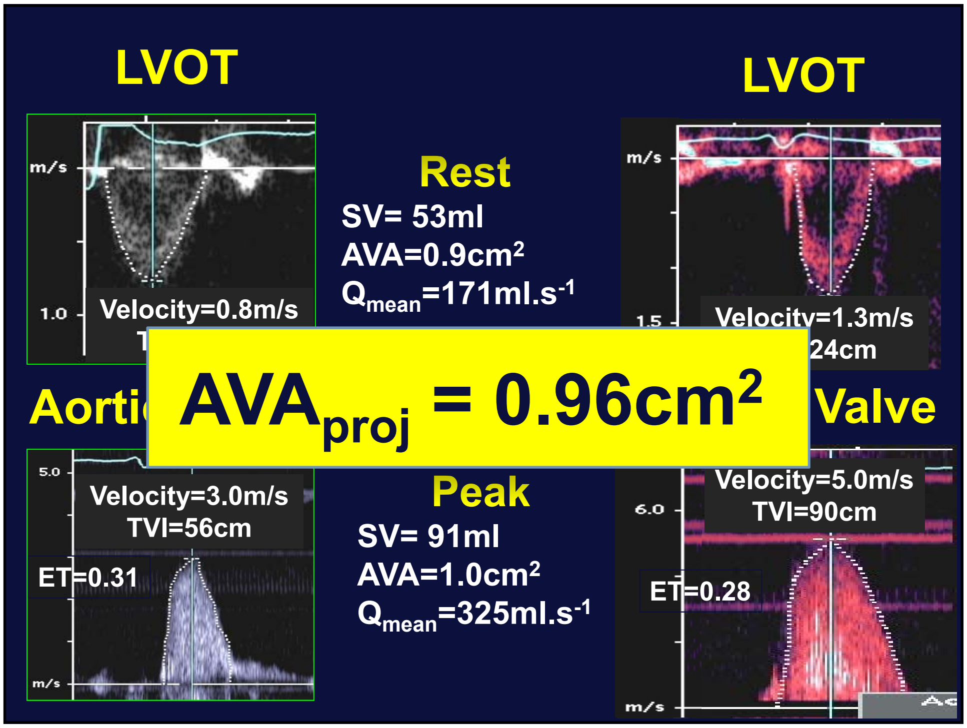
Valve Area
$0.9cm^2 – 1.0cm^2$

Projected Aortic Valve Area

$$AVA_{proj} = AVA_{rest} + VC \times (250 - Q_{rest})$$

$$\text{Valve Compliance (VC)} = \frac{AVA_{peak} - AVA_{rest}}{Q_{peak} - Q_{rest}}$$

$$Q_{mean} = \frac{\text{Stroke Volume}}{\text{LV ejection time}}$$



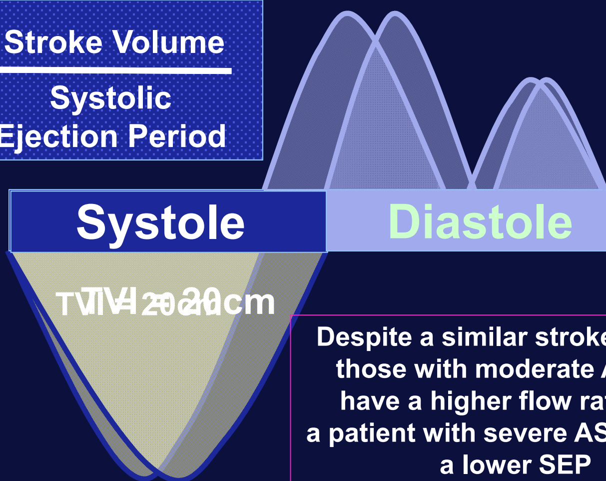
Is This Too Complicated?

1. LVOT diameter (use the same rest / stress)
2. $LVOT_{TVI}$ (rest / stress)
3. AoV_{TVI} (rest / stress)
4. Measure the ejection time

Defining Low Flow?

Stroke Volume Index vs Flow Rate

$$\text{Flow Rate} = \frac{\text{Stroke Volume}}{\text{Systolic Ejection Period}}$$



Despite a similar stroke volume those with moderate AS will have a higher flow rate than a patient with severe AS because a lower SEP

Resting Aortic Valve Area at Normal Transaortic Flow Rate Reflects True Valve Area in Suspected Low Gradient Severe Aortic Stenosis

Navtej S. Chahal, MBBS,*† Maria Drakopoulou, MD,* Ana M. Gonzalez-Gonzalez, MD,* Ramasamy Manivarmane, MBBS,* Rajdeep Khattar, MBBS,*† Roxy Senior, MD*†‡

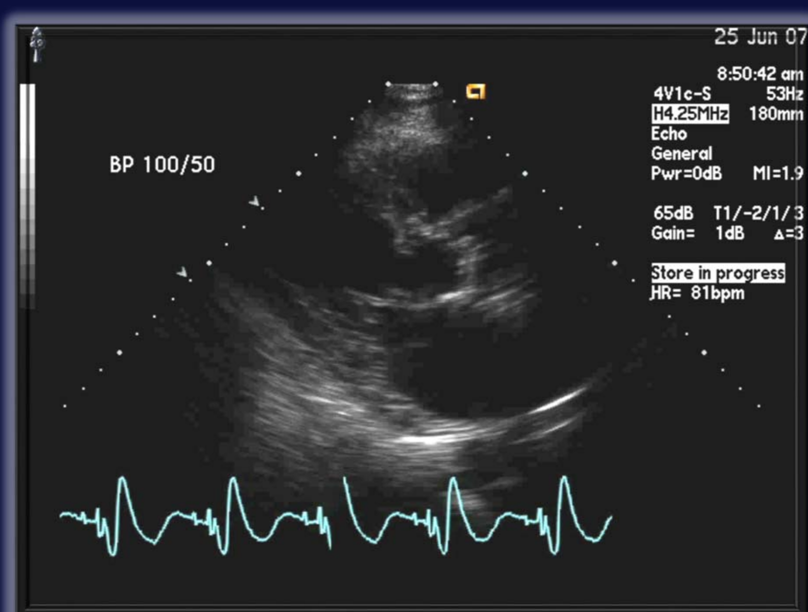
	n	Rest AVA, cm²	Stress AVA, cm²	p value
Q < 200 ml/s	48	0.74±0.12	0.89±0.25	<0.001
Q ≥ 200 ml/s	19	0.85±0.09	0.89±0.12	0.19

Interpretation: If normal resting flow rate, the corresponding AVA is likely to be represent the true hemodynamic severity of the stenosis and further "flow correction" with SECHO is not likely required.

J Am Coll Cardiol Img 2015

Case

- 75 year old male
- Presents with dyspnea and syncope
- HTN (treated BP 150/75)
- Grade III/VI mid peaking systolic murmur LSB



Echocardiography

Normal EF Area Gradient Mismatch

• LVEF	55%
• AV Mean G	26mmHg
• AVA	$0.8cm^2$
• AVA index	$0.45cm^2/m^2$
• LVEDV	88ml
• SVi	$32\ ml/m^2$

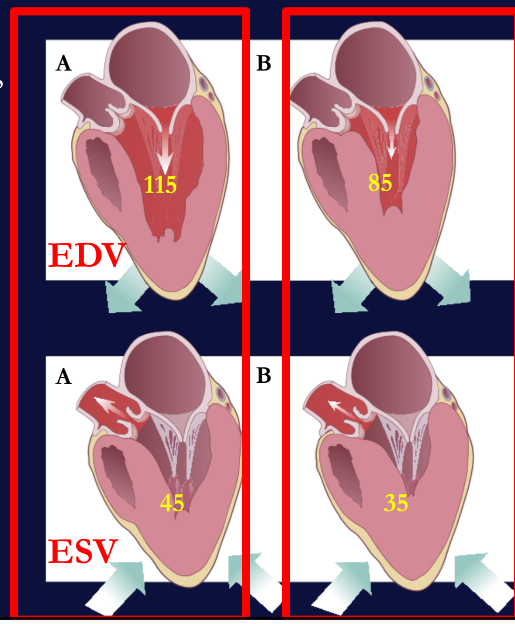
Aortic Stenosis Severity?

1. Mild
2. Moderate
3. Severe
4. Can't tell

Flow Versus EF

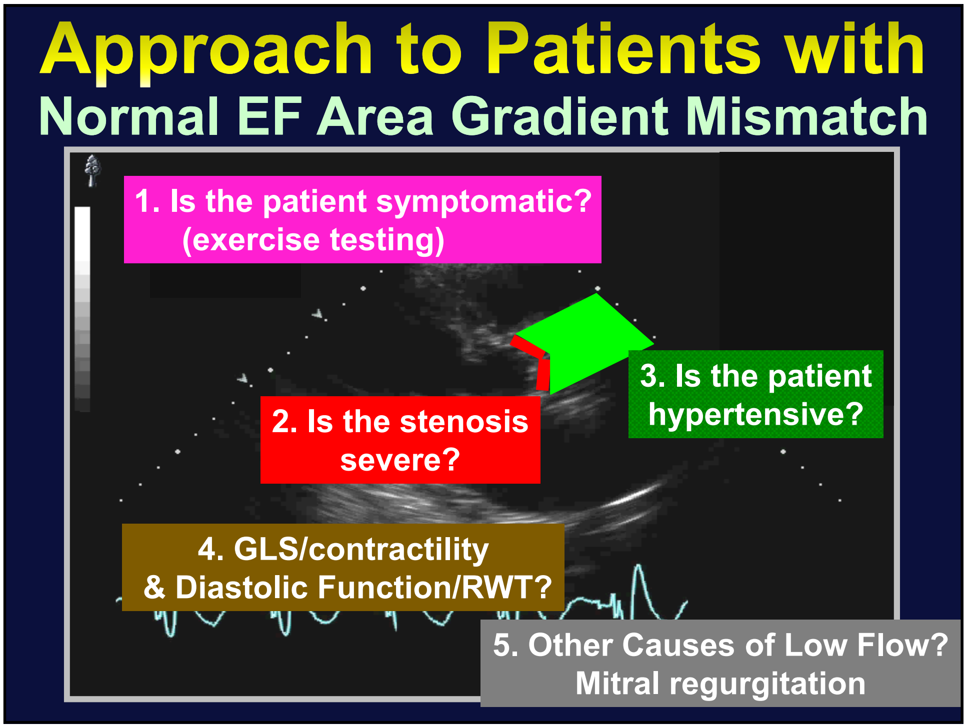
A: EDV = 115, ESV = 45,
SV= 115-45 = 70 ml
EF = 70/115 = 60%
BSA = 1.79
SVI = 39 ml/m^2

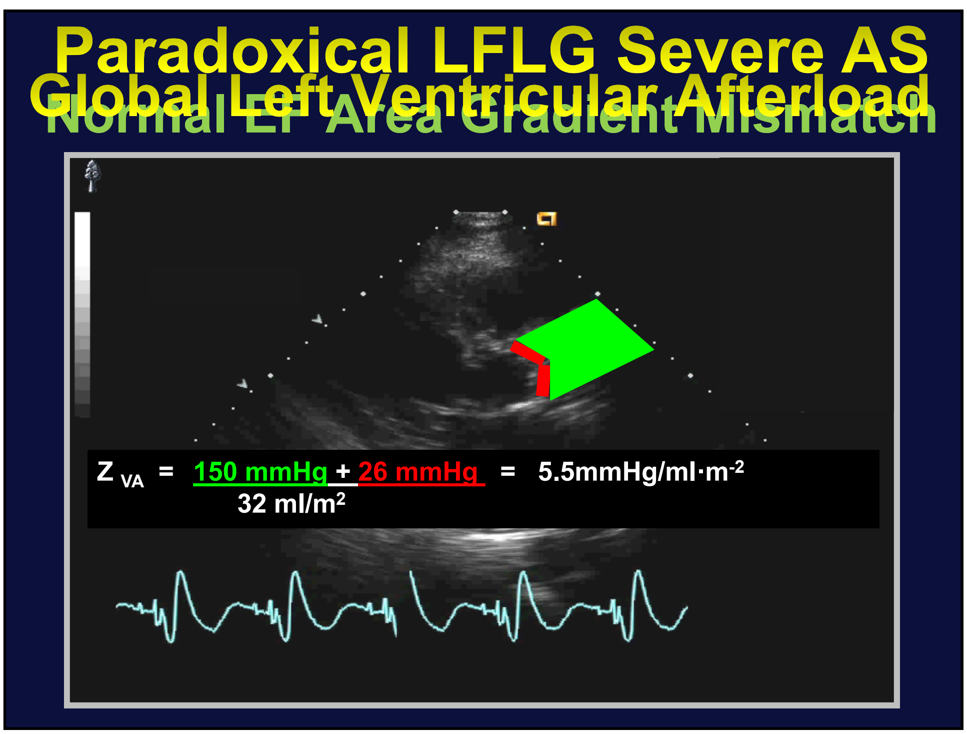
B: EDV = 85, ESV = 35,
SV= 85- 35= 50 ml
EF = 50/85 = 60%
BSA = 1.79
SVI = 28 ml/m^2



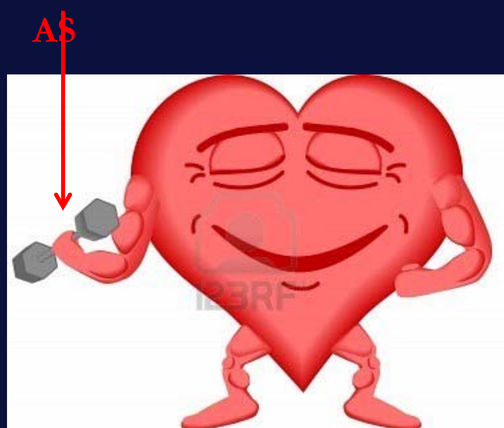
Flow Versus EF

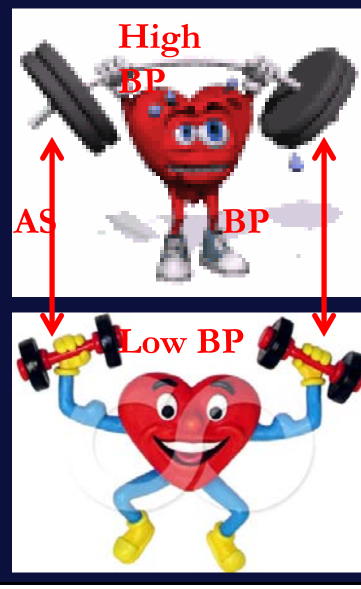
- **So why is the Flow Low?**
  - **Preload:** Small LV volume (LVH)
  - **Contractility:** Despite EF normal, contractility (&EF) impaired for degree of LVH
  - **Afterload:** Global LV afterload (Valve and Vascular)


Approach to Patients with
Normal EF Area Gradient Mismatch
1. Is the patient symptomatic? (exercise testing)
2. Is the stenosis severe?
3. Is the patient hypertensive?
4. GLS/contractility & Diastolic Function/RWT?
5. Other Causes of Low Flow? Mitral regurgitation


Paradoxical LFLG Severe AS
Global Left Ventricular Afterload
Normal EF Area Gradient Mismatch
$Z_{VA} = \frac{150\ mmHg + 26\ mmHg}{32\ ml/m^2} = 5.5 mmHg/ml \cdot m^{-2}$

Global Left Ventricular Afterload



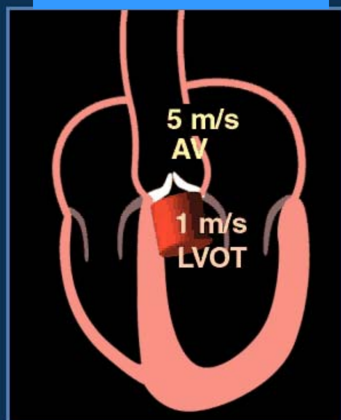


Moderate AS and low compliance =
Severe AS and normal compliance

Aortic Stenosis

Reverse Area/Gradient Mismatch

Elevated Gradient
Despite non-critical AS



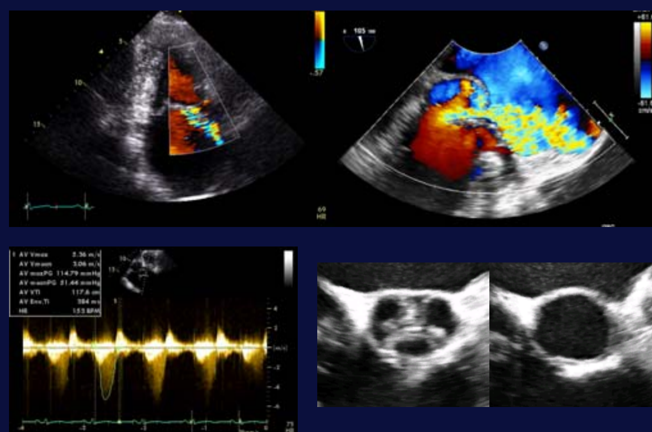
Reverse Area/Gradient
Mismatch
AVA>1cm^2
ΔP_{mean}>40mmHg

Courtesy Heidi Connolly

Causes of Reverse A/G Mismatch

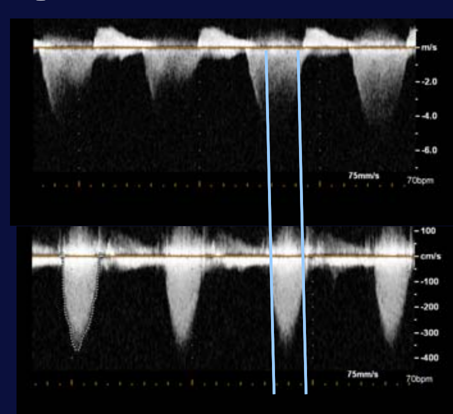
- Errors of Measurement
- High Flow
- Pressure recovery
- Eccentric Jet
- Para-valvular Obstruction
- Prosthetic-valve specific

Errors of Measurements
Eccentric Mitral



Mitral Regurgitant Jet Versus Aortic Stenosis Jet

- **Mitral regurgitation occupies IVC and IVR**

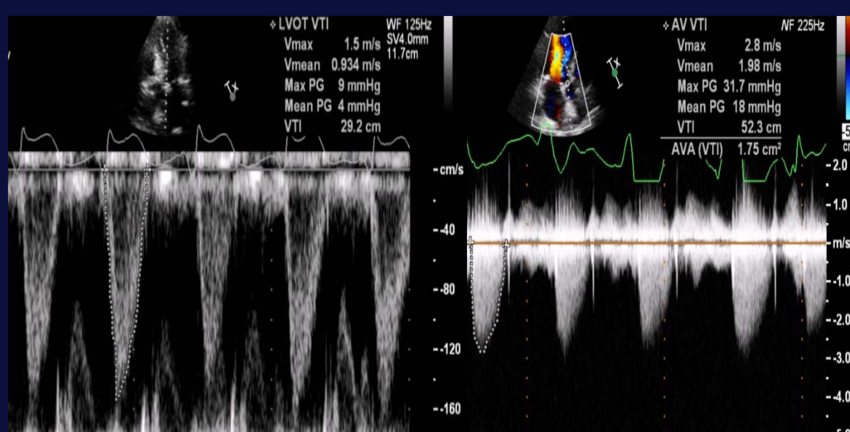


Errors of Measurements
LVOT Measurement

- Measure in systole
- At leaflet insertion
- Error squared!!
- Echo underestimates LVOT by 17%

B

High Flow



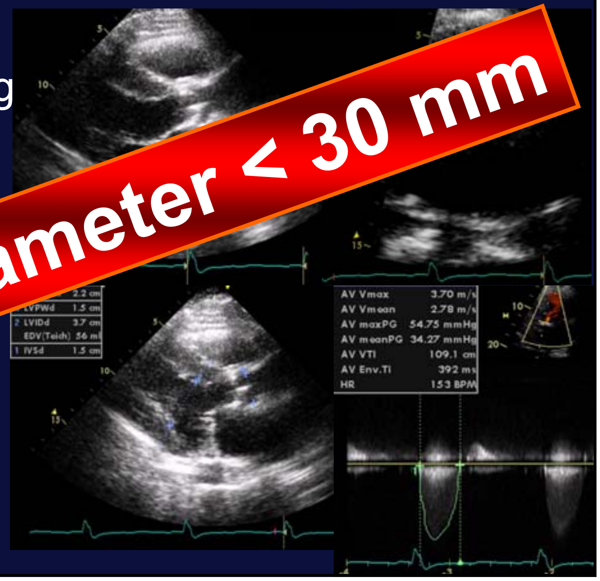
- Aortic regurgitation
- Hyperdynamic states (dialysis, anemia)
- Dimensionless Index

B

Pressure Recovery

Doppler
Pmean = 34 mmHg
EOA = 0.6 cm^2

Catheterization
Pmean ...
...
A...R= 34-18 = 16 mmHg
RPR= 16/34= 47%



Aortic Diameter < 30 mm

Energy Loss Index

- Energy loss Co-efficient

$$ELCo = \frac{AVA \times AAa}{AAa - AVA}$$

- AVA = aortic valve area, AAa = aortic area
- Energy loss index: ELCo/BSA
- ELI < 0.52-0.76 cm^2 has poor outcomes and severe AS
- More significant with increase flow and moderate aortic stenosis

B

Pressure Recovery/High Flow

EOA = 0.6 cm^2

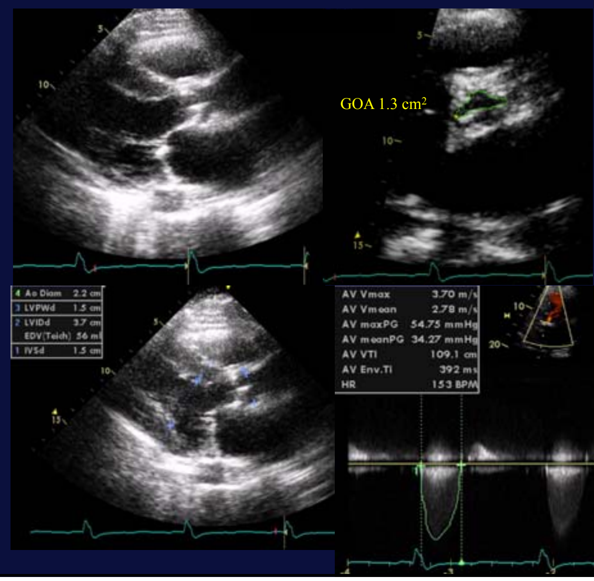
AAd = 2.2 cm

AAa = 3.8 cm^2

ElCo = 3.8x0.6/3.8-0.6

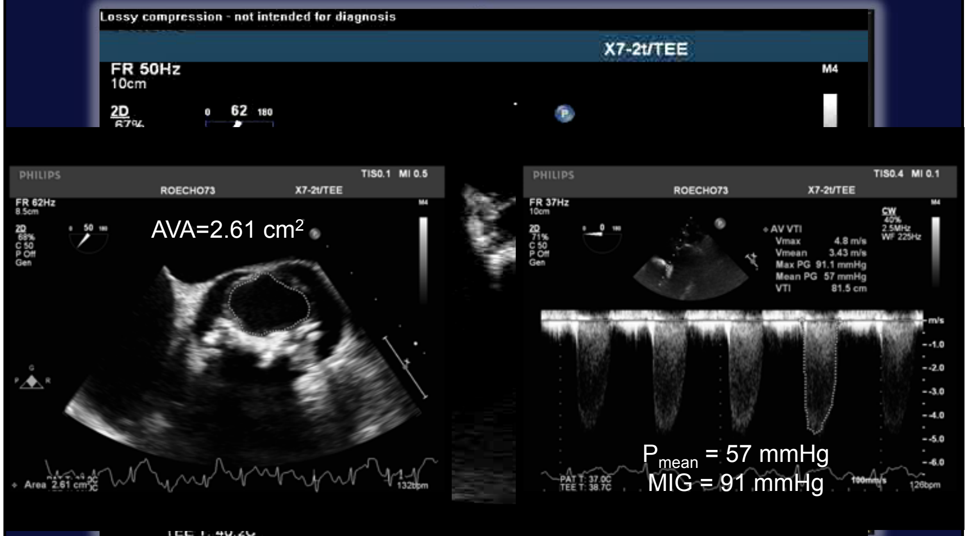
ElCo = 0.72 cm^2

ELI = 0.72/BSA



Eccentric Jet

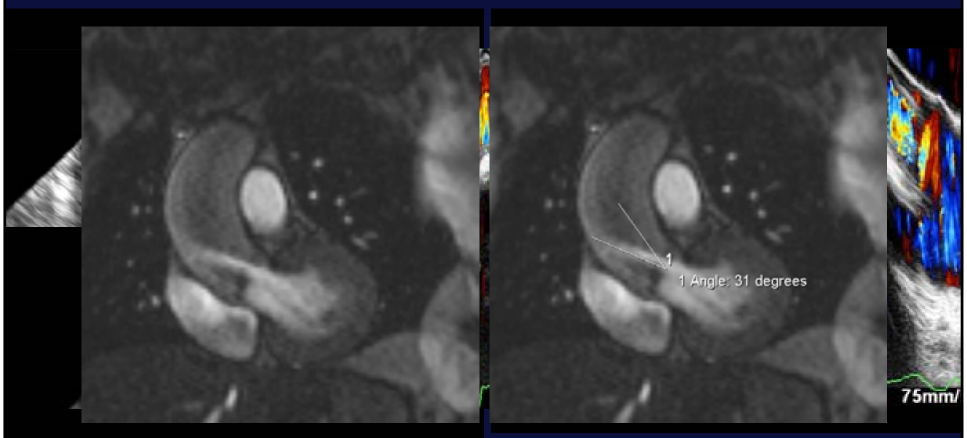
- **Case:**
- **29 y/o male**
- **Carries a diagnosis of Asymptomatic severe AS**
- **Quit Law School**



Cardiac Catheterization P_{mean} = 50 mmHg, AVA 1 cm^2

Eccentric Jet

Eccentric Jet: Echo



Aortic Stenosis

Reverse Area Gradient Mismatch

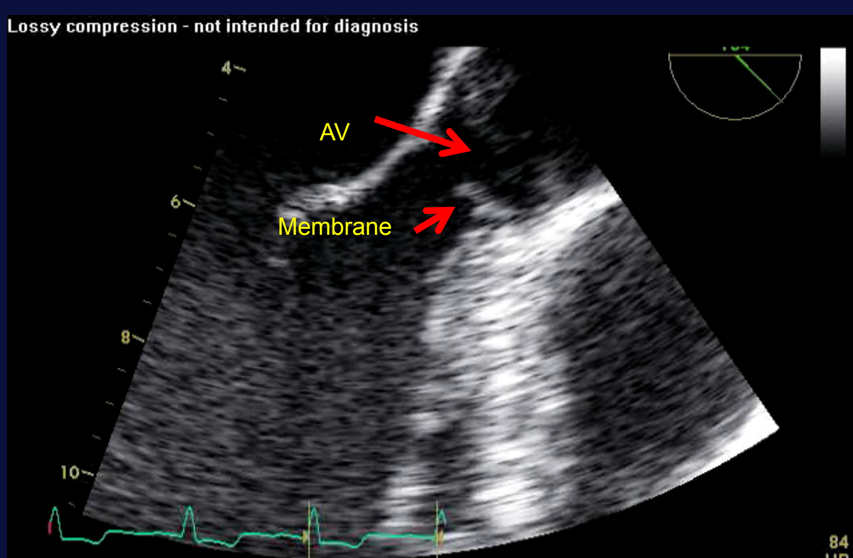
Elevated Gradient/GOA ok
Mean Gradient >40mmHg
AVA >1.0cm^2

Bicuspid Aortic Valves

Para-valvular Obstruction

- Sub-Aortic membrane
- Hypertrophic Obstructive Cardiomyopathy
- Supravalvular Obstruction
- Mitral valve Prosthesis

Sub-Aortic Membrane



Sub-Aortic Membrane

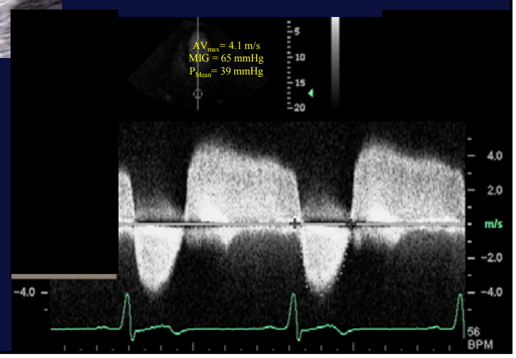
Progressive Disease
Other congenital anomalies in 50%
- VSD/PDA/Coarctation
- Shone's Complex
- Bicuspid AV
- leftsided-SVC

B

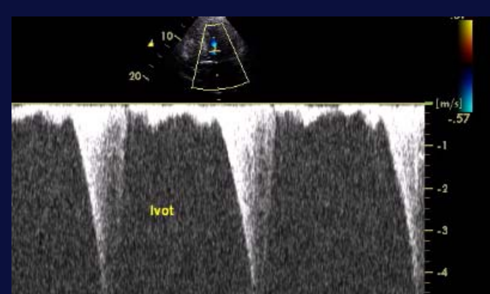
Types: Membrane, fibromuscular ridge, Diffuse tunnel narrowing, mitral tissue

May Cause aortic regurgitation
Treatment: Surgery
No symptoms: Catheter LVOT-A peak/Doppler Mean = 50 mmHg
Symptoms: Catheter LVOT-A peak/Doppler Mean = 30-50 mmHg
Adults may use Doppler Peak > 50 mmHg
Resection/Konno procedure

B

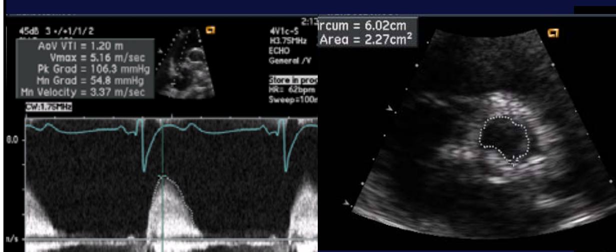


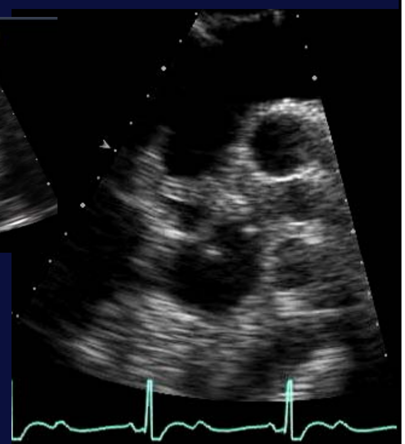
Hypertrophic Obstructive Cardiomyopathy



Alcohol Septal Ablation or Surgery
High Risk features
ICD

Supra-Aortic Obstruction



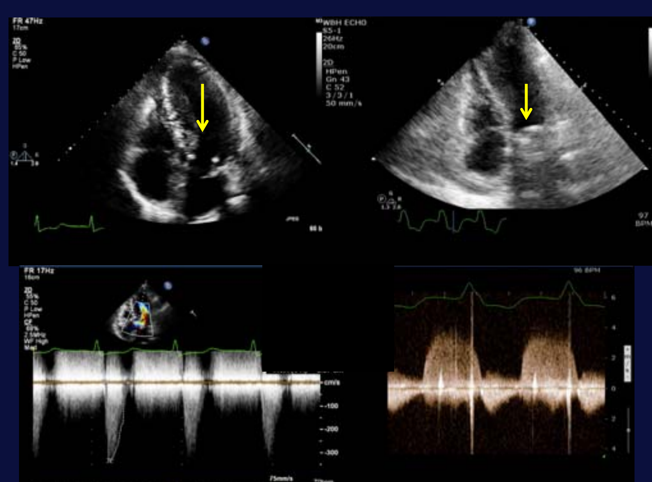


Non-Familial Sporadic
William syndrome:
- Elfin Facial
- Hypercalcemia
- Behavioral
- Diagnosed by CVS and fetal echo

B

Familial Sporadic
Coronary anomalies
Types: Hour glass, Membrane, Diffuse narrowing
Surgery

Obstruction by Mitral Valve Prosthesis

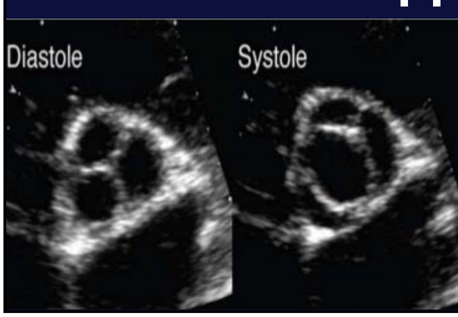


Aortic Stenosis Classification

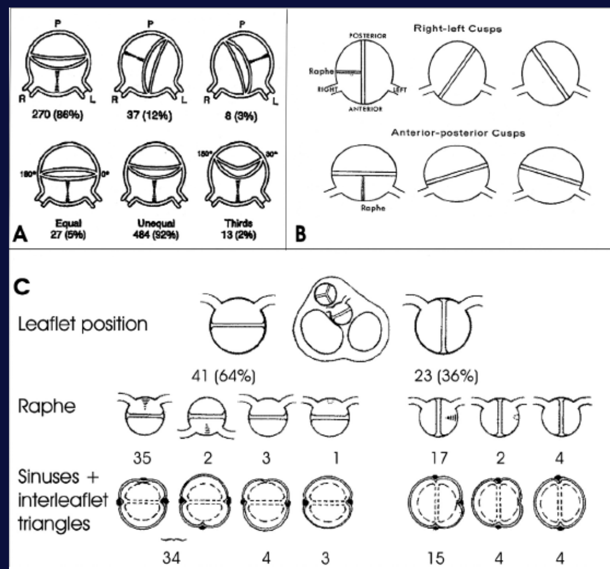
- **Area/Gradient Match**
  - Area/Gradient Match NF/HG
  - Area/Gradient Match LF/HG
- **Area/Gradient Mismatch Normal EF**
  - Area/Gradient Mismatch NF/LG
  - Area/Gradient Mismatch LF/LG
- **Area/Gradient Mismatch Low EF**
  - True
  - Pseudo
  - Indeterminate
- **Reverse Area/Gradient Mismatch**
  - Flow Related 1.Amount 2.Eccentricity
  - Supra/Sub Valve Obstruction
  - Pressure Recovery
  - Prosthetic Valve

Bicuspid Aortic Valve and Aortic Root

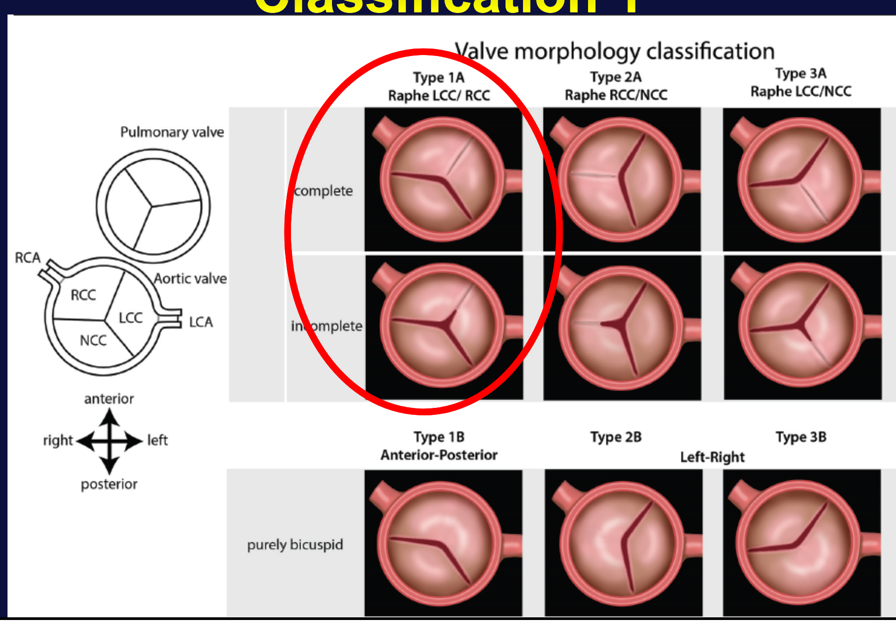
- Evaluate in Systole
- Fish Mouth
- Domed Appearance



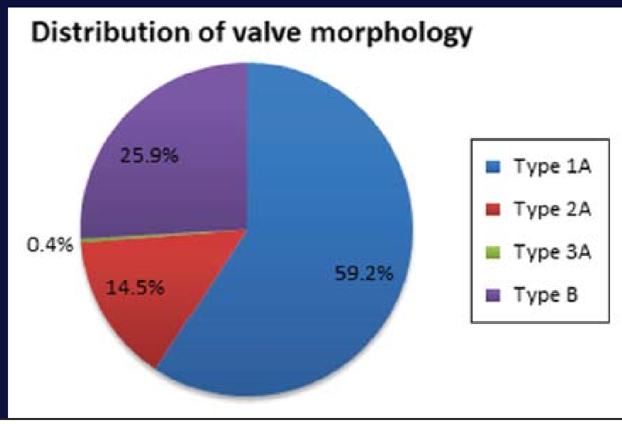
Classifications



Bicuspid Aortic Valve: Classification 1



Bicuspid Aortic Valve

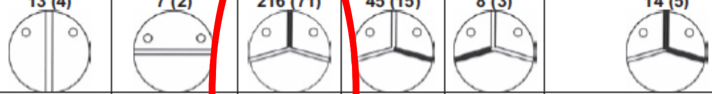


Valve dysfunction	Complete raphe	Incomplete raphe	p value
Valve dysfunction (n=144)	92 (82.9%)	52 (66.7%)	0.01
Aortic regurgitation (n=96)	63 (56.8%)	33 (42.3%)	0.05
Aortic stenosis (n=89)	55 (49.5%)	34 (43.6%)	NS

Bicuspid Aortic Valve: Ascending Aortic Measurements

- Absolute diameter: (4.2)4.5/5/5.5 cm
- Ascending aortic index (Ascending aortic diameter/BSA): >2.5 cm/m^2
- Aortic root or Ascending aortic area/height in meters: > 10 cm^2/m

Bicuspid Aortic Valve: Classification 2



main category: number of raphes	0 raphe - Type 0		1 raphe - Type 1			2 raphes - Type 2
	21 (7)		269 (88)			14 (5)
1. subcategory: spatial position of cusps in Type 0 and raphes in Types 1 and 2	lat 13 (4)	ap 7 (2)	L – R 216 (71)	R – N 45 (15)	N – L 8 (3)	L – R / R – N 14 (5)
2. subcategory: VALVULAR FUNCTION						
I	6 (2)	1 (0.3)	79 (26)	22 (7)	3 (1)	6 (2)
S	7 (2)	5 (2)	119 (39)	15 (5)	3 (1)	6 (2)
B (I + S)		1 (0.3)	15 (5)	7 (2)	2 (1)	2 (1)
No			3 (1)	1 (0.3)		

Bicuspid Aortic Valve: Guidelines Course

- Most patients will develop AS or AR
- Most are LCC/RCC fusion
- More aortic dilatation with RCC/NCC fusion than with LCC/RCC fusion
- 20-30% family members have BAV
- Complete Raphe more AR and dilatation

Aortic Root Guidelines

Aortic Root	Mean (cm)	SD	Method
Female	3.5-3.72	0.38	CT
Male	3.63-3.91	0.38	CT

Syndrome	Gene	Features
Marfan	FBN1	Skeletal Features Ectopia lentis
Loeys-Dietz	TGFBR1 TGFBR2	Skeletal Features Cleft palate/uvula
	ACTA2	Livedo reticularis PDA/BAV
	MYH11	PDA
Vascular Ehlers-Danlos	COL3A1	Thin skin GI/uterine rupture
Turner	45,X	Skeletal Feature BAV/Coarctation

Aortic Root Dissection

- **Increased wall stress: HTN**
  - **Cocaine**
  - **Pheo**
  - **Weight lifting**
  - **Trauma and deceleration**
  - **Coarctation**

Aortic Root Dissection

- Media abnormalities:
  - Genetic
  - Inflammatory
    - Takayasu arteritis
    - Giant cell arteritis
    - Behcet arteritis
  - Other:
    - Pregnancy/PCKD/steroids

Bicuspid Aortic Valve Guidelines: Imaging

- Class I (C): Initial TTE for morphology, AS/AR, sinuses, ascending aorta and timing for intervention
- Class I (C): Serial studies > 4 depending on rate of progression and FH and annually if > 4.5 cm
- Class I (C): Internal diameter, perpendicular to axis of blood flow at widest diameter mid sinus level for the root

Aortic Root Guidelines: Imaging

- Class I (C): Internal diameter, perpendicular to axis of blood flow at widest diameter mid sinus level for the root
- Class I (C): Initial TTE for BAV, Marfan, Loeys-Dietz, TGFBR1,2, FBN1,ACTA2, MYH11 and at 6 months
- Class I (C): Marfan annual studies > 4 depending on rate of progression and FH and semiannually if > 4.5 cm or the others
- Class I (C): Initial TTE for Turner, if normal then q 5-10 years and annually if abnormal

Bicuspid Aortic Valve/Aortic Root Guidelines: Imaging Relatives

- Class I (C): Imaging for first degree relative of aortic root dilatation
- Class I (C): if patient has BAV, FBN1, TGFBR1,2, FBN1,ACTA2, MYH1, then counseling and genetic testing and <u>imaging of relatives with the mutation only</u>
- Class IIa (B): If first degree positive, image second degree relative

Bicuspid Aortic Valve Guidelines: Intervention

- Class I (B): Surgery if sinuses or ascending aorta > 5.5 cm
- Class IIa (C): Surgery if sinuses or ascending aorta > 5 cm and progression > 0.5 cm/year or FH dissection or experienced center and low STS
- Class I (C): surgery on the aorta during AVR for AR/AS if > 4.5 cm

Aortic Root Guidelines: Intervention

- Class 1 (C): Degenerative aneurysm then surgery > 5.5 cm or > 0.5 cm/y progression
- Class I (C): Surgery for > 4.5 cm if concomitant with AVR
- Class IIa (C): Surgery for Marfan in women desiring to be pregnant and root or ascending aorta > 4 cm
- Class IIa (C): Surgery for Marfan if aortic root or Ascending aortic area/height in meters: > 10 cm^2/m

Aortic Root Guidelines: Intervention

- Class IIa (C): Surgery for Loeys-Dietz and TGFBR1,2 if sinuses or ascending aorta > 4.2 cm (TTE), 4.4-4.6 (CT/MR)
- Class IIa (C): Surgery for others 4-5 depending on situation

Pre Questions (1)

- The Difference between Doppler MIG and catheterization PPG
  A. Is due to pressure recovery
  B. Is due to different measurement timing of the LV and aortic pressures
  C. Occurs only in patients with small aortas
  D. Is used to calculate aortic valve area

Answer (1)

- B. Is due to different measurement timing of the LV and aortic pressures

Pre Questions (2)

- The Difference between Doppler MIG and catheterization PPG
  - A. Is due to pressure recovery
  - B. Is due to difference in the timing of the aortic pressure measurement between cath and echo
  - C. Is due to difference in the timing of the LV pressure measurement between cath and echo
  - D. Is related to the severity of aortic stenosis

Pre Questions (2)

B. Is due to difference in the timing of the aortic pressure measurement between cath and echo

Pre Questions (3)

- Catheter-Doppler Discordance maybe due to
  A. Pressure recovery
  B. Eccentric jet
  C. Very severe aortic stenosis
  D. HOCM

Pre Questions (3)

- A. Pressure recovery

Pre Questions (4)

- The most common form of bicuspid aortic valve is
  A. Fusion of the LCC/RCC
  B. Fusion of the LCC/NCC
  C. Fusion of the RCC/NCC
  D. Equal distribution of cusp fusion

Pre Questions (4)

A. Fusion of the LCC/RCC

THANK YOU