VALVULAR DISORDERS: AORTIC AND MITRAL VALVE

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AORTIC VALVE STENOSIS

- **Etiology**
- **Severity: Follow the Guidelines**
- **Quantification**

Applying Classification of Recommendations and Level of Evidence

"SIZE of TREATMENT EFFECT"

"Estimate of Certainty (Precision) of Treatment Effect"

	Class I	Class IIa	Class IIb	Class III
	Benefit >>> Risk ***No additional studies needed*** **Procedure/Treatment SHOULD be performed/administered**	***Benefit >> Risk*** ***Additional studies with focused objectives needed*** **IT IS REASONABLE to perform procedure/administer treatment**	***Benefit ≥ Risk*** ***Additional studies with broad objectives needed; Additional registry data would be helpful*** **IT IS NOT UNREASONABLE to perform procedure/administer treatment**	***Risk ≥ Benefit*** ***No additional studies needed*** **Procedure/Treatment should NOT be performed/administered SINCE IT IS NOT HELPFUL AND MAY BE HARMFUL**
Level A *Multiple (3-5) population risk strata evaluated* *General consistency of direction and magnitude of effect*	• Recommendation that procedure or treatment is useful/effective • Sufficient evidence from multiple randomized trials or meta-analyses	• Recommendation in favor of treatment or procedure being useful/effective • Some conflicting evidence from multiple randomized trials or meta-analyses	• Recommendation's usefulness/efficacy less well established • Greater conflicting evidence from multiple randomized trials or meta-analyses	• Recommendation that procedure or treatment not useful/effective and may be harmful • Sufficient evidence from multiple randomized trials or meta-analyses
Level B ***Limited (2-3) population risk strata evaluated***	• Recommendation that procedure or treatment is useful/effective • Limited evidence from single randomized trial or non-randomized studies	• Recommendation in favor of treatment or procedure being useful/ effective • Some conflicting evidence from single randomized trial or non-randomized studies	• Recommendation's usefulness/efficacy less well established • Greater conflicting evidence from single randomized trial or non-randomized studies	• Recommendation that procedure or treatment not useful/effective and may be harmful • Limited evidence from single randomized trial or non-randomized studies
Level C ***Very limited (1-2) population risk strata evaluated***	• Recommendation that procedure or treatment is useful/effective • Only expert opinion, case studies, or standard-of-care	• Recommendation in favor of treatment or procedure being useful/ effective • Only diverging expert opinion, case studies, or standard-of-care	• Recommendation's usefulness/efficacy less well established • Only diverging expert opinion, case studies, or standard-of-care	• Recommendation that procedure or treatment not useful/effective and may be harmful • Only expert opinion, case studies, or standard-of-care

Aortic Valve Disease

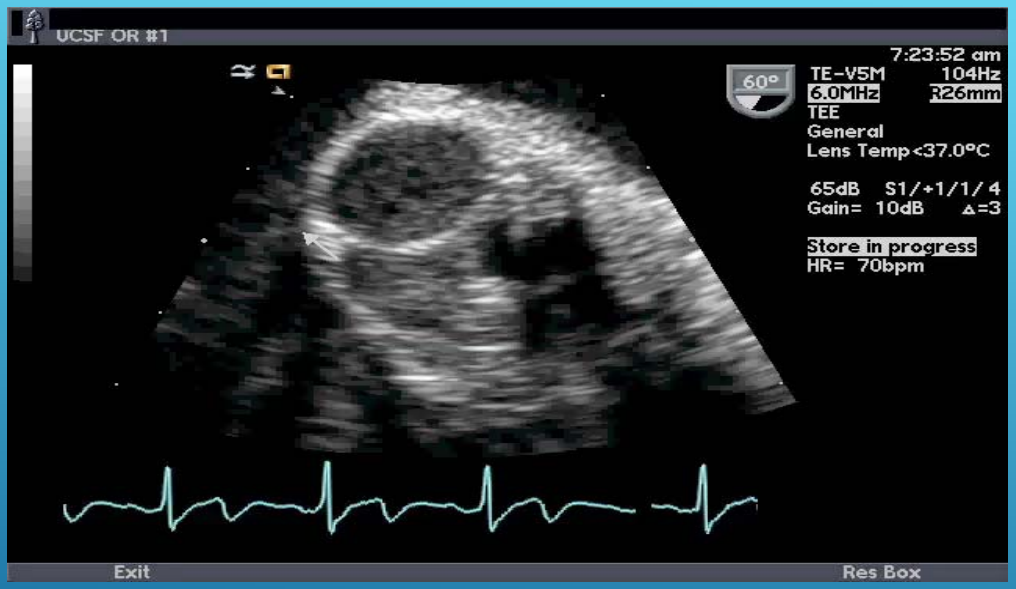
Module: Aortic Valve Disease

Aortic Stenosis – Background

Aortic Stenosis – Background

- Most common valvular lesion in USA
- Etiology
  - Bicuspid aortic valve (1%-2% of general population)
  - Rheumatic (almost always requires MV involvement)
  - Degenerative-calcific (age-related)

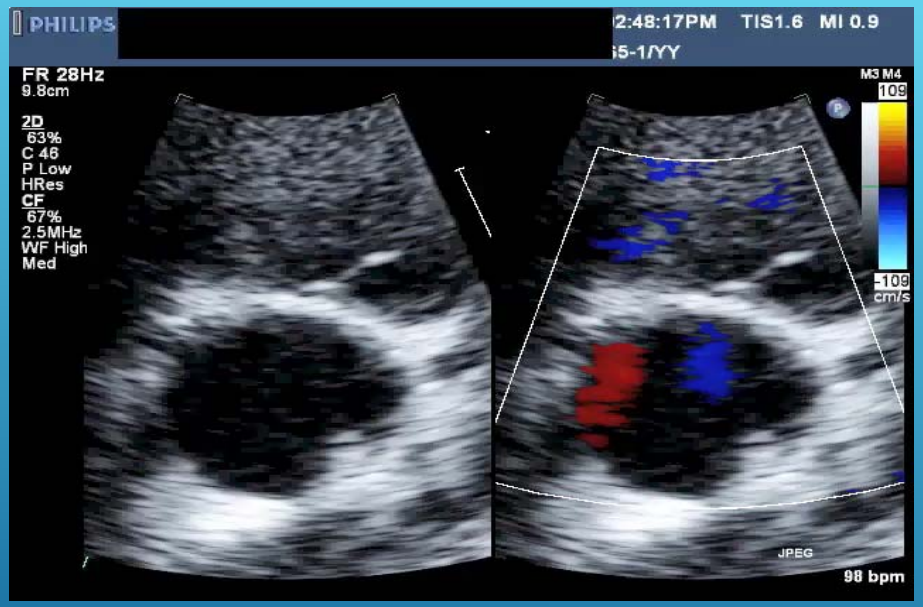
Etiology of AS



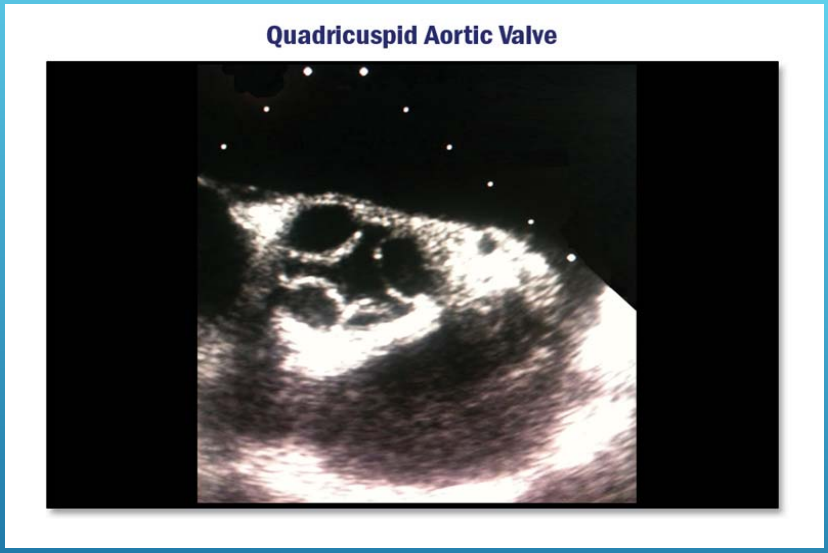
ETIOLOGY: BICUSPID AORTIC VALVE

Bicuspid Aortic Stenosis

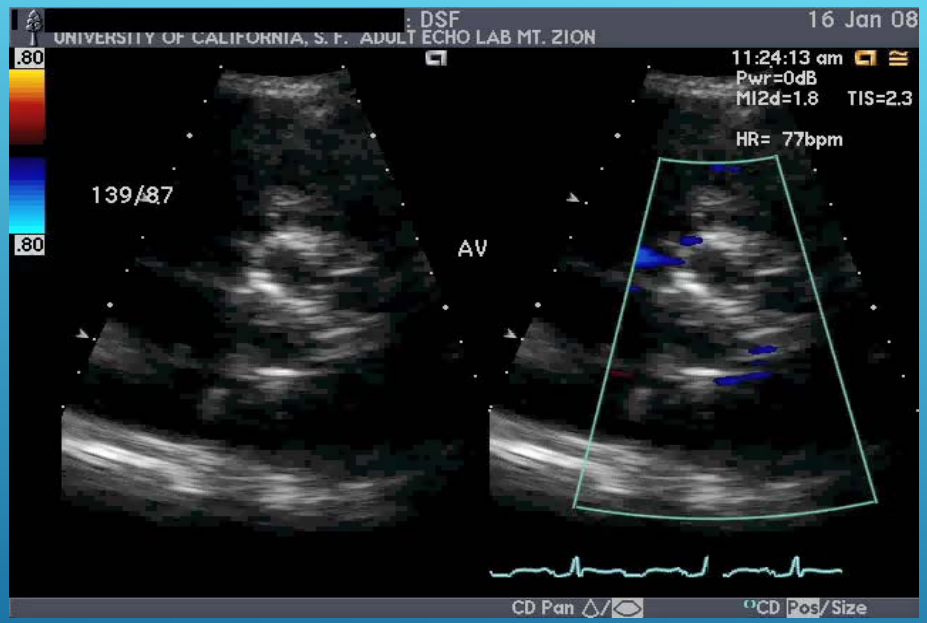
- Bicuspid aortic valve – 1%-2% of population
  - Most commonly fusion of right-left cusps
- Majority never develop stenosis
  - Those that do – younger age of presentation than degenerative (40-60)
- Associated with coarctation and dissection
  - Especially in younger patient with hypertension



ETIOLOGY: UNICUSPID AORTIC VALVE



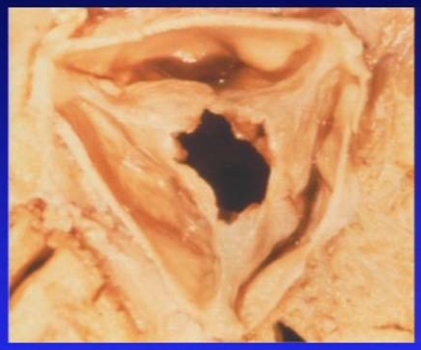
RARE VALVE DISEASE



DEGENERATIVE CALCIFIC AORTIC VALVE:

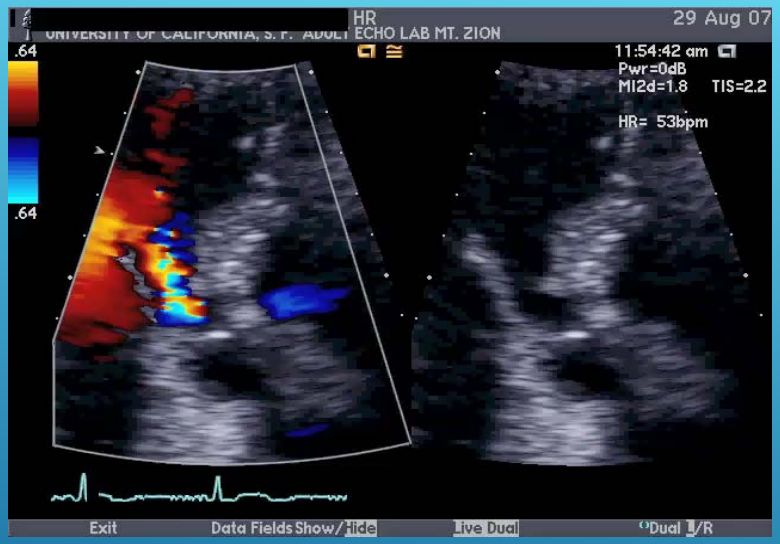
THE MOST COMMON CAUSE OF AORTIC STENOSIS IN DEVELOPED COUNTRIES

Aortic Stenosis – Rheumatic



- Fusion of commissures
- Mitral valve involvement

ETIOLOGY: RHEUMATIC

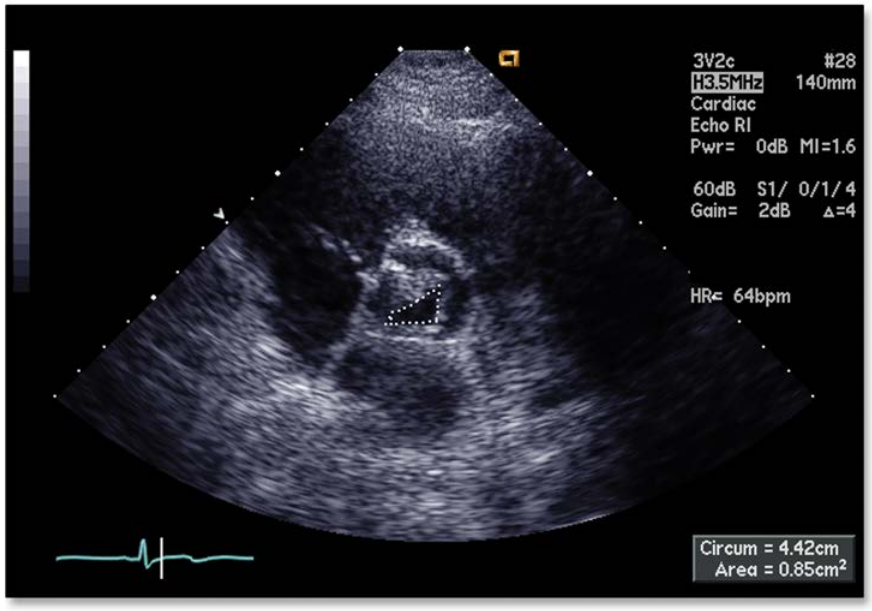


OTHERS
LVOT OBSTRUCTION-HOCM
DISCRETE SUBVALVULAR MEMBRANE

Aortic Stenosis Quantification Methods

Portion of Echocardiogram	Characteristics and Parameters
2-Dimensional Exam	Valvular thickening, calcification and restricted leaflet motion (commissural fusion if inflammatory) Left ventricular hypertrophy Poststenotic dilation of ascending aorta AV area by planimetry using TEE
Doppler Exam	Maximal and mean transvalvular pressure gradients (apical 4ch or right parasternal) AV area by continuity equation

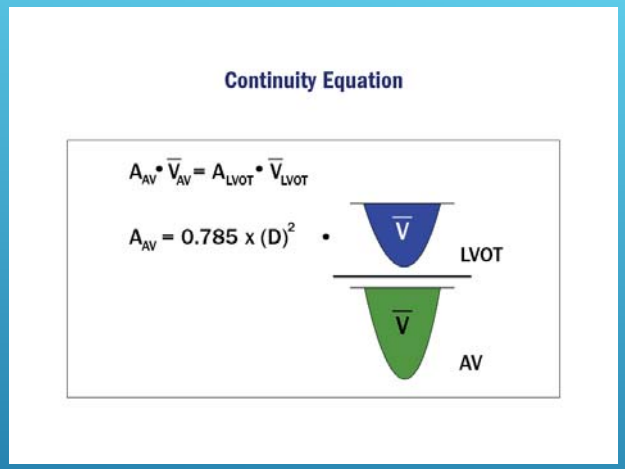
Aortic Valve Planimetry (TTE parasternal short-axis view)

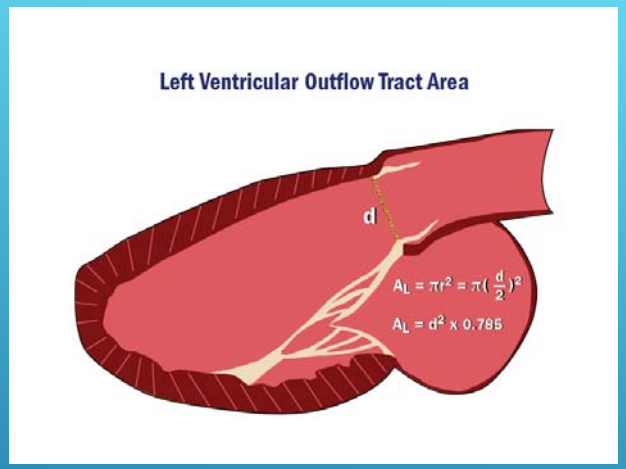


Module: Aortic Valve Disease

Aortic Stenosis – Valve Area – Echo

- Top – planimetry
- Bottom – continuity equation – a1v1=a2v2

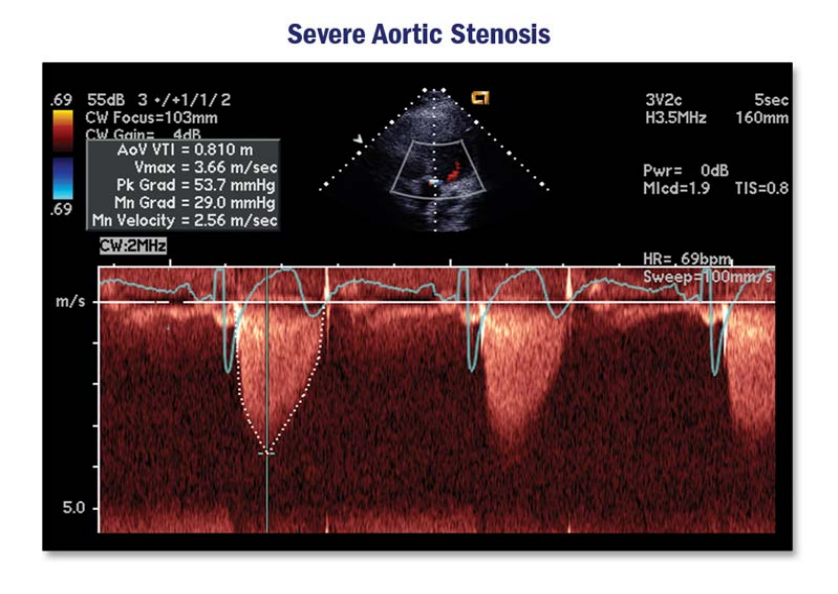




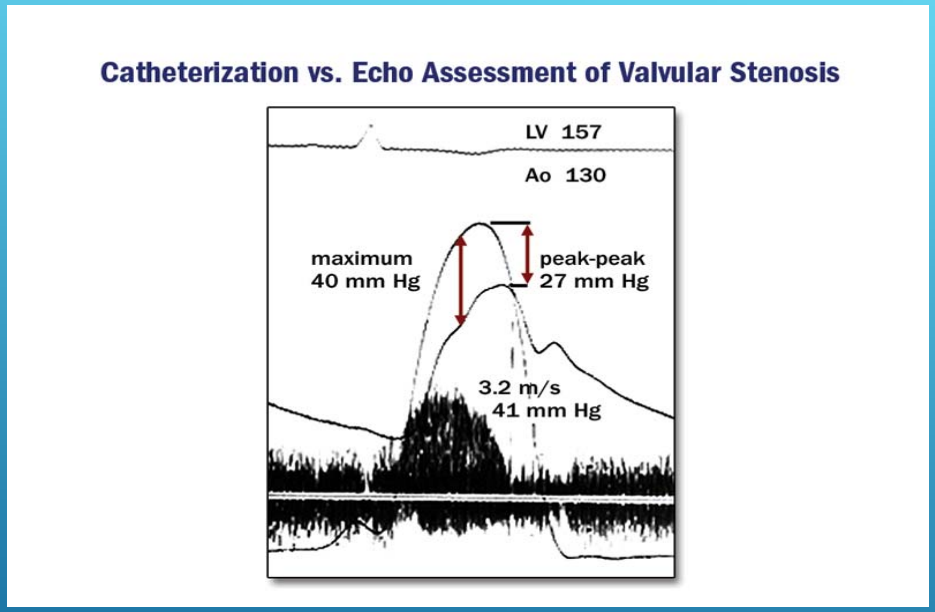
THE CONTINUITY EQUATION

ERRORS IN VALVE AREA ESTIMATION

- LVOT DIAMETER
- MISALIGMENT-UNDERESTIMATION OF THE GRADIENT
- MEASURING AN ECCENTRIC MR JET-OVERESTIMATION
- CE ASSUMES THAT THE LVOT DIAMETER IS CIRCULAR-IT IS ELLIPTICAL
- **USE THE DIMENSIONLESS VELOCITY RATIO**
- **(DVR)=PEAK LVOT VEL(VTI)/PK AV VEL(VTI)**



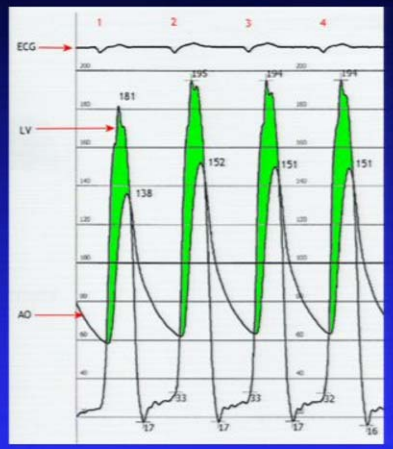
CWD USING THE PEDOFF TRANSDUCER FROM THE APICAL AND SSN WINDOWS- INSTANTANEOUS GRADIENT



DISCREPANCIES WITH CARDIAC CATHETERIZATION

Module: Aortic Valve Disease

Aortic Stenosis – Valve Area – Cath



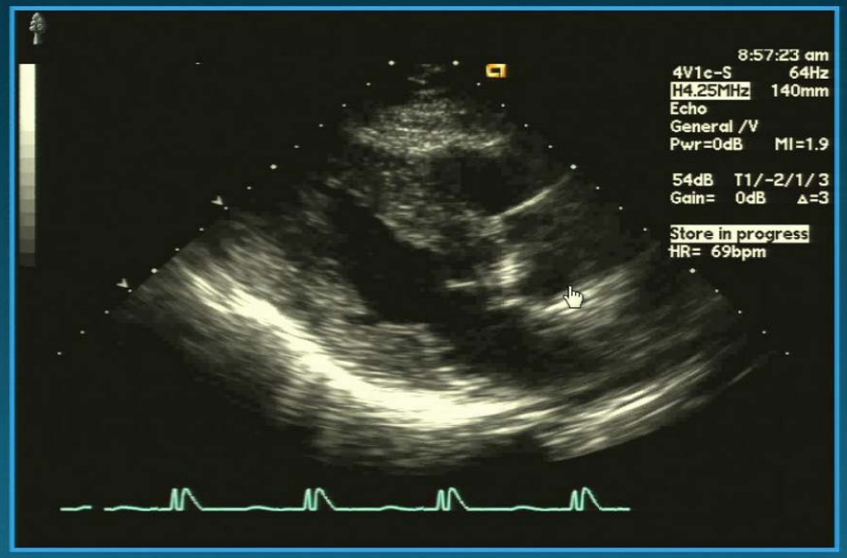
- Gorlin: $$Aortic\ Valve\ Area = \frac{Cardiac\ Output}{Heart\ rate \cdot Systolic\ ejection\ period \cdot 44.3 \cdot \sqrt{Gradient}}$$
- Hakki: $$Aortic\ Valve\ Area = \frac{Cardiac\ Output}{\sqrt{Gradient}}$$

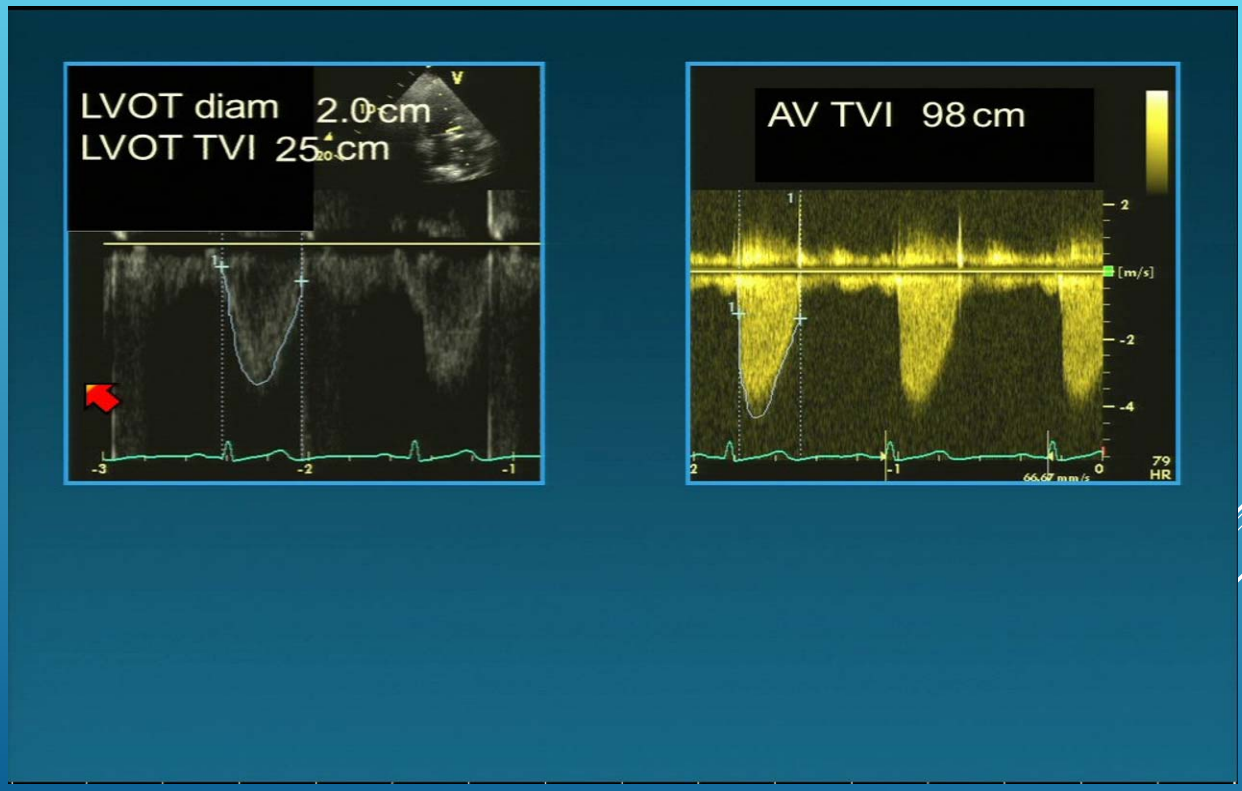
Grading severity of AS

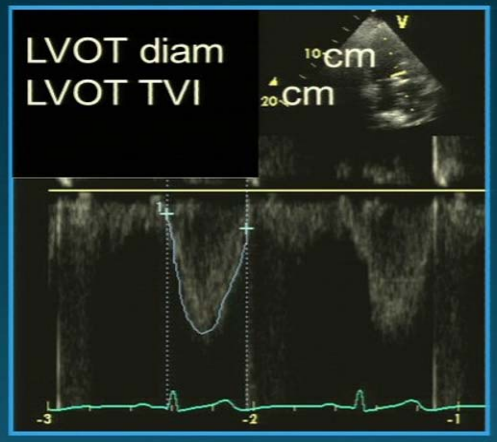
Variable	Mild	Moderate	Severe
Jet velocity (m/sec)	<3	3-4	>4
Mean gradient (mmHg)	<25	25-40	>40
Valve area (cm^2)	>1.5	1-1.5	<1
Valve area indexed(cm^2/m^2)	NA	NA	<0.6

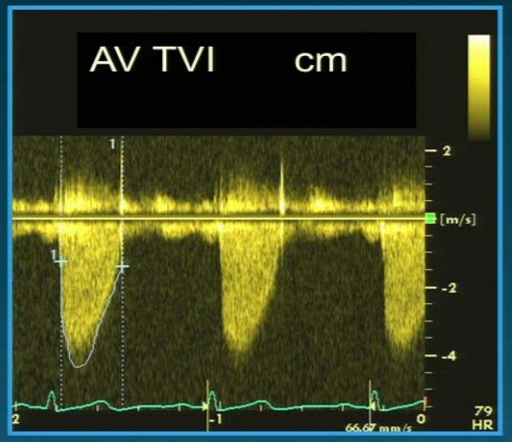
JACC 2006: 48(3) e1-148

52 year old male: Class II dyspnea




LVOT diam 2.0 cm
LVOT TVI 25 cm
AV TVI 98 cm
[m/s]
79
HR





Area 1 x TVI_1 = Area 2 x TVI_2

.785 (2.0)^2 x25 = AVA x 98

AVA = 78.8 / 98

= 0.8cm^2

Question 1

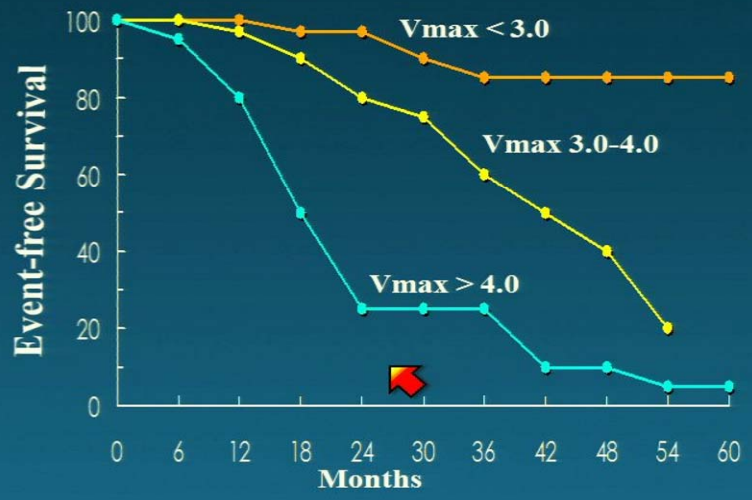
Which of the following Doppler parameters may predict event-free survival in patients with AS?

A. E/E' ratio
B. Aortic valve peak jet velocity
C. Rapid E wave deceleration time
D. Reversal of systolic PV flow

Event-Free Survival

Predictors

- **V max**
- **Δ V max**
- **NYHA Class**



Otto CM, et al. *Circulation* 1997; 95: 2262-70.

ERRORS IN VALVE AREA ESTIMATION

LEFT VENTRICULAR DYSFUNCTION

LOW FLOW/LOW GRADIENT: DEFINITION

1.EOA<1 CM 2.EF<40% 3. MEAN PG<30 MM HG

USE DOBUTAMINE STRESS ECHO FOR A BETTER ESTIMATION

LEFT VENTRICULAR HYPERTROPHY WITH DIASTOLIC DYSFUNCTION

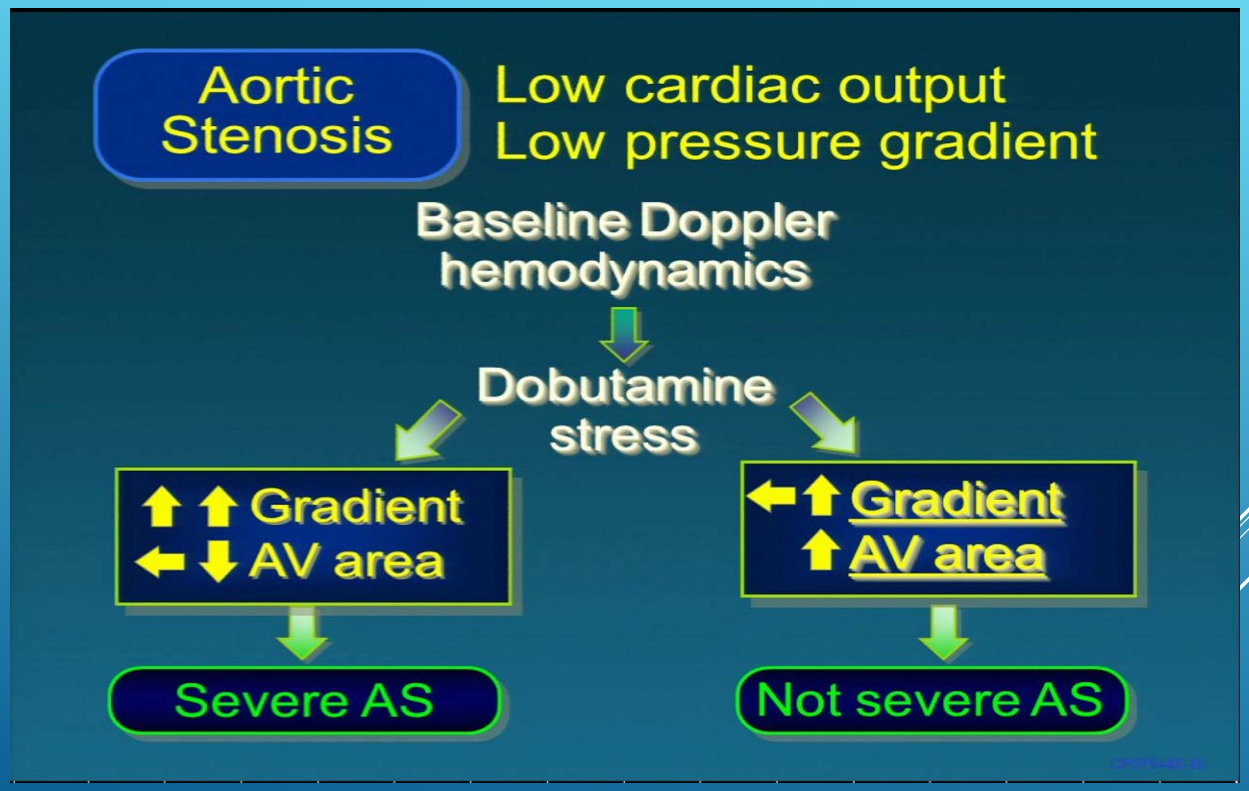
LOW SV/GRADIENT-CAN UNDERESTIMATE SEVERITY-RECENTLY TERMED PARADOXICAL LOW FLOW, LOW GRADIENT AS-ASSOCIATED WITH HIGHER AFTERLOAD AND REDUCED SURVIVAL

SYSTEMIC HYPERTENSION

AORTIC REGURGITATION

HIGH CARDIAC OUTPUT **-CHECK FOR EARLY PEAKING OF THE JET**

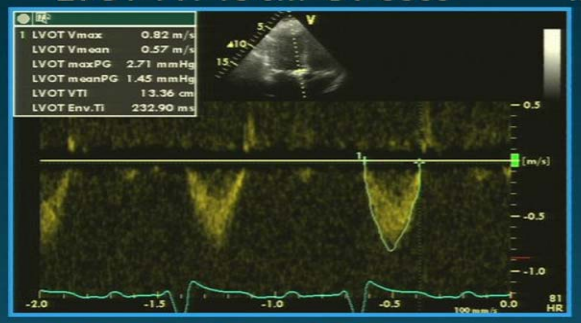
MITRAL REGURGITATION **-SEVERE MR---UNDERESTIMATION OF AS SEVERITY**


Aortic Stenosis
Low cardiac output
Low pressure gradient
Baseline Doppler hemodynamics
Dobutamine stress
Gradient
AV area
Severe AS
Gradient
AV area
Not severe AS

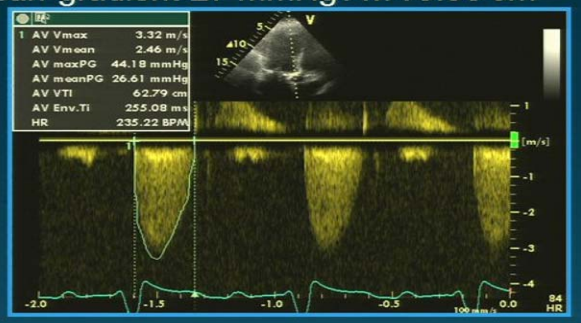
Case. Question 2

- 54 year old man: progressive DOE
- NYHA class III/IV
- Edema, orthopnea, PND
- Exam: II/VI late-peaking SEM

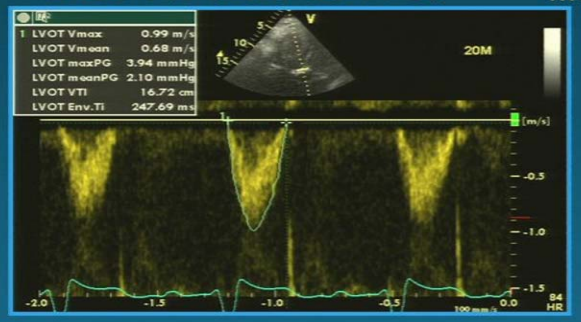
LVOT TVI 13 cm SV 59cc



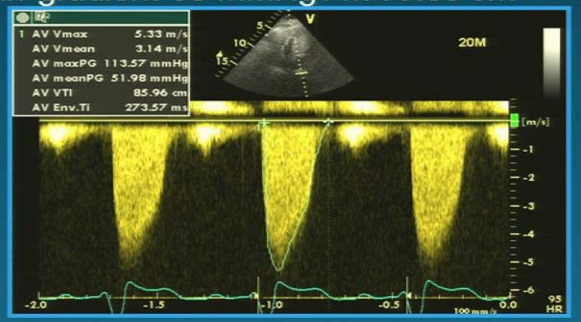
Mean gradient 27 mmHg AVA 0.93 cm²

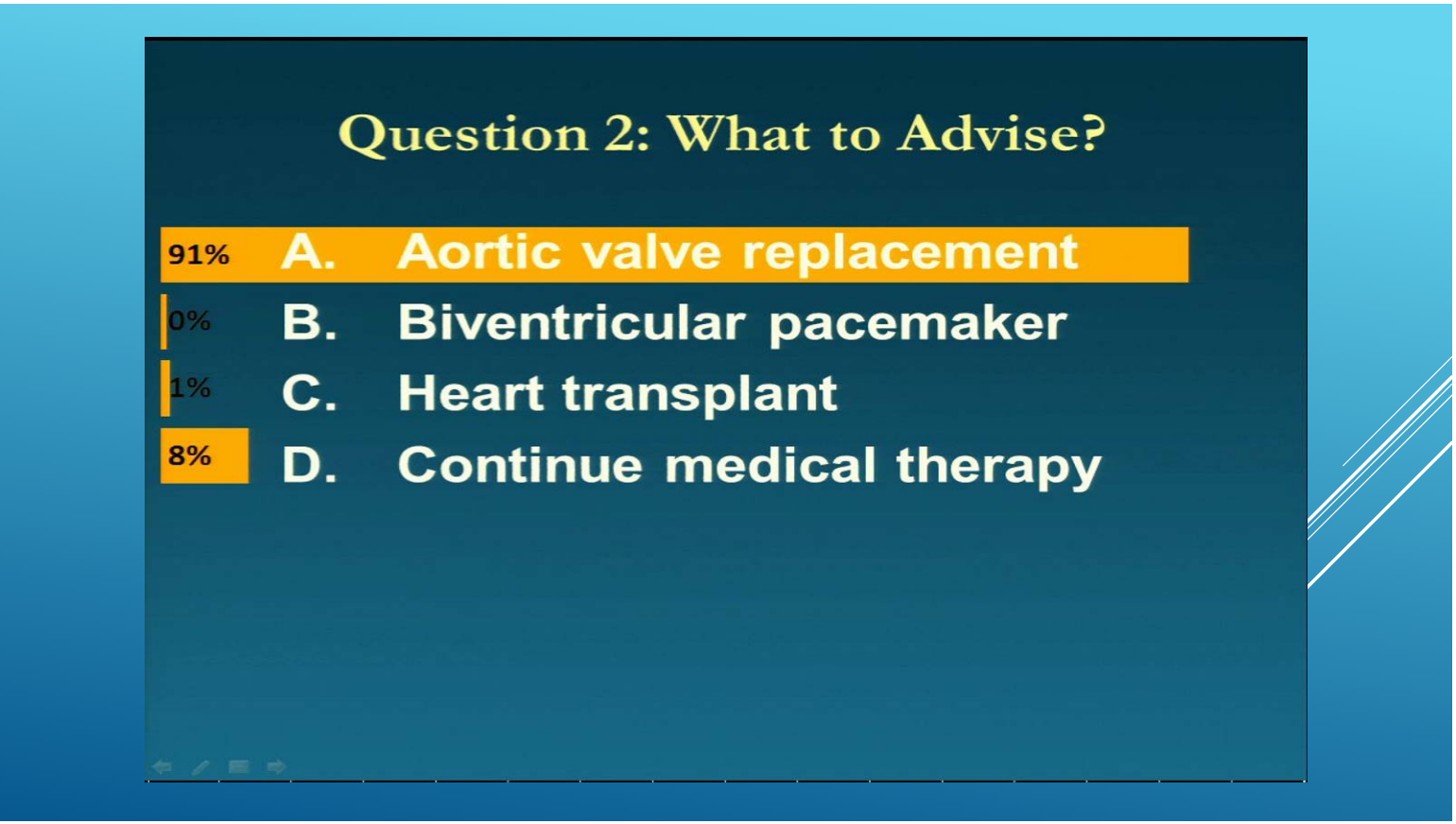


LVOT TVI 17cm SV 77 cc



Mean gradient 38 mmHg AVA 0.89 cm²




Question 2: What to Advise?
91% A. Aortic valve replacement
0% B. Biventricular pacemaker
1% C. Heart transplant
8% D. Continue medical therapy

Low Gradient AS

Take home points

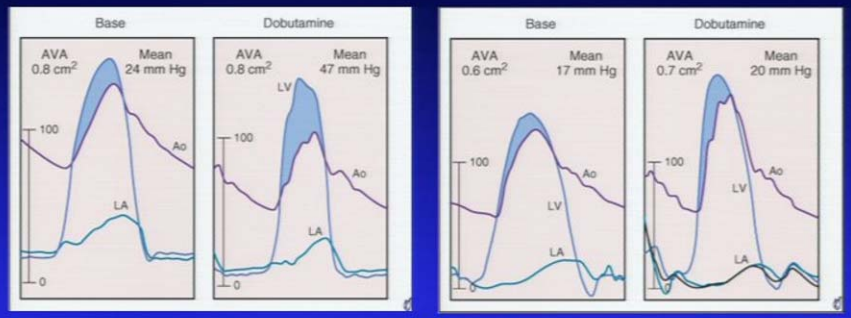
- EF < 40%; MG < 30 mmHg; AVA < 1cm²
- Dobutamine stress echo: best way to assess contractile reserve and distinguish between true and pseudo AS
- AVR is the best option

Low Gradient AS

- In low-flow states (LV dysfunction)
  - Aortic stenosis may be the cause
    - Due to afterload mismatch
    - Resultant low gradient
  - Low flow may lead to decreased valve excursion
    - Low gradient because low-flow and normal valve
    - Appearance of stenosis – "pseudostenosis"
- Need to determine whether low output/low gradient is due to valve or to myocardium
- To differentiate – dobutamine
  - Start at 5 mcg/kg/min – titrate up
  - If Increase in gradient – then valve is culprit and pt will likely benefit from AVR

Nishimura RA, Circulation 2002; 106 (7):809-13.

Low Gradient AS *cont'd*



- Left: increase in gradient with dobutamine
  - At AVR – severe AS
- Right: increase in CO, not in gradient
  - At AVR – minimal AS

Nishimura RA, Circulation 2002; 106 (7):809-13.

DOBUTAMINE STRESS TEST

ACCORDING TO RECENT CONSENSUS STATEMENT, THREE RELIABLE CONCLUSIONS CAN BE DRAWN OF A DOBUTAMINE STRESS ECHO:

1. AN AVA AT PEAK DOBUTAMINE DOSE OF OVER 1 CM2 EXCLUDES SEVERE DISEASE.

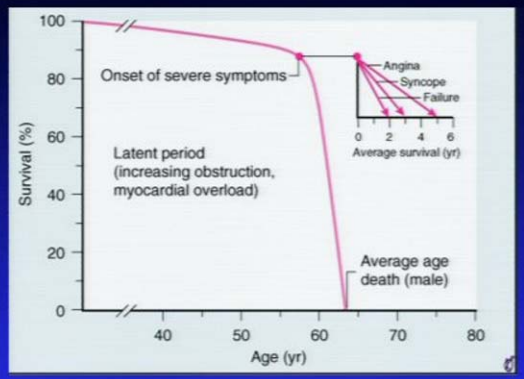
2. IF AT ANY DOSE, THE AORTIC VELOCITY EXCEEDS 4M/SEC OR MEAN GRADIENT EXCEEDS 40 MM HG AT ANY STAGE, THE AS IS SEVERE AS LONG AS THE CALCULATED AVA IS LESS THAN 1 CM2.

3. IF THE STROKE VOLUME OR LVEF DOES NOT INCREASE BY 20%, THIS SIGNIFIES A LACK OF CONTRACTILE RESERVE THAT SUGGEST POOR SURGICAL AND LONG- TERM OUTCOMES.

AS – Pathophysiology

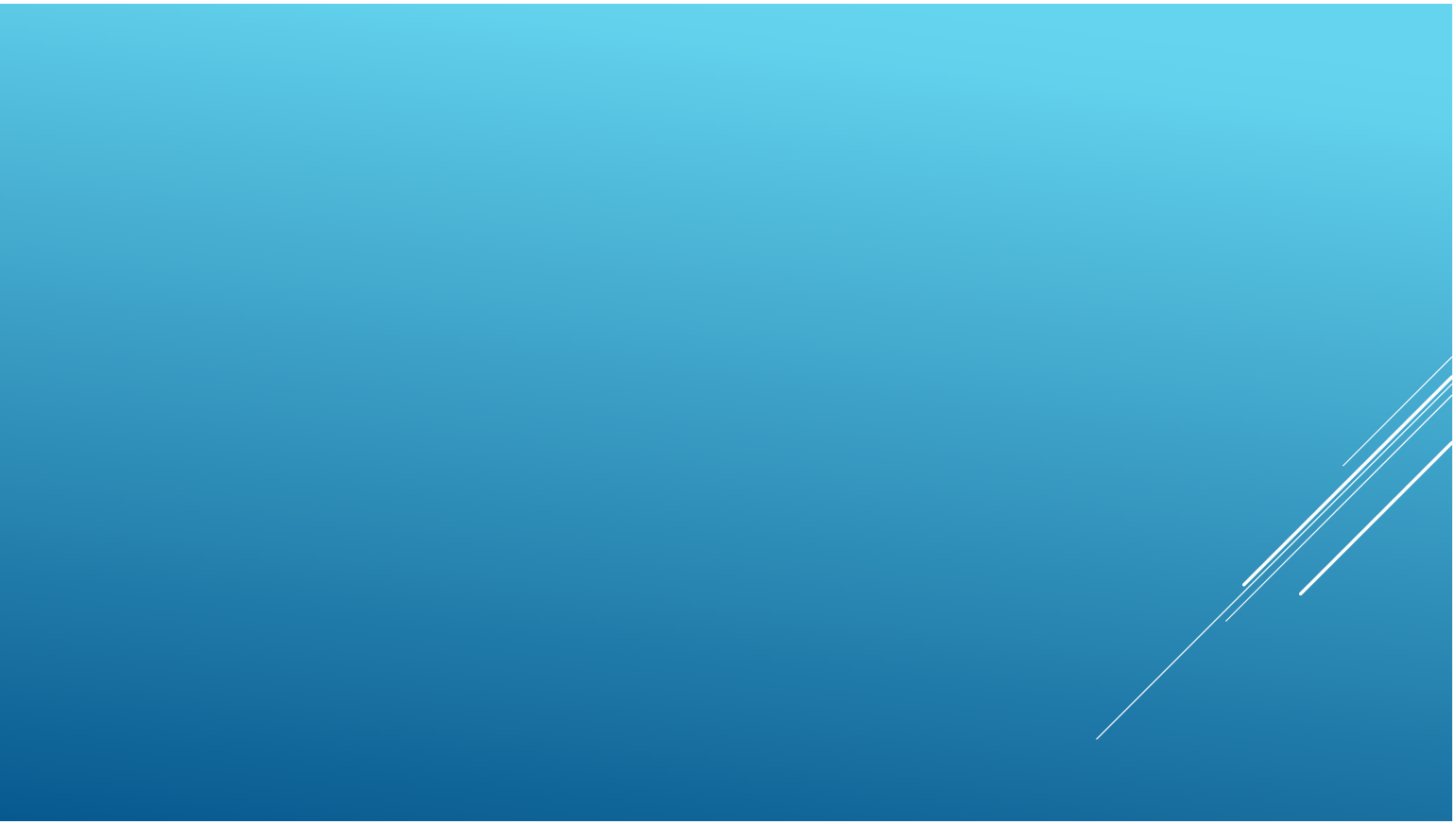
- Decrease in valve area to < 2 cm^2 produces pressure overload on LV
- Concentric hypertrophy is compensatory
- Hypertrophied myocardium
  - Decreased coronary flow reserve
    - Leads to diastolic and systolic dysfunction
      - Causing symptoms
        - Angina – coronary insufficiency
        - Syncope – decreased cardiac output (fixed stenosis)
        - CHF – ventricular dysfunction

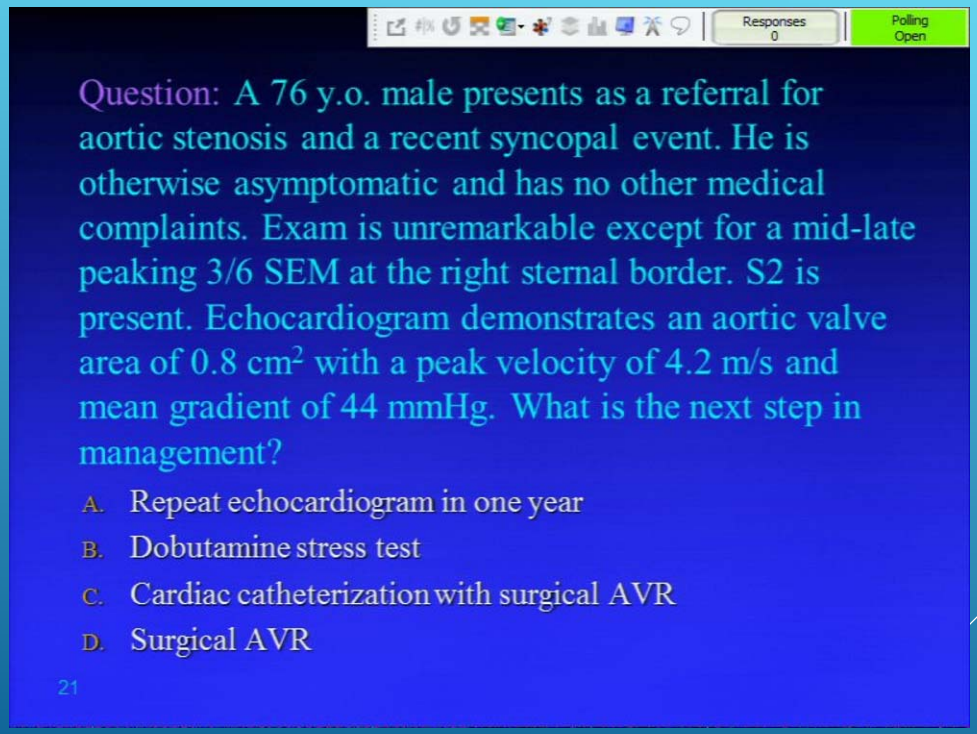
Aortic Stenosis



- Natural history
  - Asymptomatic disease – no increased mortality
  - Symptomatic disease – limited life expectancy
    - Angina – 5 years
    - Syncope – 3 years
    - CHF – 1-2 years

Ross J, Jr., Braunwald E. Aortic stenosis. Circulation 1968; 38 (1 Suppl):61-7.




Responses
0
Polling
Open
Question: A 76 y.o. male presents as a referral for aortic stenosis and a recent syncopal event. He is otherwise asymptomatic and has no other medical complaints. Exam is unremarkable except for a mid-late peaking 3/6 SEM at the right sternal border. S2 is present. Echocardiogram demonstrates an aortic valve area of 0.8 cm2 with a peak velocity of 4.2 m/s and mean gradient of 44 mmHg. What is the next step in management?
A. Repeat echocardiogram in one year
B. Dobutamine stress test
C. Cardiac catheterization with surgical AVR
D. Surgical AVR
21

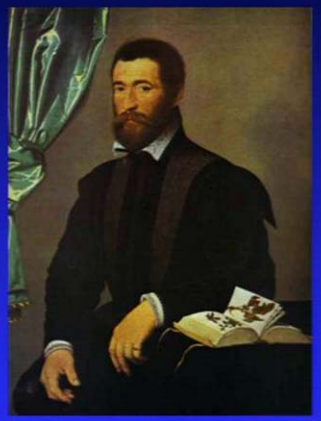
Aortic Stenosis – F/U

- Echo indicated on initial evaluation
- After initial evaluation
  - Change in symptoms
  - Asymptomatic disease
    - Yearly for severe AS
    - Every 2 years for moderate AS
    - Every 5 years for mild AS
- Expectation
  - Jet velocity increases by 0.3 m/s per year
  - Gradient increases by 7 mmHg per year
  - Valve area decreases by 0.1 cm^2 per year

Cheitlin et al. *Am Heart J* 1979 98 689
ACC/AHA guidelines *J Am Coll Cardiol* 2008 52 e1

Aortic Stenosis – Treatment

- Medical
  - Statins – potentially slow progression of AS
    - Retrospective Data for Delayed Progression and Decreased Aortic Valve Calcification
    - SALTIRE*
      - No clinical, echo, CT benefit to statin
  - ACE inhibitor
    - Benefit possibly mediated by drug effects on inflammation



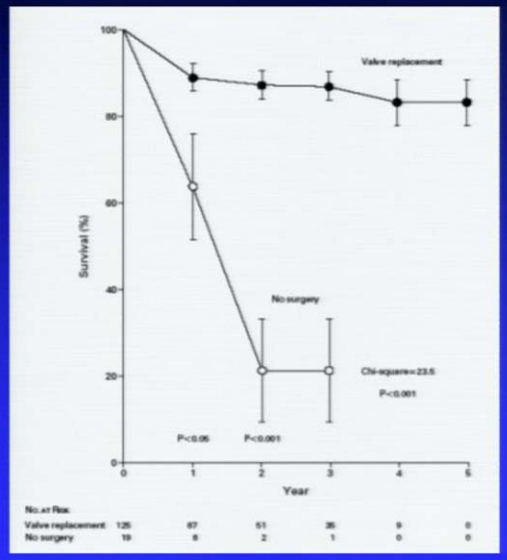
Clouet - Portrait of Apothecarist Pierre Quthe - 1562

*NEJM, 2005

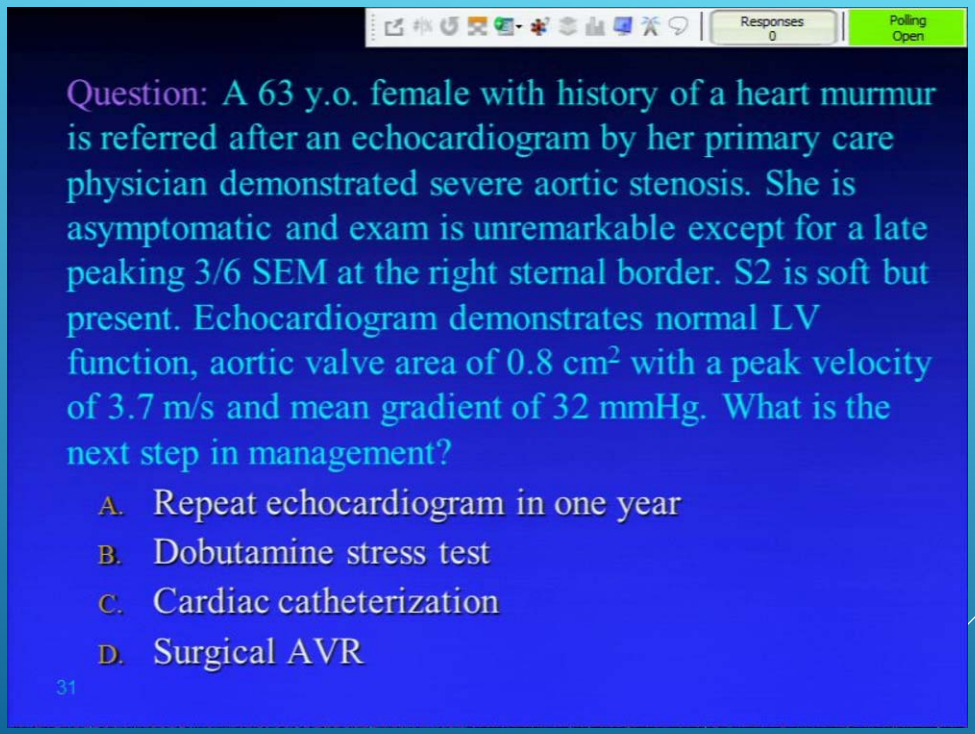
Aortic Stenosis – Treatment *cont'd*

- Surgery
  - Aortic valve replacement
    - Pros
      - 2%-4% mortality for stand-alone AVR
      - Excellent long-term outcomes
    - Cons
      - Mortality approaches 15%-20% in high risk subsets
      - Many patients with severe, symptomatic disease do not undergo surgery
        - Patient and physician factors

Aortic Stenosis – Treatment



Carabello BA. Clinical practice. Aortic stenosis. *N Engl J Med* 2002; 346 (9):677-82.


Responses
0
Polling
Open
Question: A 63 y.o. female with history of a heart murmur is referred after an echocardiogram by her primary care physician demonstrated severe aortic stenosis. She is asymptomatic and exam is unremarkable except for a late peaking 3/6 SEM at the right sternal border. S2 is soft but present. Echocardiogram demonstrates normal LV function, aortic valve area of 0.8 cm2 with a peak velocity of 3.7 m/s and mean gradient of 32 mmHg. What is the next step in management?
A. Repeat echocardiogram in one year
B. Dobutamine stress test
C. Cardiac catheterization
D. Surgical AVR
31

Responses 18 | Polling Closed

Question: A 63 y.o. female with history of a heart murmur is referred after an echocardiogram by her primary care physician demonstrated severe aortic stenosis. She is asymptomatic and exam is unremarkable except for a late peaking 3/6 SEM at the right sternal border. S2 is soft but present. Echocardiogram demonstrates normal LV function, aortic valve area of 0.8 cm^2 with a peak velocity of 3.7 m/s and mean gradient of 32 mmHg. What is the next step in management?

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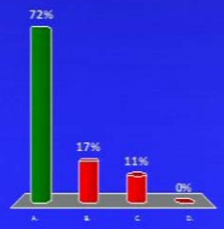
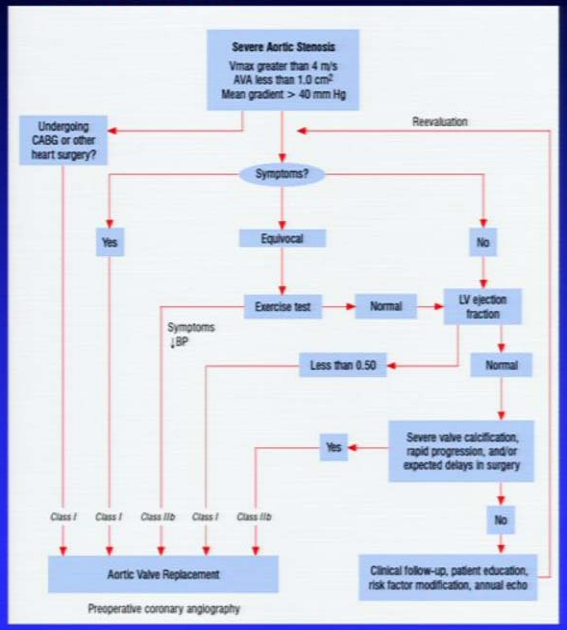


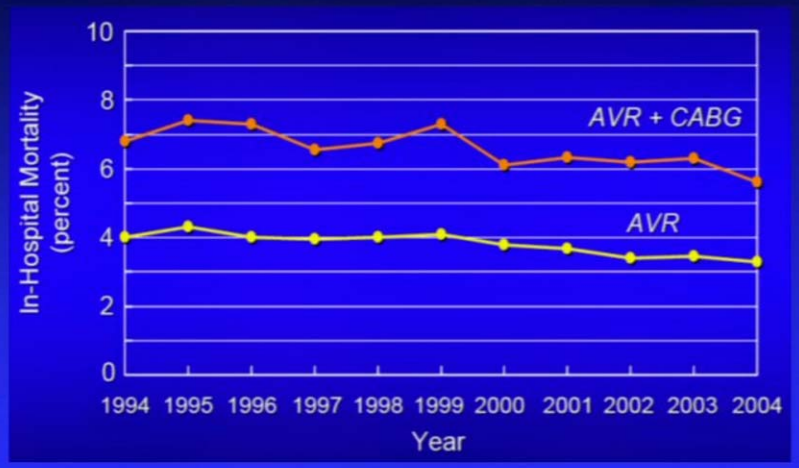
Module: Aortic Valve Disease

AS – Guidelines



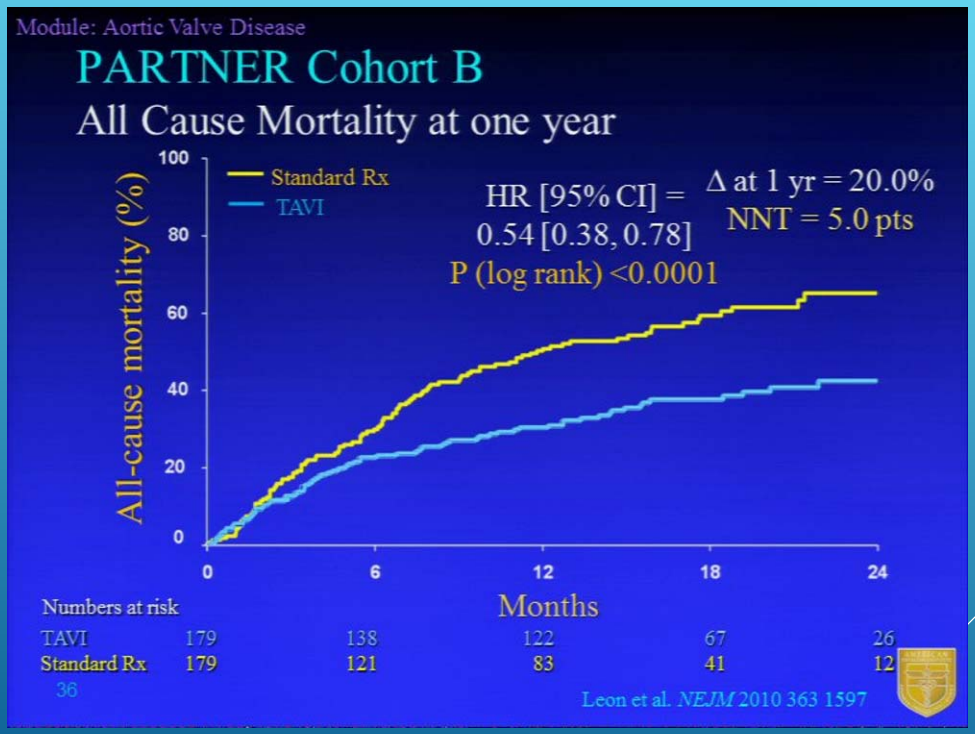
Bonow RO et al. ACC//AHA Guidelines on Valvular Disease 2006

AVR – Surgical Mortality



Society of Thoracic Surgeons Database, 2005
Adapted from Bonow RO TCT 2006

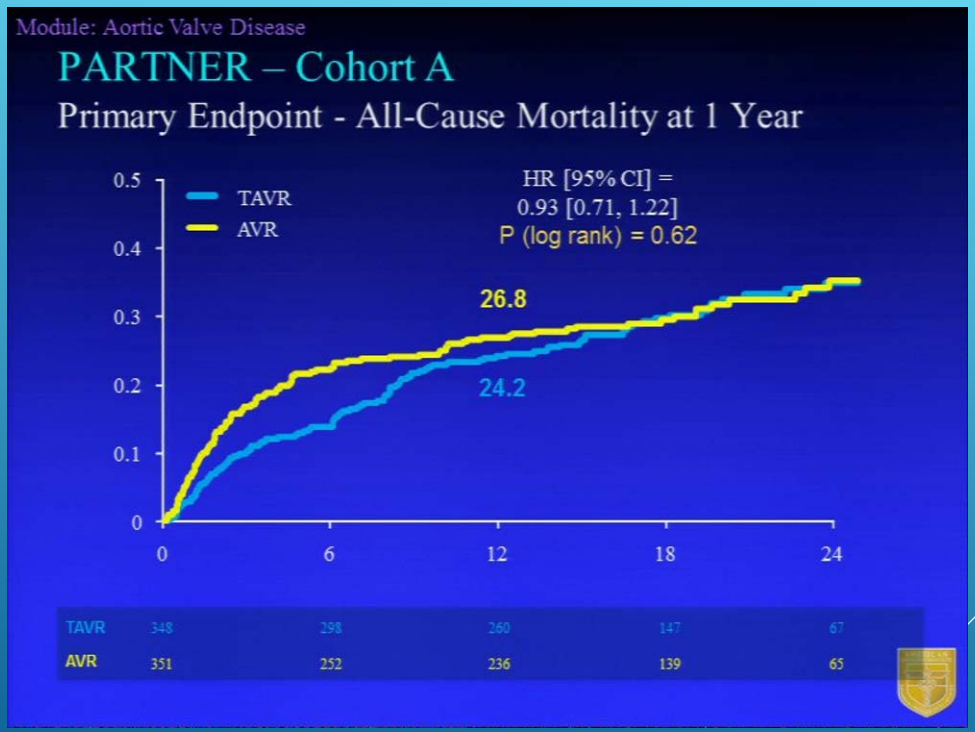
Percutaneous Therapy


Module: Aortic Valve Disease
PARTNER Cohort B
All Cause Mortality at one year
All-cause mortality (%)
100
80
60
40
20
0
Standard Rx
TAVI
HR [95% CI] = 0.54 [0.38, 0.78]
P (log rank) <0.0001
Δ at 1 yr = 20.0%
NNT = 5.0 pts
0
6
12
18
24
Months
Numbers at risk
TAVI 179 138 122 67 26
Standard Rx 179 121 83 41 12
36
Leon et al. NEJM 2010 363 1597

Module: Aortic Valve Disease

PARTNER – Cohort A

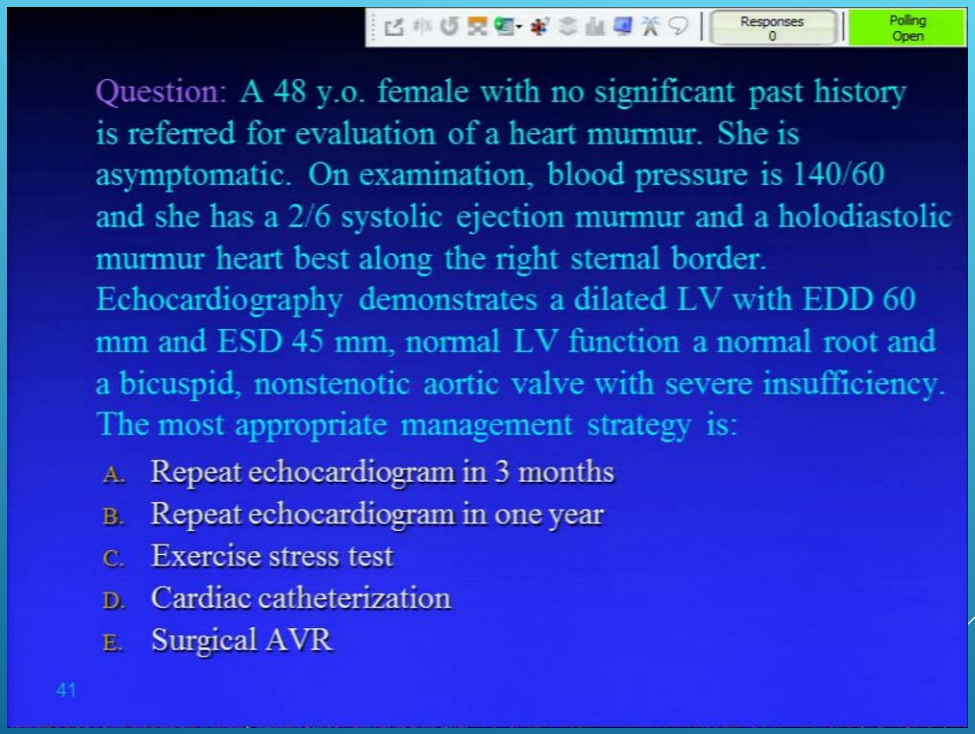
Primary Endpoint - All-Cause Mortality at 1 Year



Module: Aortic Valve Disease

TAVR – "approved" indications

- Severe aortic stenosis – Guideline Based
- STS greater than 8%
  - Or mortality estimate > 15% in opinion of cardiologist and two cardiac surgeons
- Life expectancy greater than 1 year
  - Outside of Aortic stenosis
- Requires multidisciplinary heart team
- Inoperable transapical technically "off label"


Responses
0
Polling
Open
Question: A 48 y.o. female with no significant past history is referred for evaluation of a heart murmur. She is asymptomatic. On examination, blood pressure is 140/60 and she has a 2/6 systolic ejection murmur and a holodiastolic murmur heart best along the right sternal border. Echocardiography demonstrates a dilated LV with EDD 60 mm and ESD 45 mm, normal LV function a normal root and a bicuspid, nonstenotic aortic valve with severe insufficiency. The most appropriate management strategy is:
A. Repeat echocardiogram in 3 months
B. Repeat echocardiogram in one year
C. Exercise stress test
D. Cardiac catheterization
E. Surgical AVR
41

Responses 16 | Polling Closed

Question: A 48 y.o. female with no significant past history is referred for evaluation of a heart murmur. She is asymptomatic. On examination, blood pressure is 140/60 and she has a 2/6 systolic ejection murmur and a holodiastolic murmur heart best along the right sternal border. Echocardiography demonstrates a dilated LV with EDD 60 mm and ESD 45 mm, normal LV function a normal root and a bicuspid, nonstenotic aortic valve with severe insufficiency. The most appropriate management strategy is:

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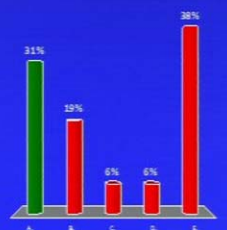


Aortic Regurgitation

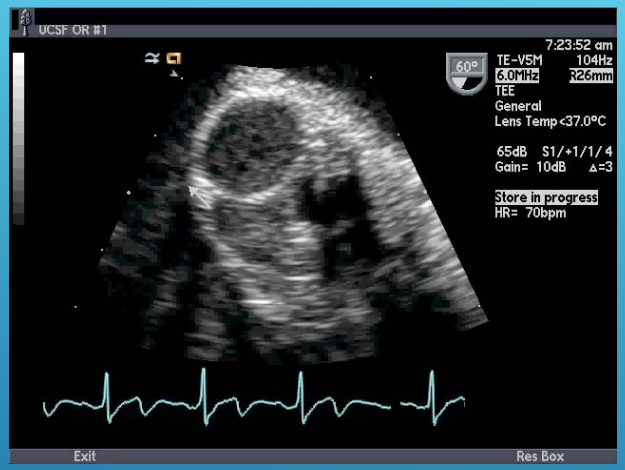
Etiology

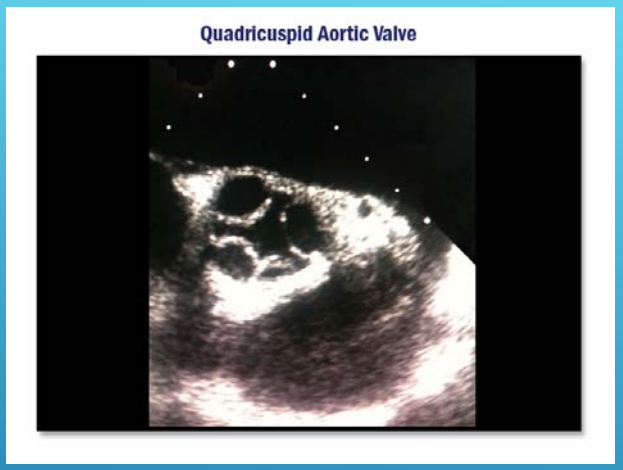
VALVE

- BAV DISEASE
- RHEUMATIC
- IE
- MYXOMATOUS
- APLA
- TRAUMA

ROOT

- CT DISORDER
- DISSECTION
- IE
- AORTITIS
- HTN
- OTHER (Congenital)



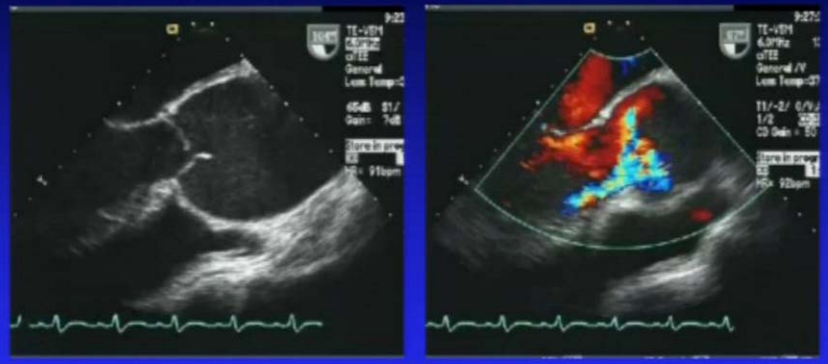


AORTIC REGURGITATION ETIOLOGIES

Aortic Insufficiency

- Etiology
  - Formerly, syphilis was most common cause
  - Today
    - Aortic root dilatation
    - Bicuspid valve
    - Calcific degeneration
    - Dissection
    - Rheumatic heart disease
    - Endocarditis
    - Connective tissue disease

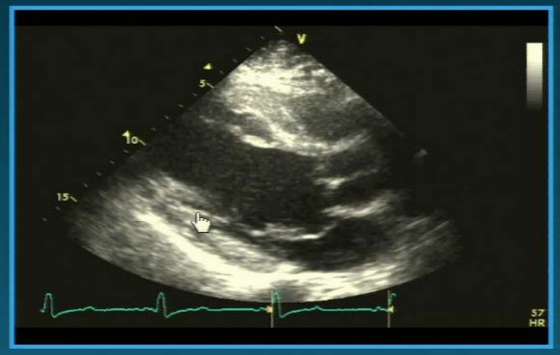
AI – Aortic Root Dilatation

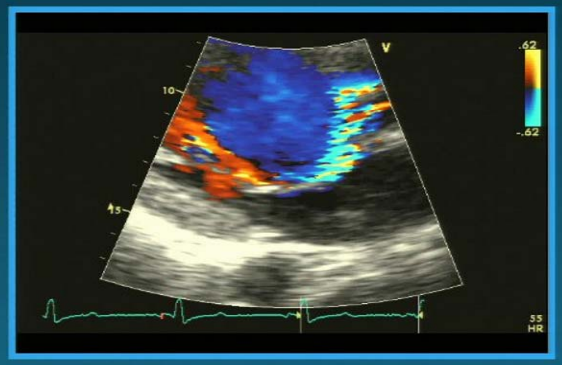


- Dilated root
- Malcoaptation of aortic valve leaflets
- Resultant aortic insufficiency

Question 3

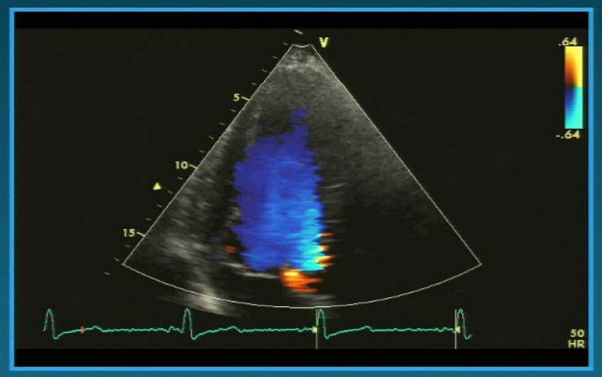
EDD: 76 mm; ESD: 51 mm

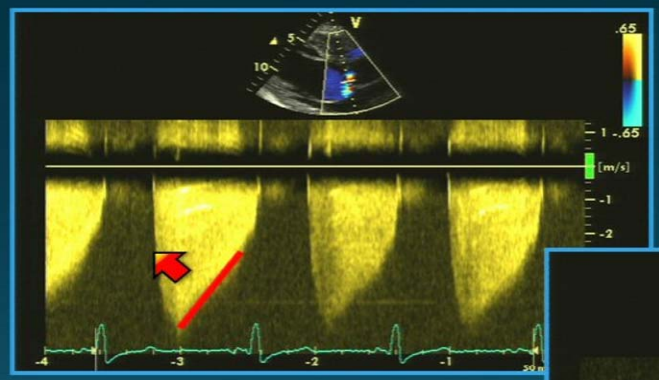




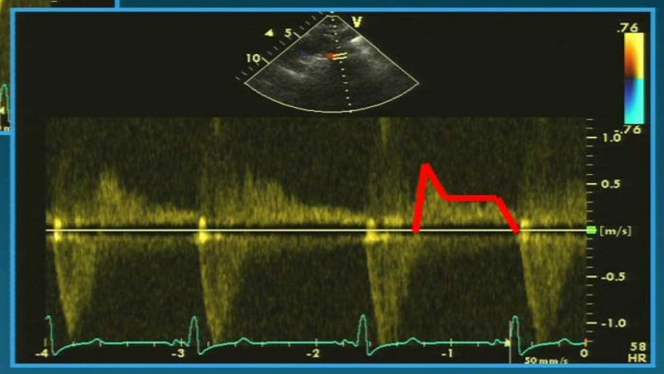
Question 3

Regurgitant volume:140 mL; ERO:0.62 cm²





T ½: 200 msec



TVI SSN: 16 cm

Question 3: Severity of AR?

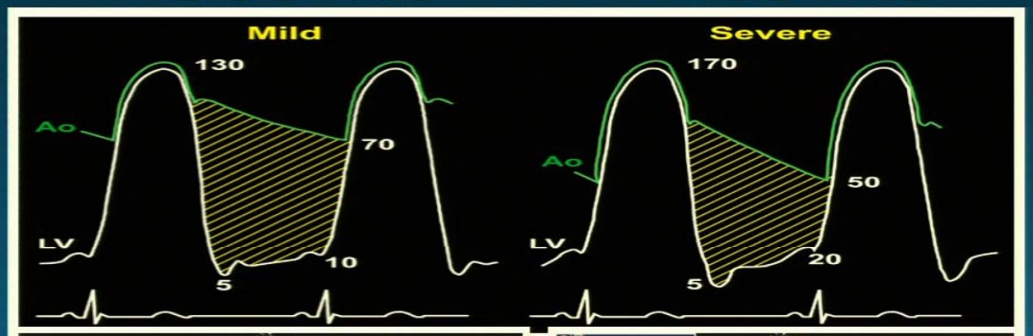
1. Moderate
2. Moderate-Severe
3. Severe

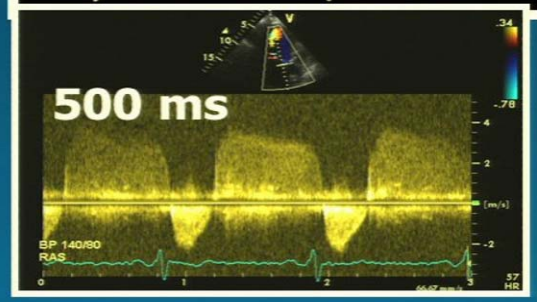
Summary Severe AR: TTE

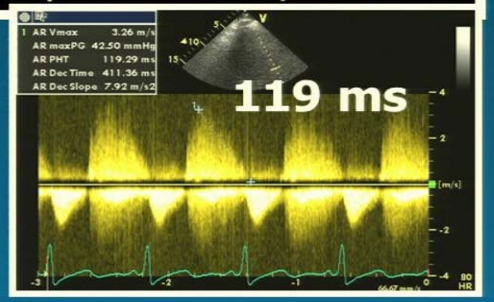
- Color jet width > 60%
- Vena contracta > 6 mm
- $T_{1/2}$ AR CW < 200 msec
- TVI flow reversal (SSN): 13-15 cm
- RV $\geq$ 60 mL
- ERO $\geq$ 30 mm^2

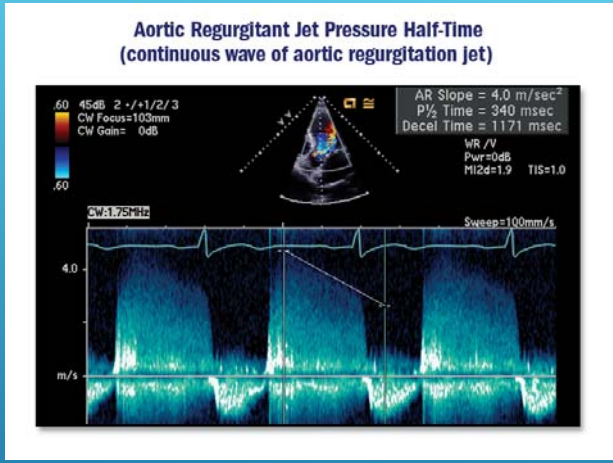
Pressure Half Time

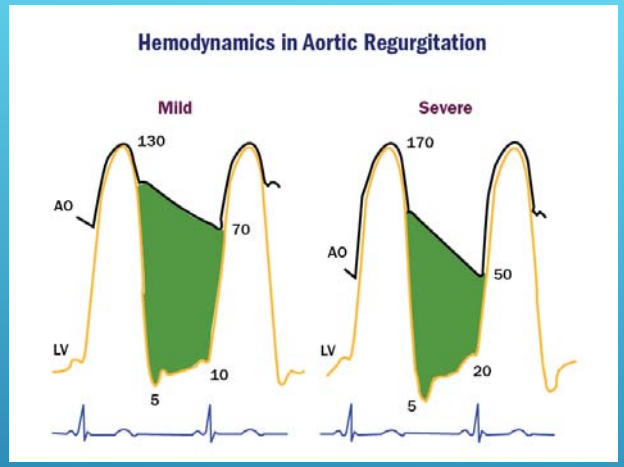
>500 ms <200 ms







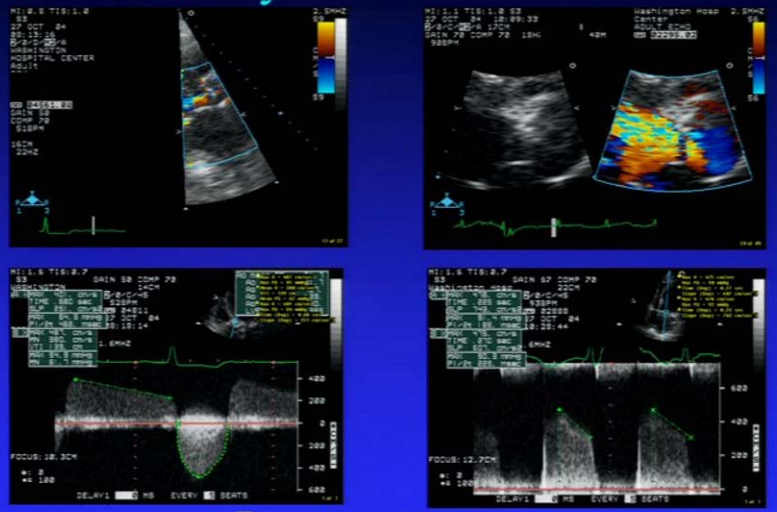




AORTIC REGURGITATION

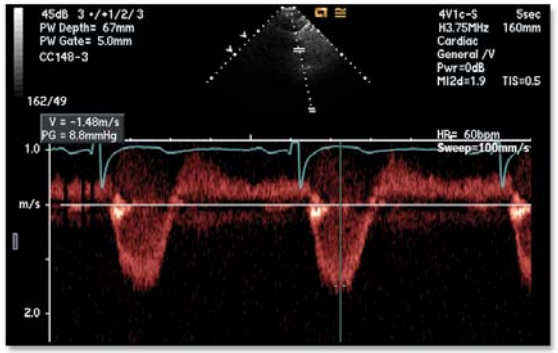
Module: Aortic Valve Disease

AI – Severity

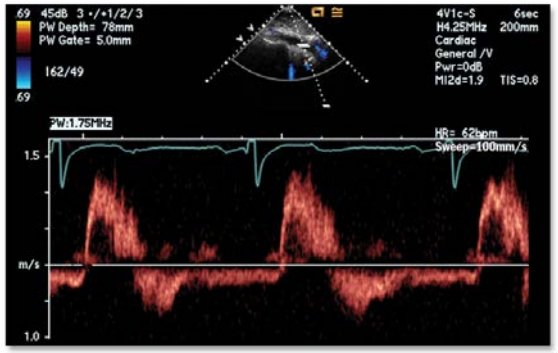


- Top – vena contracta
  - Mild: <0.3; severe: >0.6
- Bottom – pressure half-time
  - Mild: >450; severe <250

Aortic Arch Flow Reversal
(TTE pulsed wave Doppler sample from the suprasternal notch view)

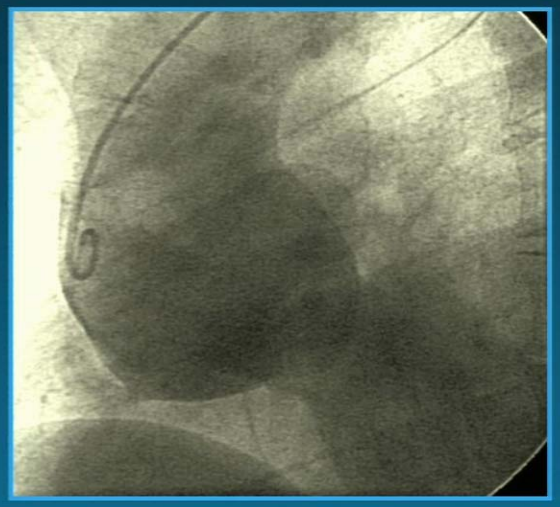


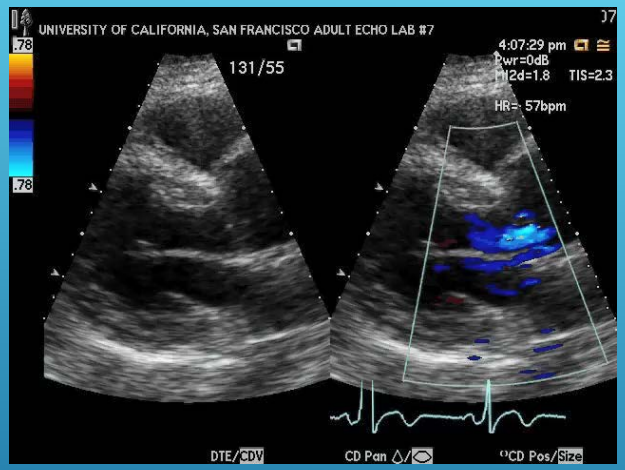
Abdominal Aorta Flow Reversal
(TTE pulsed wave Doppler sample from the subcostal view)

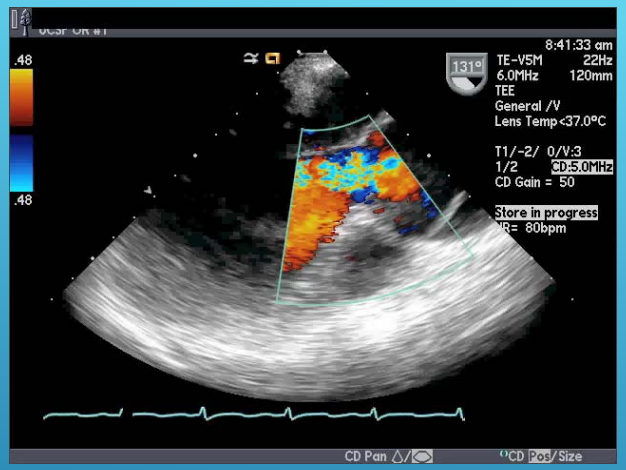


AORTIC REGURGITATION
FLOW REVERSAL

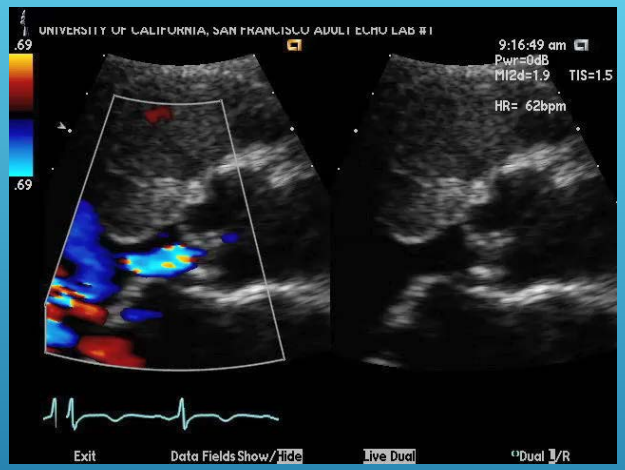
Root Aneurysm with Bicuspid Ao Valve

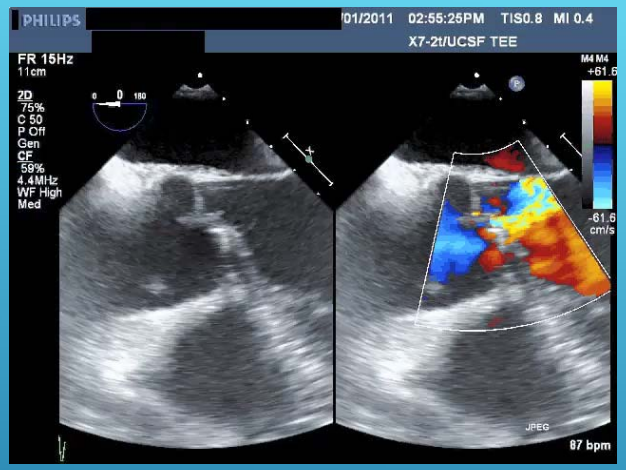




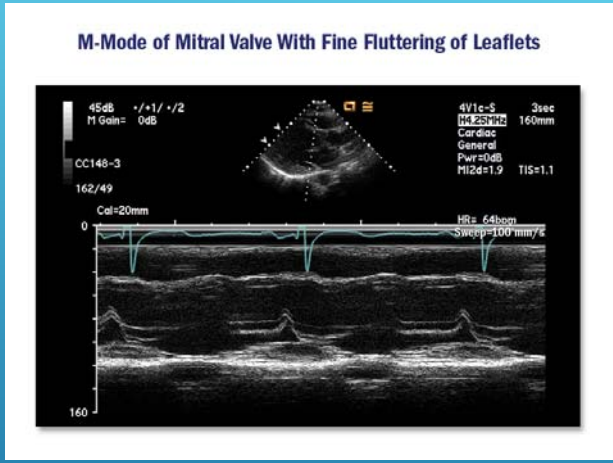


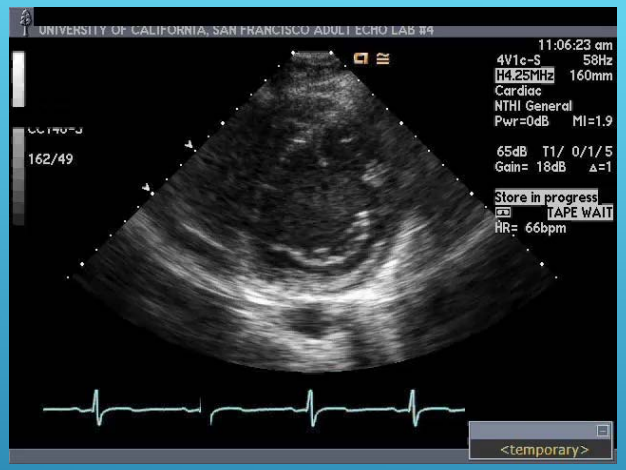
AORTIC REGURGITATION ETIOLOGIES





AORTIC REGURGITATION ETIOLOGIES





AORTIC REGURGITATION

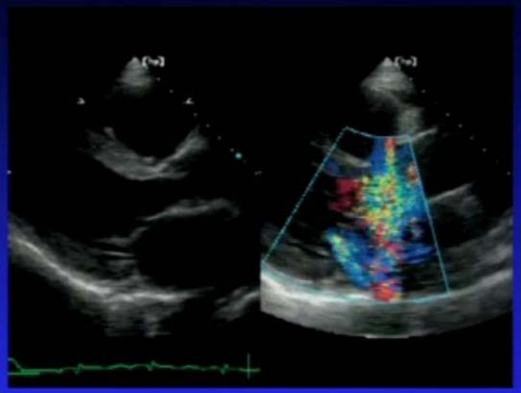
Severe AI – Echocardiography

- Jet dimension >60% LVOT diameter
  - May be misleading on eccentric jets
- Flow reversal in proximal descending aorta
  - >0.6 m/s initially, 0.2 m/s holodiastolic
- Regurgitant volume >60 ml
- Regurgitant fraction >55%
- Look for supportive signs
  - Eccentric LVH
  - LV Dilation
- Catheterization if discrepancy

Application of Specific and Supportive Signs, and Quantitative Parameters in the Grading of Aortic Regurgitation Severity

	Mild	Moderate		Severe
Specific signs for AR Severity	• Central Jet, width <25% of LVOT[ξ]	• Signs of AR>mild present but no criteria for severe AR		• Central Jet, width _ ≥65% of LVOT[ξ]
	• Vena contracta _ 0.3 cm[ξ]			• Vena contracta
	• No or brief early diastolic flow reversal in descending aorta			• >0.6 cm[ξ]
Supportive signs	• Pressure half-time >500 ms	• Intermediate values		• Pressure half-time <200 ms
	• Normal LV size*			• Holodiastolic aortic flow reversal in descending aorta
				• Moderate or greater LV enlargement**
Quantitative parameters[ψ]				
R Vol, ml/beat	<30	30-44	45-59	≥60
RF, %	<30	30-39	40-49	≥50
ERAO, cm^2	<0.10	0.10-0.19	0.20-0.29	≥0.30

Acute AI

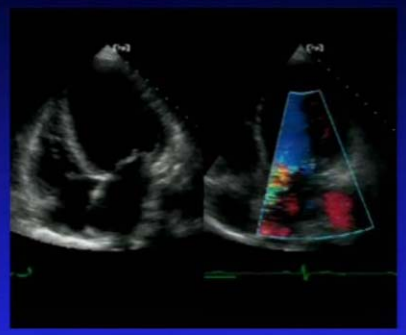


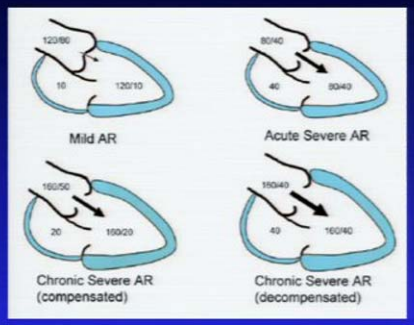
- Sudden increase in LV end diastolic volume and pressure
  - Murmur may be short or inaudible
  - Physical exam findings diminished or even absent
- Insufficient time for LV to dilate
  - Leads to tachycardia (compensatory) and pulmonary edema
- On echo – may see diastolic mitral regurgitation

Bonow RO et al. ACC//AHA Guidelines on Valvular Disease 2006

Module: Aortic Valve Disease

Chronic AI

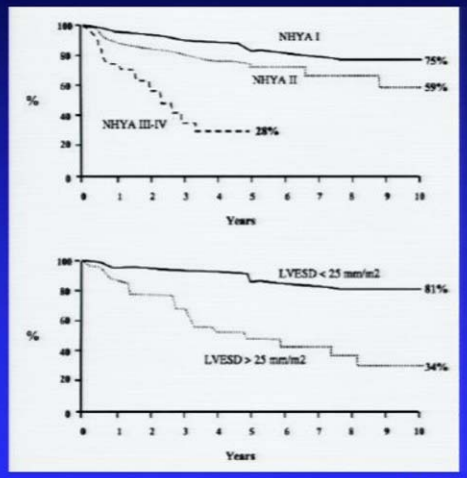




- Increased end diastolic volume, increased preload
- Compensatory LV dilatation and hypertrophy
  - Produces increase in afterload
  - Thus, chronic AI is a state of both pressure and volume overload
    - This compensated state may persist for decades
      - Systolic performance remains normal
      - Stroke volume is increased – widened pulse pressure

AI – Natural History

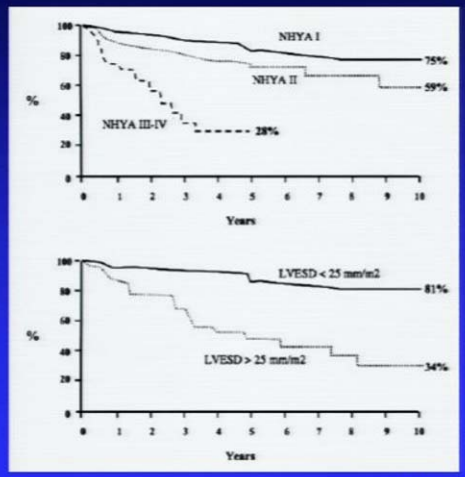
- Asymptomatic patients with normal LVSF
  - Progress to Sx or LV dysfunction – 6%/yr
  - Sudden death – 0.2%/yr



Bekeredjian R Circulation 2005; 112 (1):125-34.

AI – Natural History

- Asymptomatic patients with normal LVSF
  - Progress to Sx or LV dysfunction – 6%/yr
  - Sudden death – 0.2%/yr
- Asymptomatic patients with LV dysfunction
  - Symptoms – 25%/yr
- Symptoms
  - Death – 10%/yr



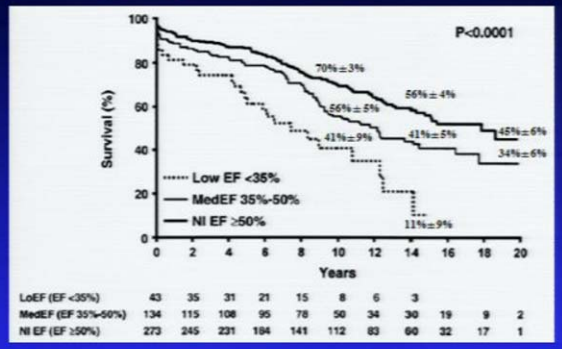
Bekeredjian R Circulation 2005; 112 (1):125-34.

Chronic AI – Treatment

- Echocardiography
  - Initial evaluation
  - Yearly for severe disease or root dilatation
- Medical therapy
  - Long-term vasodilator therapy
    - Retrospective data exist for both nifedipine and ACE-I
      - Slows LV dilatation
      - Reduces LV dysfunction with eventual surgery
      - Recently called into question

AI – Surgery

AI – Surgery Based on EF

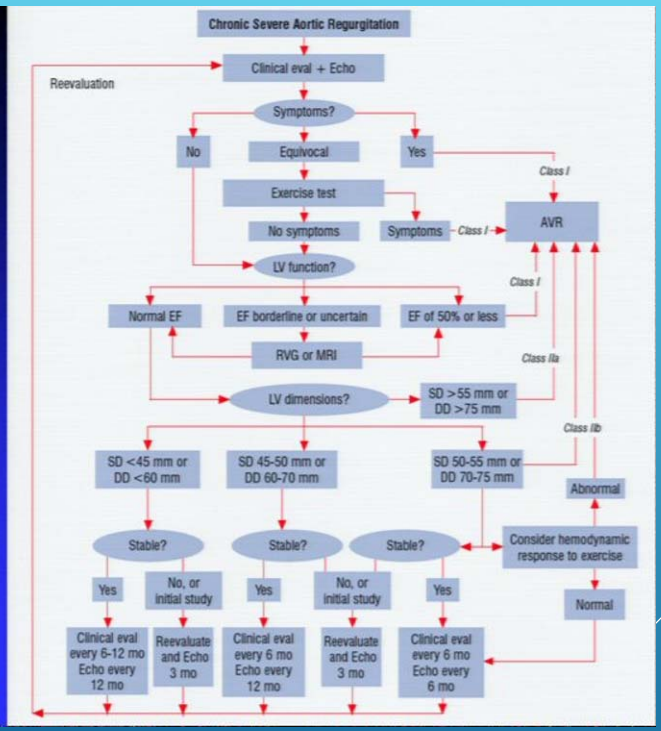


- Operative mortality
  - EF >50% - 3.7%
  - EF 35%-50% - 6.7%
  - EF <35% - 14%
- Long-term survival also affected by EF

Bekeredjian R, Gray Circulation 2005; 112 (1):125-34.

Module: Aortic Valve Disease

AI – Indications for Surgery



Bonow RO et al. ACC//AHA Guidelines on Valvular Disease 2006

Indications for AVR: Severe AR

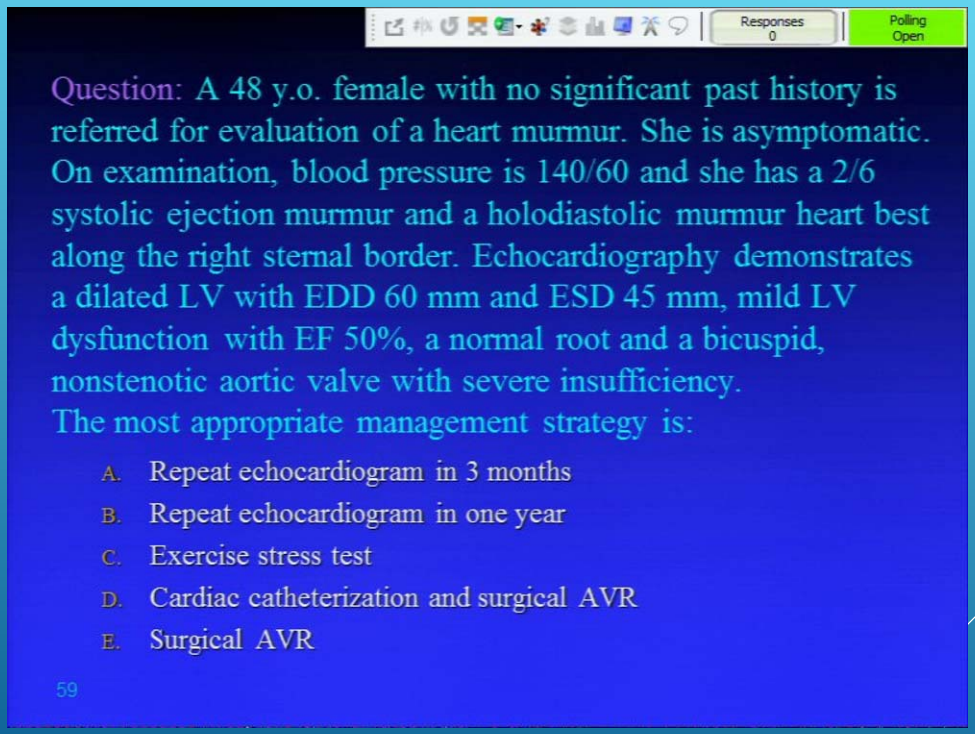
Class I

- Symptoms
- EF < 0.50
- Need for Ao surgery

Class II

- LVESD > 55 mm or > 25 mm/M^2
- LVEDD > 75 mm
- LVESD > 50 mm or LVEDD > 70 mm and progressing

ACC/AHA Valve Guidelines 2006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The most appropriate management strategy is:
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B. Repeat echocardiogram in one year
C. Exercise stress test
D. Cardiac catheterization and surgical AVR
E. Surgical AVR
59

Responses 13 | Polling Closed

Question: A 48 y.o. female with no significant past history is referred for evaluation of a heart murmur. She is asymptomatic. On examination, blood pressure is 140/60 and she has a 2/6 systolic ejection murmur and a holodiastolic murmur heart best along the right sternal border. Echocardiography demonstrates a dilated LV with EDD 60 mm and ESD 45 mm, mild LV dysfunction with EF 50%, a normal root and a bicuspid, nonstenotic aortic valve with severe insufficiency.
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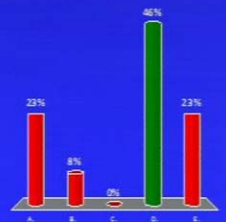


AI – Indications for Surgery

- Symptoms (1)
- LV dysfunction
  - EF <50% (1)
- LV dilatation
  - ESD > 55 mm or EDD > 75 (2a)
  - ESD 50-55 mm or EDD 70-75 mm (2b)

Bonow RO et al. ACC//AHA Guidelines on Valvular Disease 2006

Question 4

Below is shown the CT scan of an asymptomatic 34 year old software engineer with an ejection click and a grade 3 mid-systolic murmur at the 2nd RICS.

Question 4

In addition to restricting his activities, which of the following management strategies do you recommend?

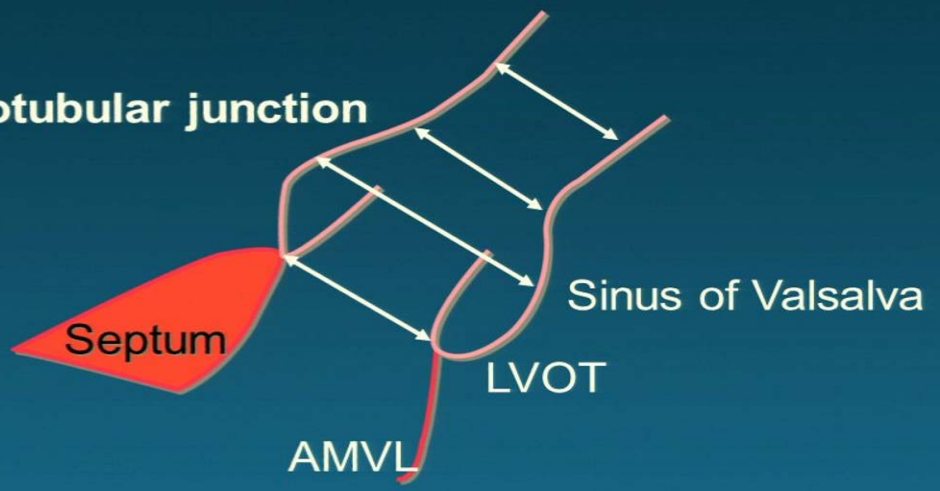
9% A. Lisinopril 10 mg daily

13% B. Losartan 25 mg daily

0% C. Endovascular stenting

79% D. Aortic valve and ascending aortic surgery.

Aortic Root Measurements



Bicuspid Aortic Valve

Dilated Aortic Root

Class I Indications for Surgery

- Maximal dimension > 5.0 cm or annual increase in size > 0.5 cm / year.*
- Maximal dimension > 4.5 cm and surgery indicated for severe AS or AR.*

* Consider lower threshold values for patients of small stature of either gender

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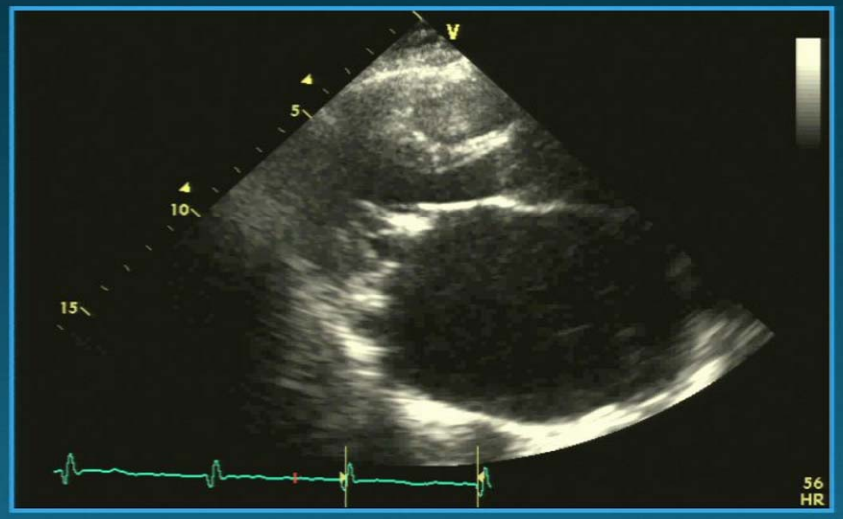
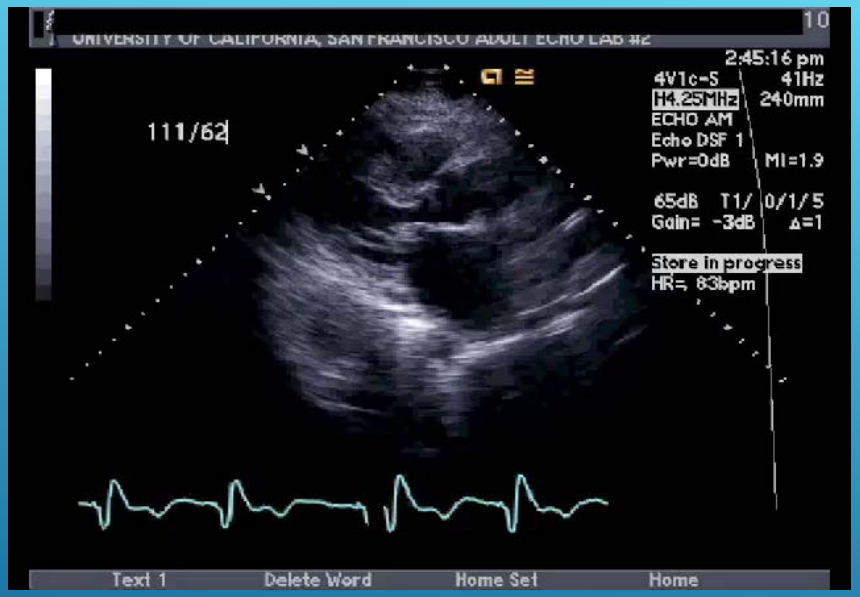
61 woman: MV commissurotomy 34 years ago NYHA Class III





MITRAL VALVE STENOSIS

Mitral Stenosis

Severity Grades

	Mean gradient (mmHg)	Mitral valve Area (cm^2)
Mild	< 5	1.6-2
Moderate	5-9	1.1-1.5
Severe	≥ 10	≤ 1

JASE 2003; 16 (7):777

Pitfalls Pressure Half-time

$$MVA = 220 / T^{1/2}$$

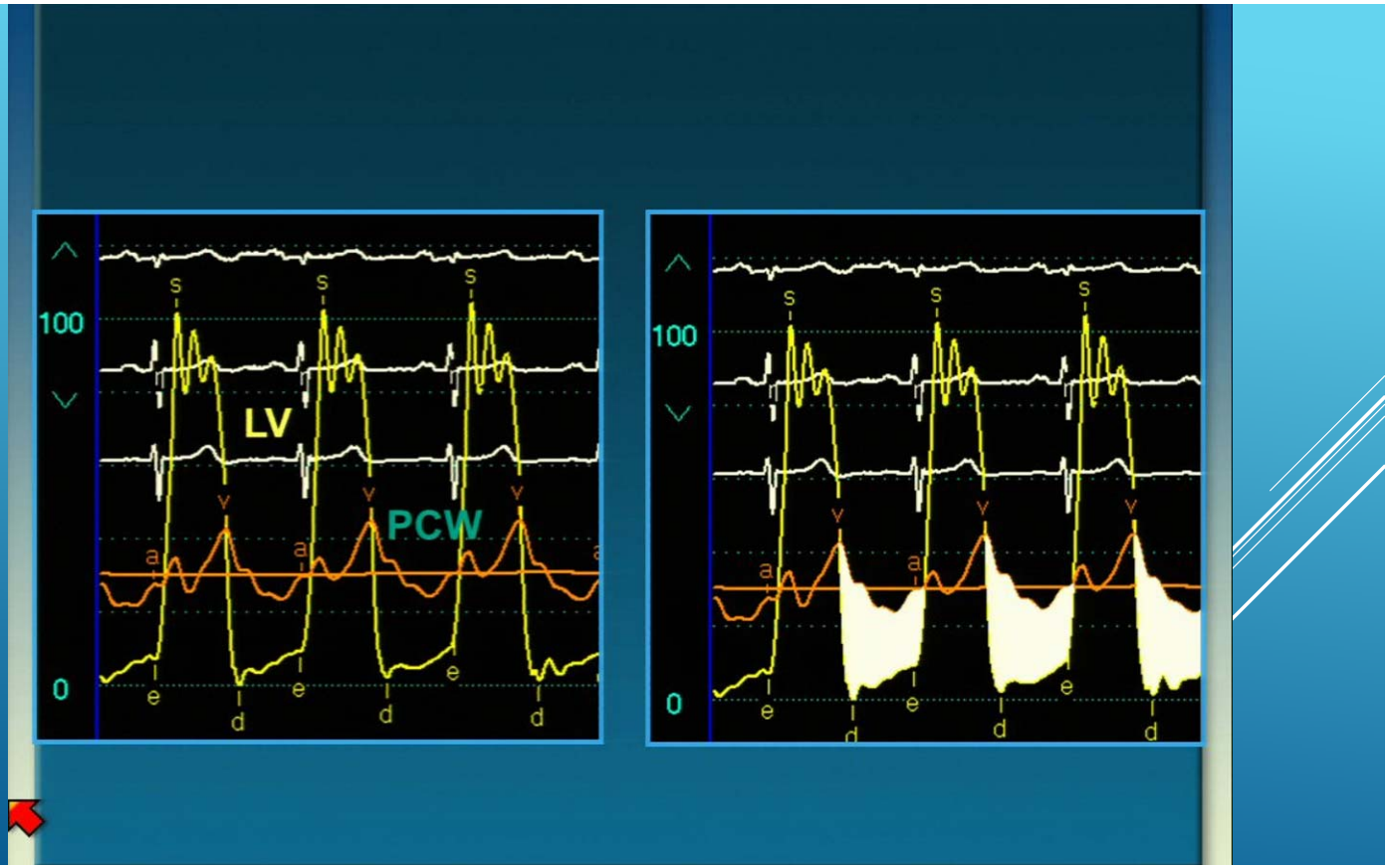
- Post balloon valvuloplasty
- Significant AR
- Significant diastolic dysfunction
- Heart rate

Pitfalls Continuity Equation

$$SV\ AV\ /\ TVI_{MS\ Jet}$$

- AF
- Significant MR
- Significant AR

JASE 2009:22(1):1


100
0
LV
PCW
s
v
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e
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100
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v
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d

Mitral Stenosis

Anticoagulation

Class I

- AF: Paroxysmal, Persistent, Permanent
- Hx TIA/CVA, systemic embolus
- Presence of LA thrombus

Question 5

A 27 year old woman who is 26 weeks pregnant is admitted to the ICU with pulmonary edema. She is intubated, paralyzed and treated with broad spectrum antibiotics. TTE shows MS with mean gradient of 16 mm Hg at HR 115 BPM. Her BP is 105/76. No murmur is audible. Fetal heart sounds are normal and the maternal fetal medicine group are following.

Select the best initial management strategy:

1. **Terminate pregnancy**
2. **IV beta-blocker**
3. **Heparin**
4. **Consult cardiac surgery**

PMBV

Class I Indications

- **Symptoms**
- **PA HTN (PA > 50 rest, > 60 ex)**

Predicated on:

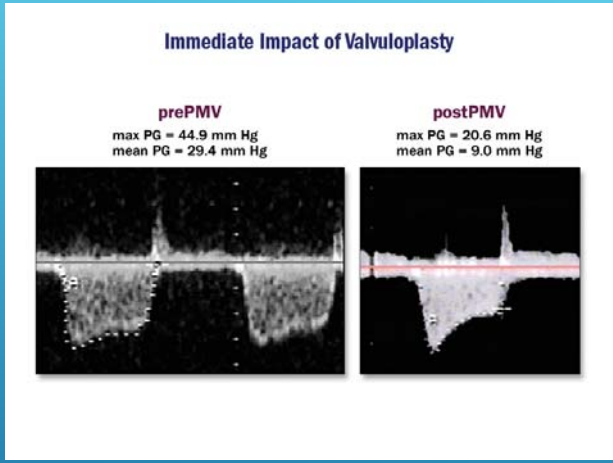
1. Favorable morphology (ECHO score)
2. Operator and Lab experience

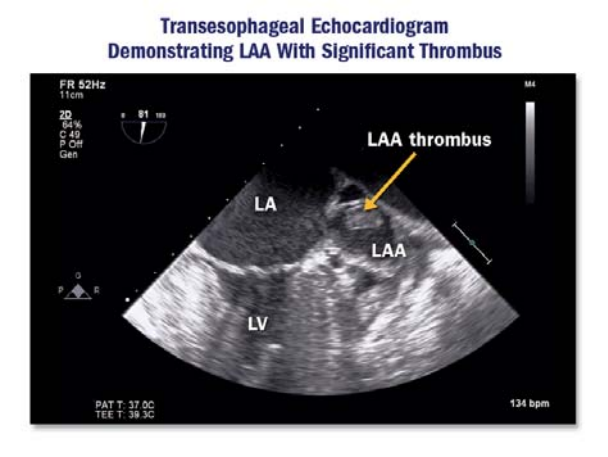
Absent:

1. Moderate to severe MR
2. LA thrombus
3. Inability to perform trans-septal puncture

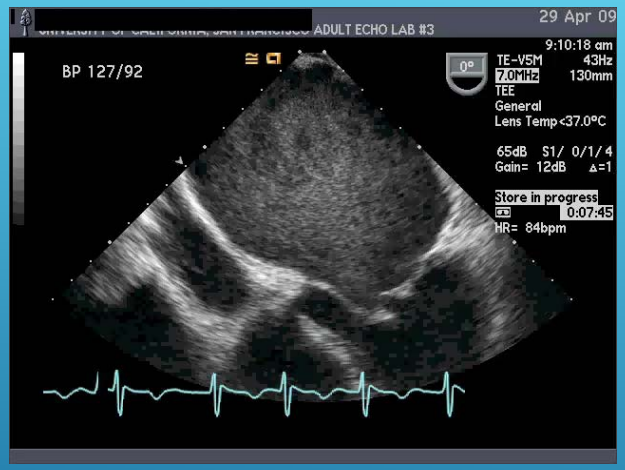
Assessment of Mitral Valve Anatomy According to the Wilkins Score

Grade	Mobility	Thickening	Calcification	Subvalvular Thickening
1	Highly Mobile Valve with only leaflet tips restricted	Leaflets near normal in thickness (4-5 mm)	A single area of increased echo brightness	Minimal thickening just below the mitral leaflets
2	Leaflet mid and base portions have normal mobility	Midleaflets normal, cosiderable thickening of margins (5-8 mm)	Scattered area of brightness confined to leaflet margins	Thickening of cordal structures extending to one-third of the cordal length
3	Valve continues to move forward in diastole, mainly from the base	Thickening extending through the entire leaflet (5-8 mm)	Brightness extending into the mid-portions of the leaflets	Thickening extended to distal third of the chords
4	No or minimal forward movement of the leaflets in diastole	Considerable thickening of all leaflet tissue (>8-10 mm)	Extensive brightness throughout much of the leaflet tissue	Extensive thickening and shortening of all chordal structures extending down to the papillary muscles



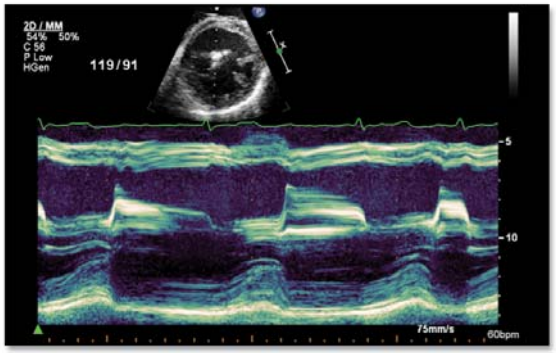


PERCUTANEOUS VALVULOPLASTY

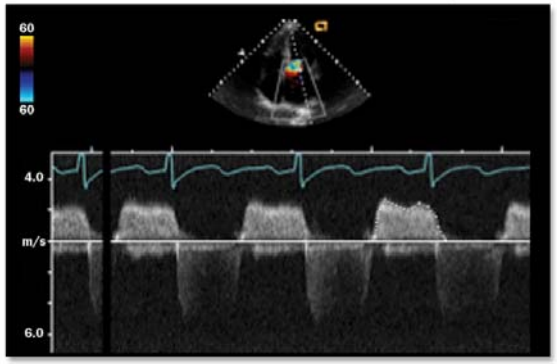


RHEUMATIC VALVE DISEASE

M-Mode of Mitral Stenosis in Patient With Atrial Fibrillation



Continuous Wave Transesophageal Echocardiogram of Mitral Stenosis Jet (four-chamber view)



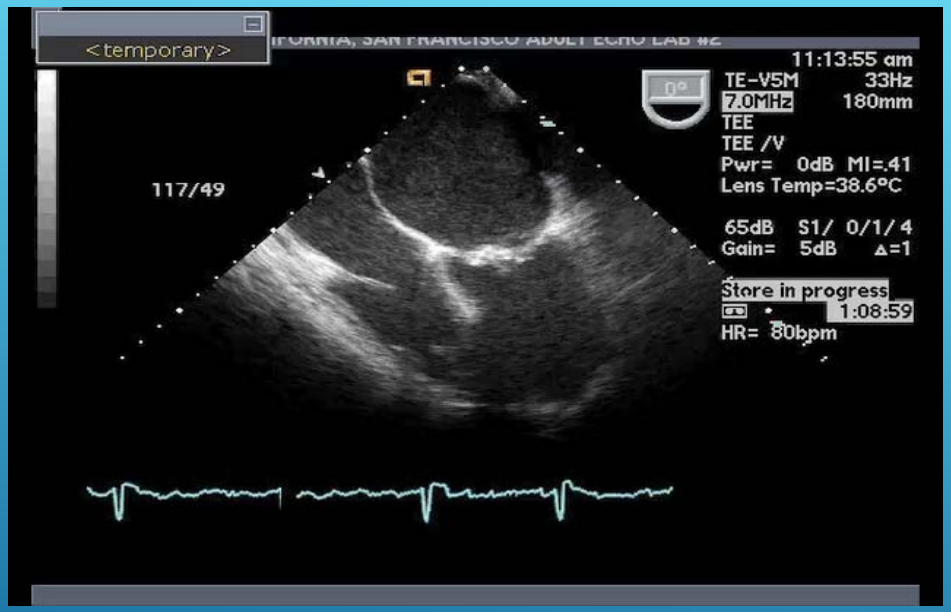
EVALUATION OF SEVERITY OF MITRAL STENOSIS

Approaches to Evaluation of Mitral Stenosis

Measurement	Units	Formula / Method	Concept	Advantages	Disadvantages
Valve area - Planimetry by 2D echo	cm^2	Tracing mitral orifice using 2D echo	Direct measurement of anatomic MVA	- Accuracy - Independence from other factors	- Experience required - Not always feasible (poor acoustic window, severe valve calcification)
- Pressure half-time	cm^2	$220 / T_{1/2}$	Rrate of decrease of transmitral flow is inversely proportional to MVA	Easy to obtain	Dependence on other factors (AR, LA compliance, LV diastolic function…)
- Continuity equation	cm^2	$MVA=(CSA_{LVOT})(VTI_{Aortic}) / VTI_{Mitral}$	Volume flows through mitral and aortic orifices are equal	Independence from flow conditions	- Multiple measurements (sources of errors) - Not valid if significant AR or MR
- PISA	cm^2	$MVA=2\pi(r^2)(V_{aliasing}) / peakV_{Mitral} \cdot \alpha/180^{\circ}$	MVA assessed by dividing mitral volume flow by the maximum velocity of diastolic mitral flow	Independence from flow conditions	Technically difficult
Mean gradient	mm Hg	$\Delta P=\Sigma 4v^2 / N$	Pressure gradient calculated from velocity using the Bernoulli equation	Easy to obtain	Dependent on heart rate and flow conditions
Systolic pulmonary artery pressure	mm Hg	$sPAP = 4v^2_{Tricuspid}$ + RA pressure	Addition of RA pressure and maximum gradient between RV and RA	Obtained in most patients with MS	- Arbitrary estimation of RA pressure - No estimation of pulmonary vascular resistance
Mean gradient and systolic pulmonary artery pressure at exercise	mm Hg	$\Delta P = \Sigma 4v^2 / N$ $sPAP = 4v^2_{Tricuspid}$ + RA pressure	Assessment of gradient and sPAP for increasing workload	Incremental value in assessment of tolerance	- Experience required - Lack of validation for decision-making
Valve resistance	dyne. sec^{-1}. cm^{-5}	$\_Mvres= P_{Mitral} / (CSA_{LVOT})(VTI_{Aortic}) / DFT$	Resistance to flow caused by MS	Initially suggested to be less flow-dependent, but not confirmed	No prognostic value No clear threshold for severity No additional value vs. valve area

Recommendations for Classification of Mitral Stenosis Severity

	Mild	Moderate	Severe
Specific findings			
Valve area (cm^2)	>1.5	1.0-1.5	<1.0
Supportive findings			
Mean gradient (mm Hg)[a]	<5	5-10	>10
Pulmonary artery pressure (mm Hg)	<30	30-50	>50



SECONDARY EFFECTS OF MITRAL STENOSIS

Mitral Regurgitation
Etiology

Acute MR
- Acute MI (Inf-Post)
- Endocarditis
- Trauma
- "Acute on chronic"

Chronic MR
- Myxomatous
- Ischemic
- DCM
- Rheumatic
- MAC
- HOCM
- Other (APLS, etc.)

Mitral Regurgitation
Pathophysiology

	LAC	LAP	EDV	EF	Contr
Acute MR	nl, ↓	↑↑↑	↑	nl, ↑	nl
Chronic MR	↑	nl, ↑	↑↑	↓, ↑, nl	↓, ↓↓

Myxomatous MV

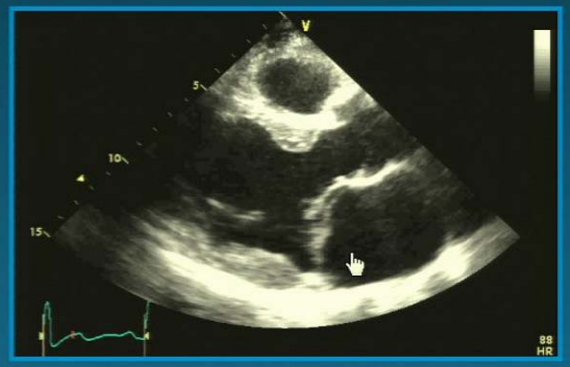
Barlow's Disease

Leaflet thickening, large redundant leaflets, chordal rupture, annular dilation, often multi-segmental

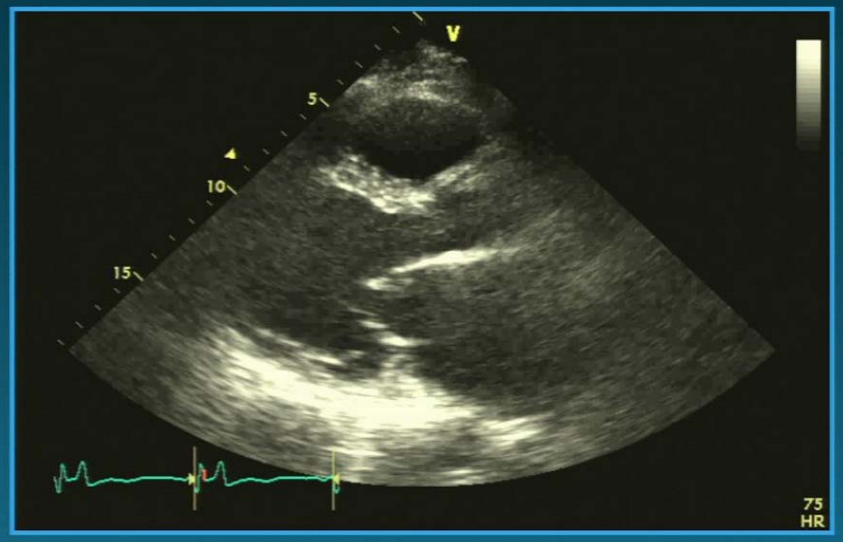
Myxomatous MV

Fibroelastic Deficiency

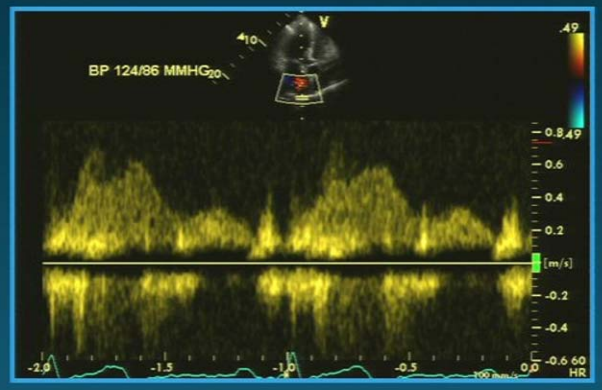
Lack of connective tissue →leaflet and chordal thinning, eventually prolapse and rupture. Often single segment



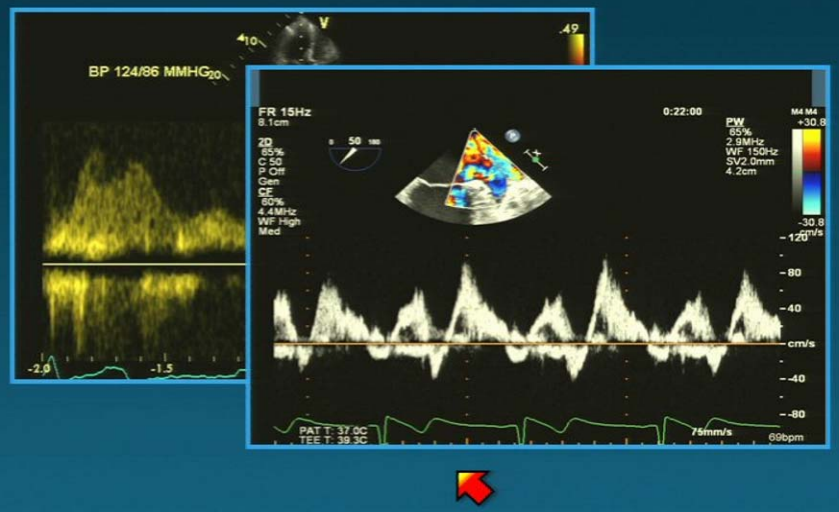
Functional MR



Pulmonary Vein Flow

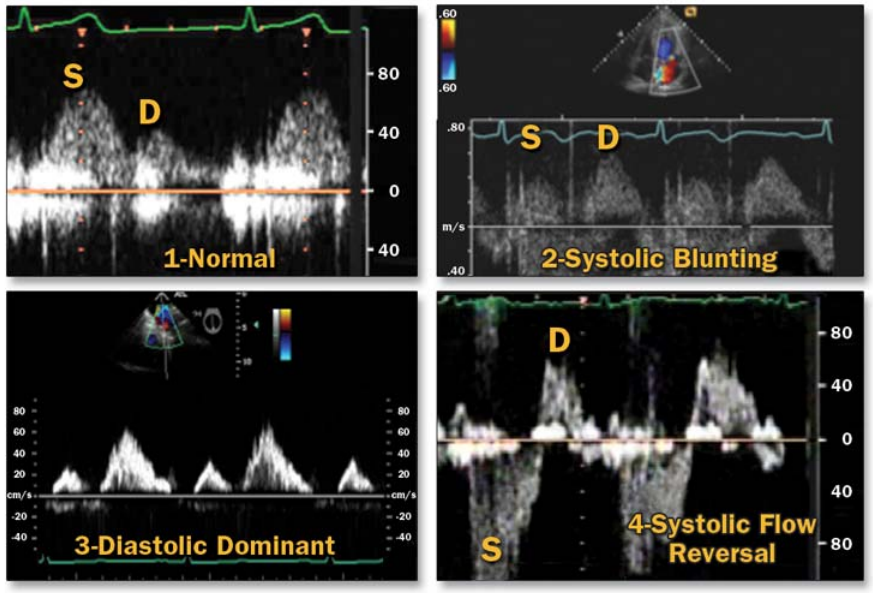


Pulmonary Vein Flow



Pulmonary Vein Flow

Spectral Doppler Patterns Obtained on TTE (four-chamber view)



Mitral Regurgitation Severity Grades

	ERO(mm^2)	RVol (ml)
Mild	< 20	< 30
Moderate	20-49	30-59
Severe	≥ 40	≥ 60

JASE 2003; 16 (7):777

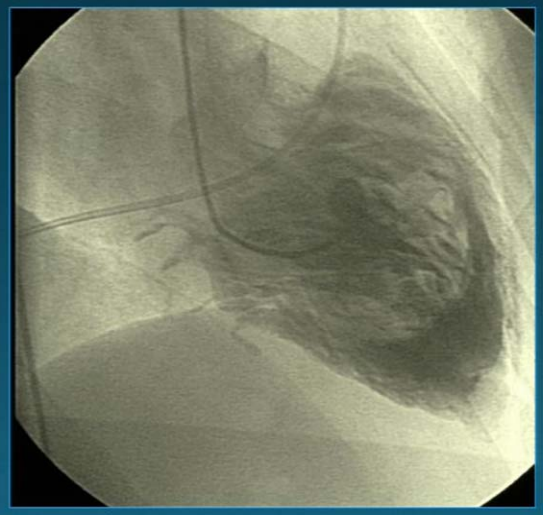
Summary

Severe Organic MR

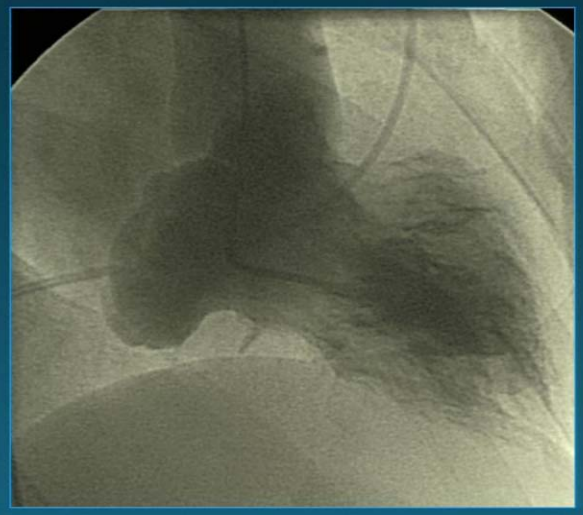
- ERO ≥ 40 mm²
- RVol ≥ 60 cc
- RF ≥ 50%
- Vena contracta ≥ 7 mm
- Peak E velocity >1.2 m/s
- "V" wave configuration on CW
- Flow reversal both pulmonary veins

JASE 2003; 16 (7):777

MVP/MR



Diastole



Systole

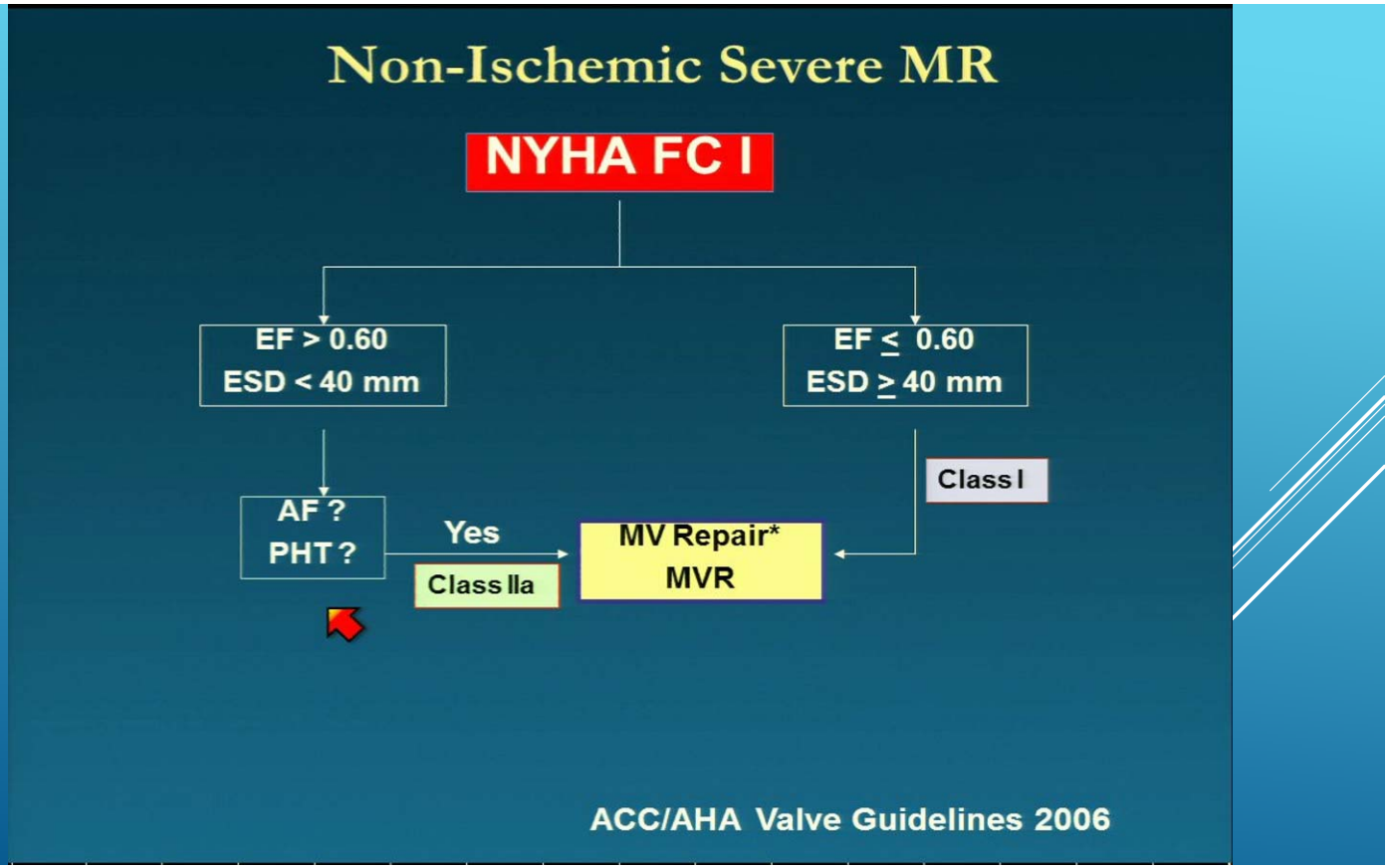
PCW "v" waves in MR

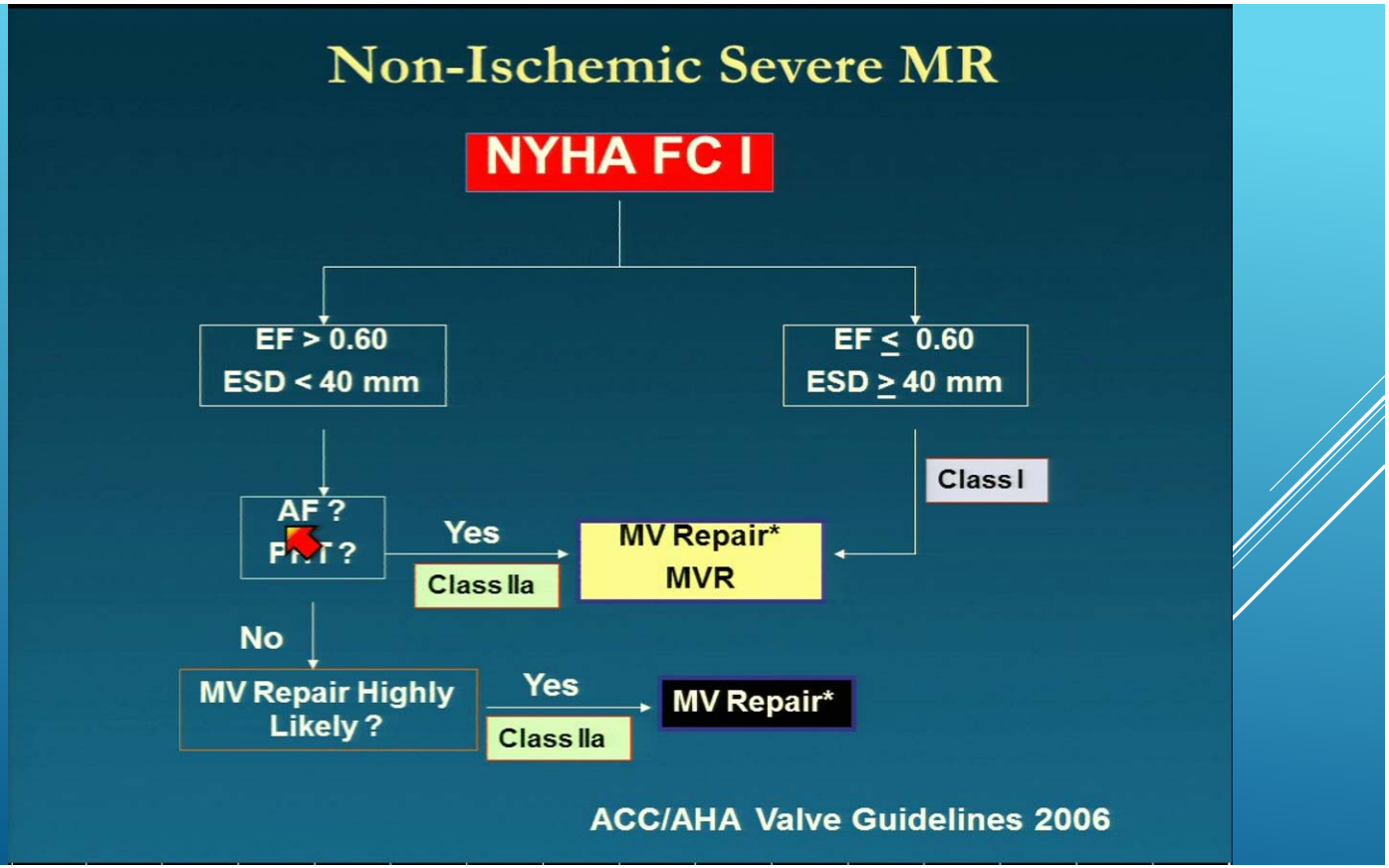
Severe MR

Mild MR

PCW "V" Waves

- Mitral regurgitation
- Ventricular septal defect
- Noncompliant left atrium


Non-Ischemic Severe MR
NYHA FC I
EF > 0.60
ESD < 40 mm
EF ≤ 0.60
ESD ≥ 40 mm
Class I
AF ?
PHT ?
Yes
Class IIa
MV Repair*
MVR
ACC/AHA Valve Guidelines 2006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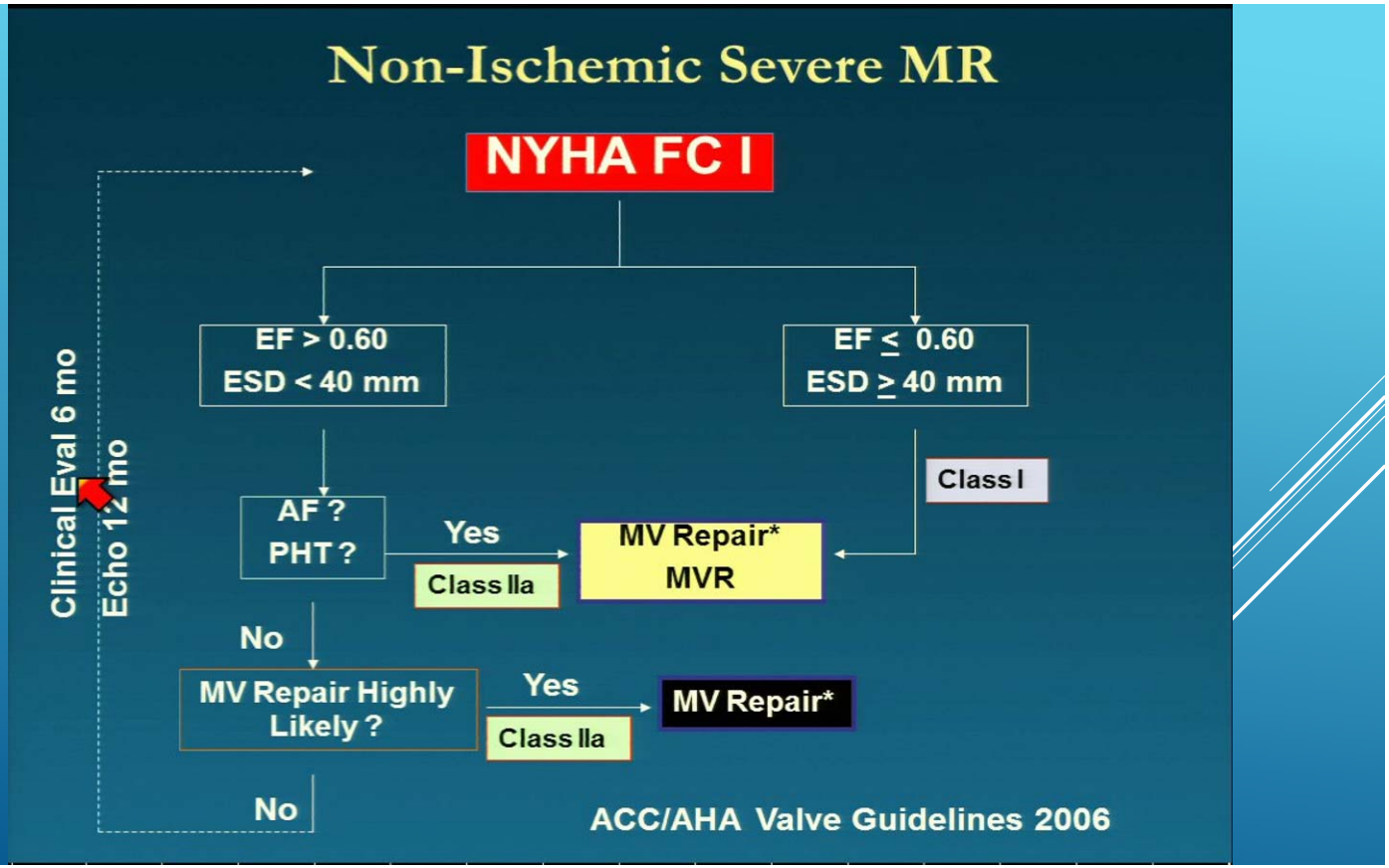
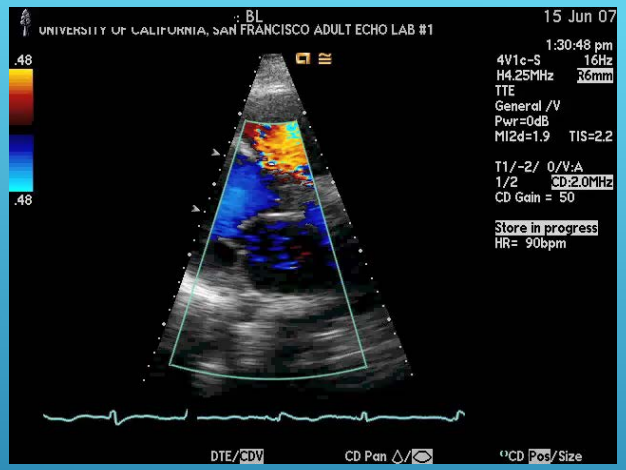
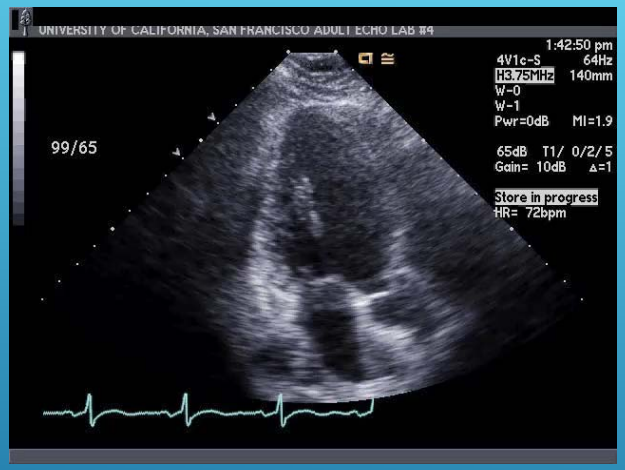
ESD < 40 mm
EF ≤ 0.60
ESD ≥ 40 mm
Class I
AF ?
PMT ?
Yes
Class IIa
MV Repair*
MVR
No
MV Repair Highly Likely ?
Yes
Class IIa
MV Repair*
ACC/AHA Valve Guidelines 2006

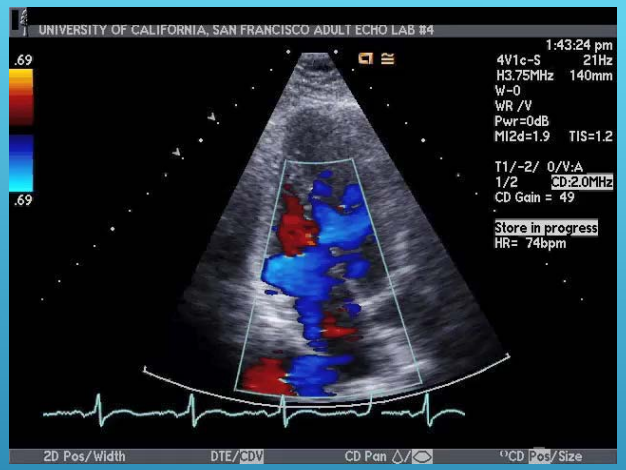

Non-Ischemic Severe MR
NYHA FC I
EF > 0.60
ESD < 40 mm
EF ≤ 0.60
ESD ≥ 40 mm
Class I
AF ?
PHT ?
Yes
Class IIa
MV Repair*
MVR
No
MV Repair Highly Likely ?
Yes
Class IIa
MV Repair*
No
Clinical Eval 6 mo
Echo 12 mo
ACC/AHA Valve Guidelines 2006



MITRAL VALVE REGURGITATION

PRIMARY AND FUNCTIONAL(LV DYSFUNCTION)





FOCAL PROLAPSE OF THE ANTERIOR LEAFLET

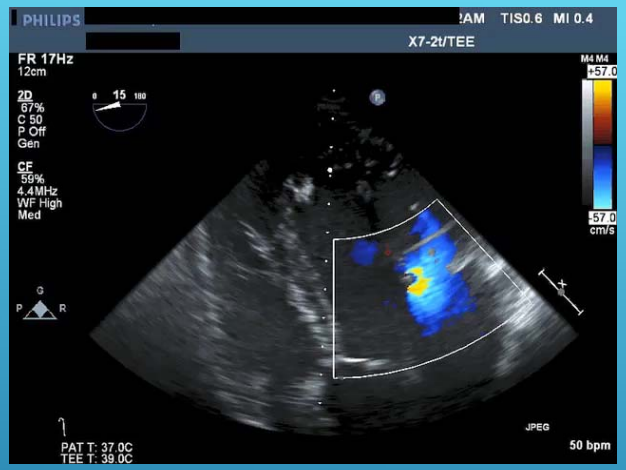
OTHERS: IP INFARCT-POSTERIOR LEAFLET RESTRICTION

SAM-HOCM

CONGENITAL CLEFT ANTERIOR MV LEAFLET

RHEUMATIC

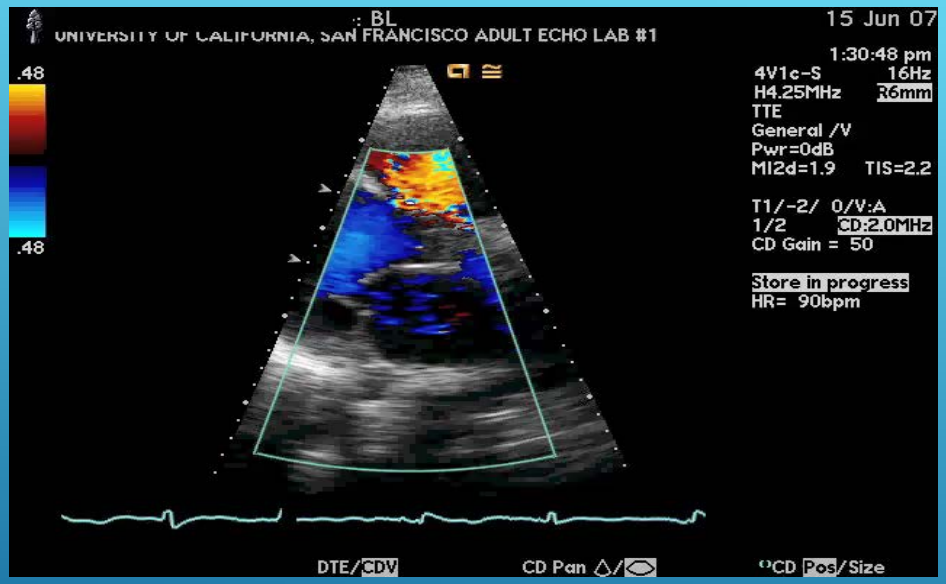
INFECTIVE ENDOCARDITIS WITH PERFORATION OF THE AML



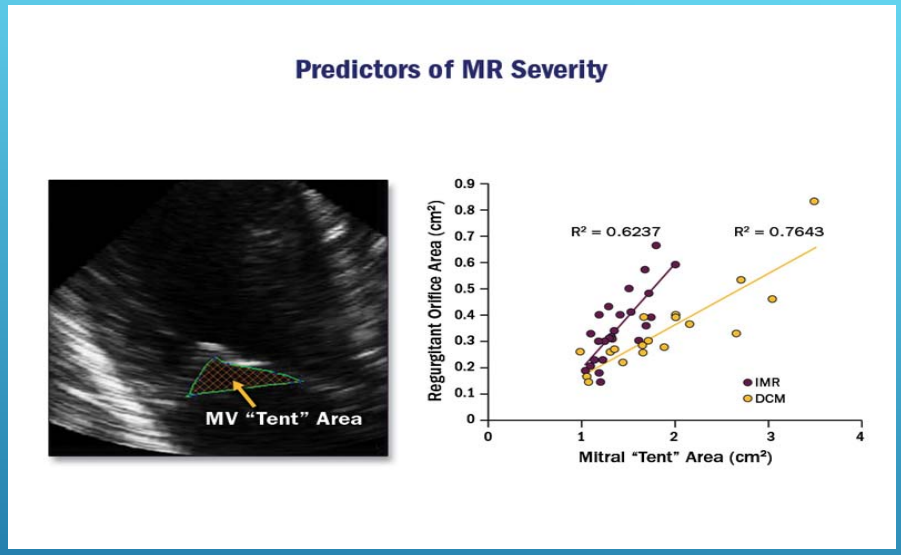
COMPLICATIONS OF MVP

CHORDAL RUPTURE

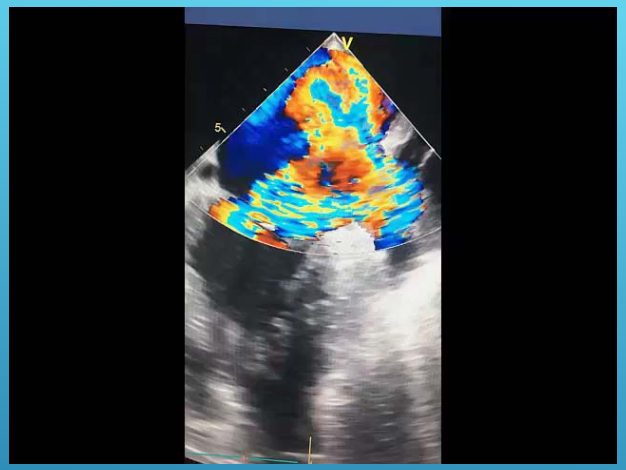
RHEUMATIC MITRAL REGURGITATION



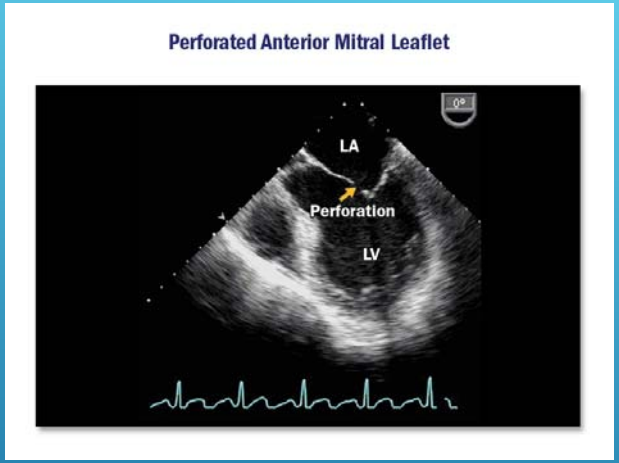
FUNCTIONAL MITRAL REGURGITATION



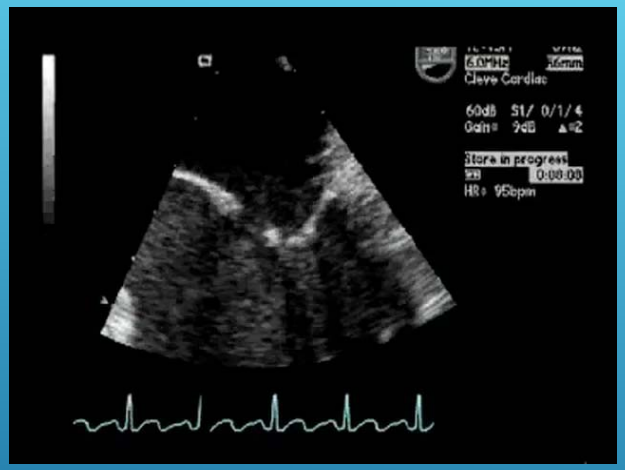
3D BEST PARAMETER-THE AREA SUBTENTED BY THE OUTWARDLY TETHERED MITRAL VALVE LEAFLETS

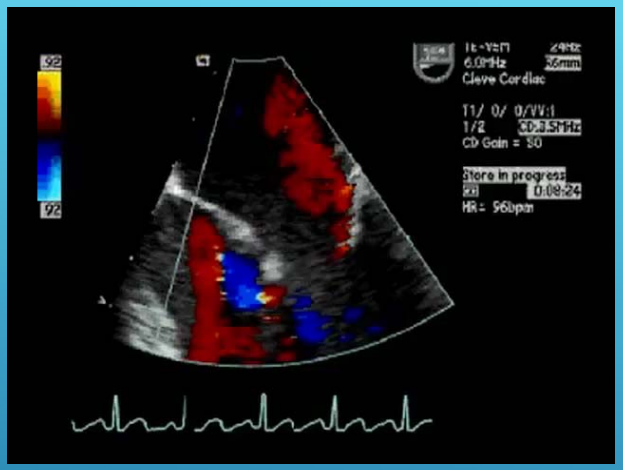


ISCHEMIC MR-PAPILLARY MUSCLE RUPTURE



MITRAL VALVE ENDOCARDITIS PERFORATION



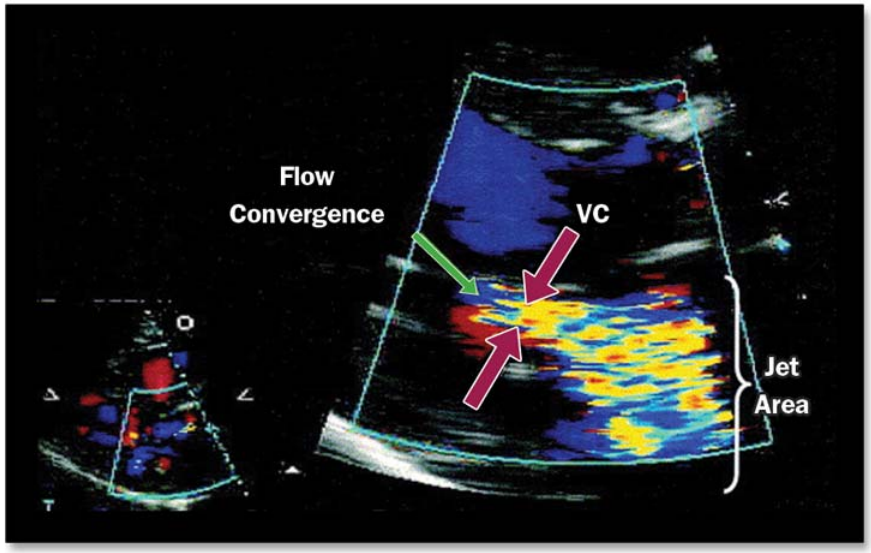


ENDOCARDITIS
PERFORATION

Qualitative and Quantitative Parameters Useful in Grading Mitral Regurgitation Severity

	Mild	Moderate	Severe
Structural parameters			
LA size	Normal*	Normal or dilated	Usually dilated**
LV size	Normal*	Normal or dilated	Usually dilated**
Mitral leaflets or support apparatus	Normal or abnormal	Normal or abnormal	Abnormal/flail leaflet/ ruptured papillary muscle
Doppler parameters			
Color flow jet area[ζ]	Small, in central jet (usually <4 cm^2 or <20% of LA area)	Variable	Large in central jet (usually >10 cm^2 or >40% of LA area or variable size wall-impinging jet swirling in LA
Mitral inflow-PW	A wave dominant[Ψ]	Variable	E wave dominant[Ψ]/C> (E usually 1.2 m/s)
Jet density-CW	Incomplete or faint	Dense	Dense
Jet contour-CW	Parabolic	Usually parabolic	Early peaking - triangular
Pulmonary vein flow	Systolic dominance[§]	Systolic blunting[§]	Systolic flow reversal[†]
Quantitative parameters[Ψ]			
VC width (cm)	<0.3	0.3 – 0.69	≥0.7
R Vol (ml/beat)	<30	30-44 45-59	≥60
RF, %	<30	30-39 40-49	≥50
ERAO (cm^2)	<0.20	0.20-0.29 0.30-0.39	≥0.40

Color Flow Recording of a Mitral Regurgitation Jet



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	Mild	Moderate	Severe
Structural parameters			
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Jet density-CW	Incomplete or faint	Dense	Dense
Jet contour-CW	Parabolic	Usually parabolic	Early peaking - triangular
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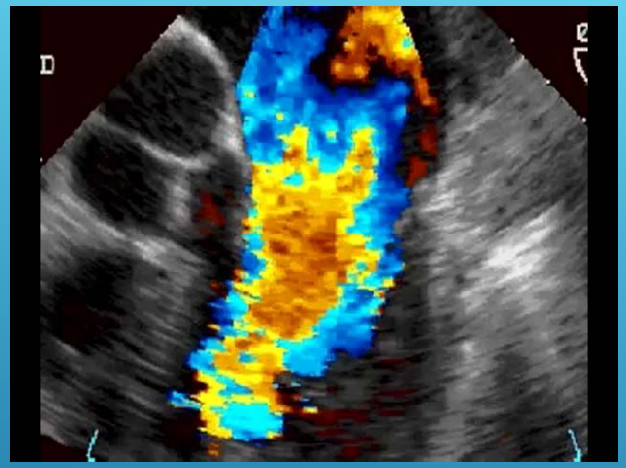
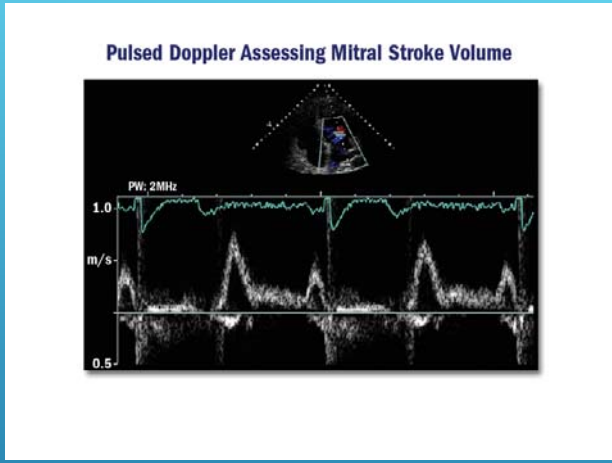


PR0XIMAL CONVERGENCE ZONE- PISA MORE ACCURATE FOR CENTRAL JETS



REGURGITANT VOLUME

DIFFERENCE OF THE FLOW ACROSS THE MR AND THE LVOT

RV OVER 60 CC-SEVERE MR

RV=(0.785 X MVD2) X VTI MV – (0.785 X LVOT2) X LVOT VTI

REGURGITANT FRACTION AND EFFECTIVE REGURGITANT ORIFICE AREA

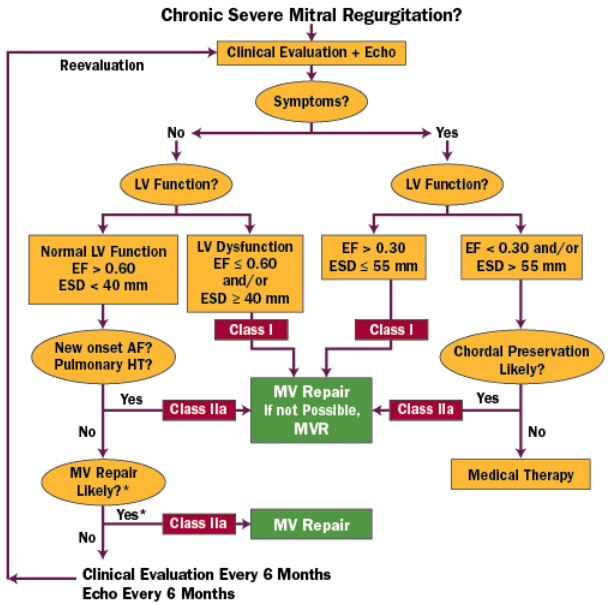
REGURGITANT FRACTION

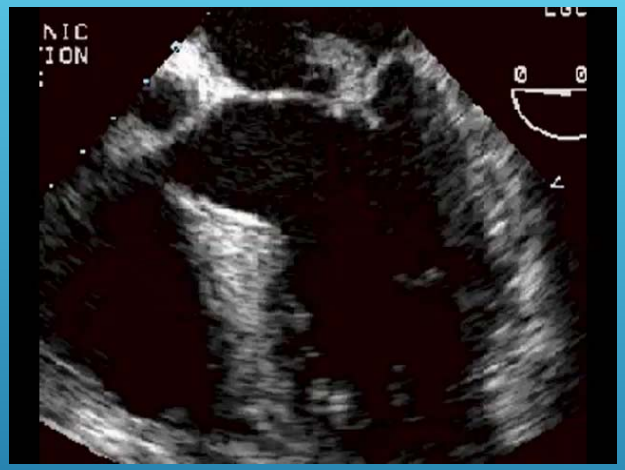
- **RF =(RV / MV flow) x 100**

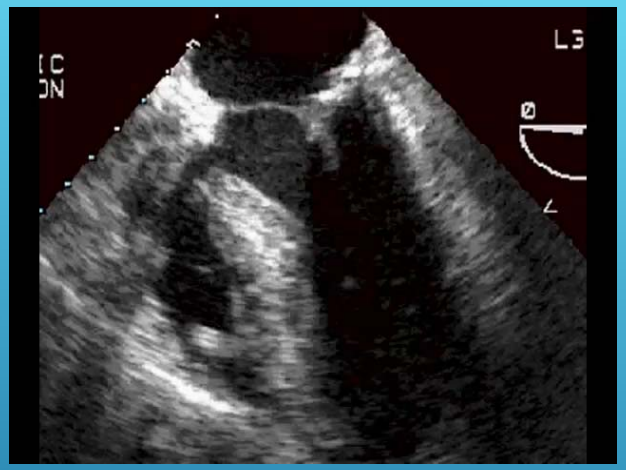
EFFECTIVE REGURGITANT ORIFICE

- **ERO (MV) = RV/ VTI (MR)**

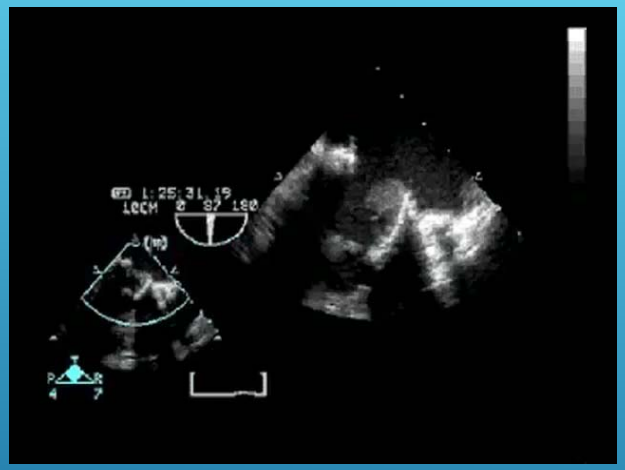
Management Strategy for Patients With Chronic Severe Mitral Regurgitation

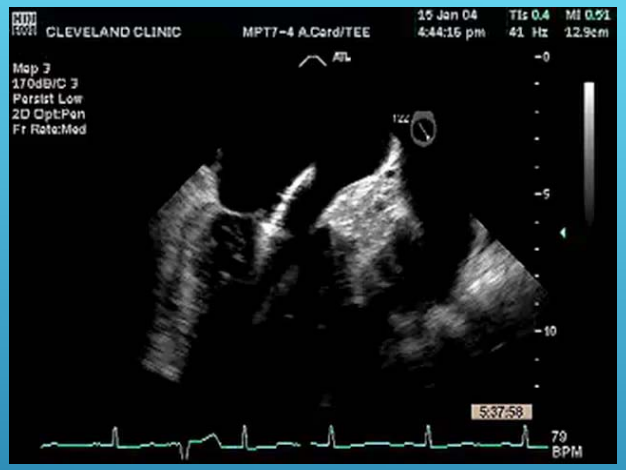






MITRAL VALVE REPAIR

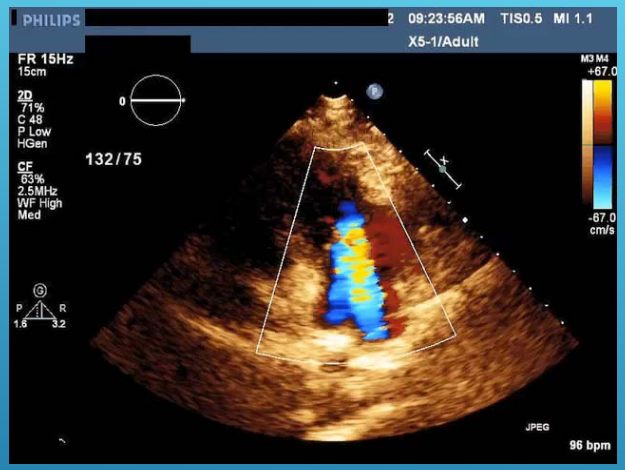


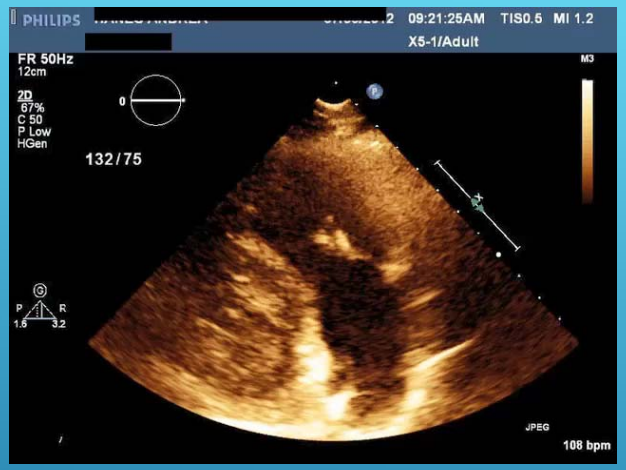


OTHER ROLES OF ECHOCARDIOGRAPHY

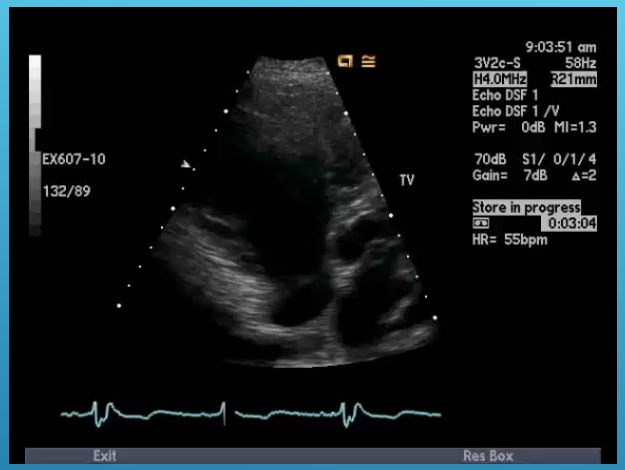
PROSTHETIC VALVE FUNCTION

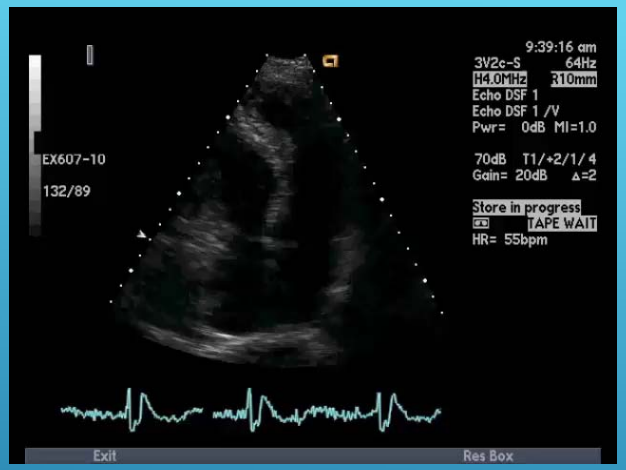
MITRAL VALVE CLIP





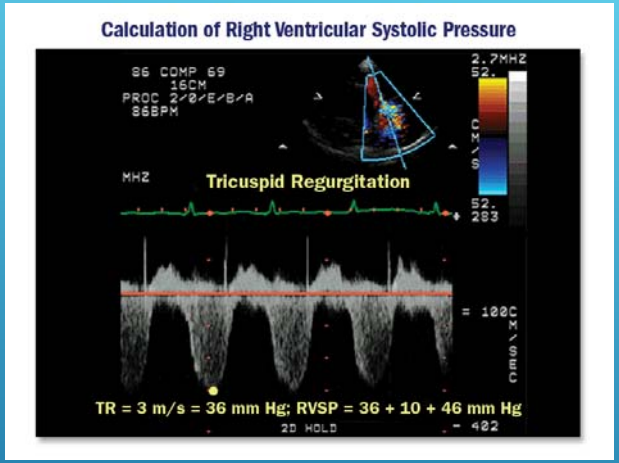
TRICUSPID VALVE

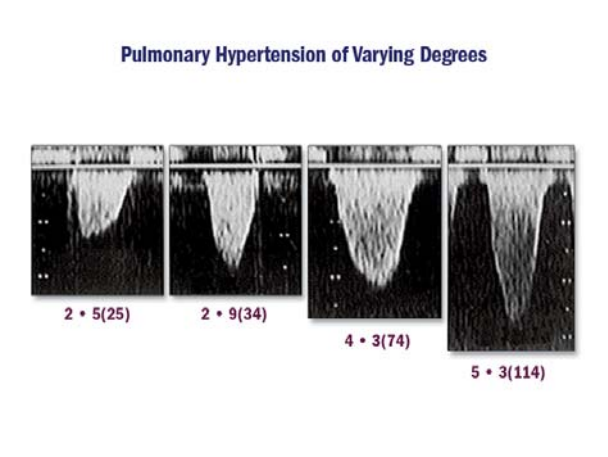




ETIOLOGIES OF TRICUSPID VALVE DISEASE

EPSTEIN ANOMALY





RIGHT VENTRICULAR SYSTOLIC PRESSURE

Echocardiographic and Doppler Parameters Used in Grading Pulmonary Regurgitation Severity

Parameter	Mild	Moderate	Severe
Tricuspid valve	Usually normal	Normal or abnormal	Abnormal/flail leaflet/ poor coaptation
RV/RA/IVC size	Normal*	Normal or dilated	Usually dilated**
Jet area-central jets (cm^2)§	<5	5-10	>10
VC width (cm)$^{\Phi}$	Not defined	Not defined, but <0.7	>0.7
PISA radius (cm)$^{\Psi}$	≤0.5	0.6-0.9	>0.9
Jet density and contour-CW	Soft and parabolic	Dense, variable contour	Dense, triangular with early peaking
Hepatic vein flow	Systolic dominance	Systolic blunting	Systolic reversal

Findings Indicative of Haemodynamically Significant Tricuspid Stenosis

Specific findings	
Mean pressure gradient	≥5 mm Hg
Inflow time-velocity integral	>60 cm
$T_{1/2}$	≥190 ms
Valve area by continuity equation[a]	≤1cm^{2a}
Supportive findings	
Enlarged right atrium ≥moderate	
Dilated inferior vena cava	

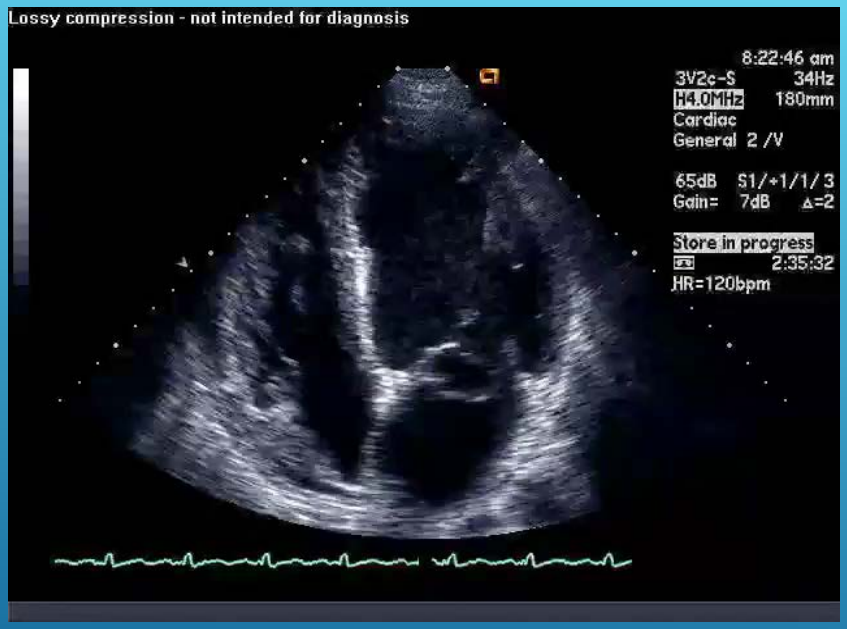
Grading of Pulmonary Stenosis

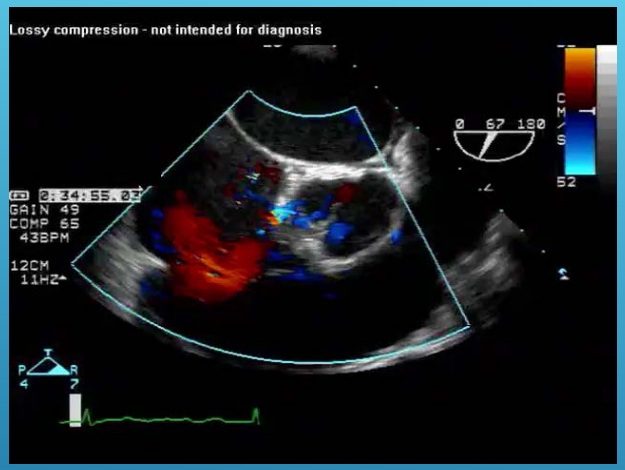
	Mild	Moderate	Severe
Peak velocity (m/s)	<3	3-4	>4
Peak gradient (mm Hg)	<36	36-64	>64

Echocardiographic and Doppler Parameters Used in Grading Pulmonary Regurgitation Severity

Parameter	Mild	Moderate	Severe
Pulmonic valve	Normal	Normal or abnormal	Abnormal
RV size	Normal*	Normal or dilated	Dilated
Jet size by color Doppler[§]	Thin (usually <10 mm in length) with a narrow origin	Intermediate	Usually large, with a wide origin; May be brief in duration
Jet density and deceleration rate-CW[†]	Soft; slow deceleration	Dense; variable deceleration	Dense; steep deceleration, early termination of diastolic flow
Pulmonic systolic flow compared to systemic flow - PW[‡]	Slightly increased	Intermediate	Greatly increased

CASE 1


Lossy compression - not intended for diagnosis
8:22:46 am
3V2c-S
34Hz
H4.0MHz
180mm
Cardiac
General 2 /V
65dB S1/+1/1/3
Gain= 7dB Δ=2
Store in progress
2:35:32
HR=120bpm



VALVE DISEASE CASES