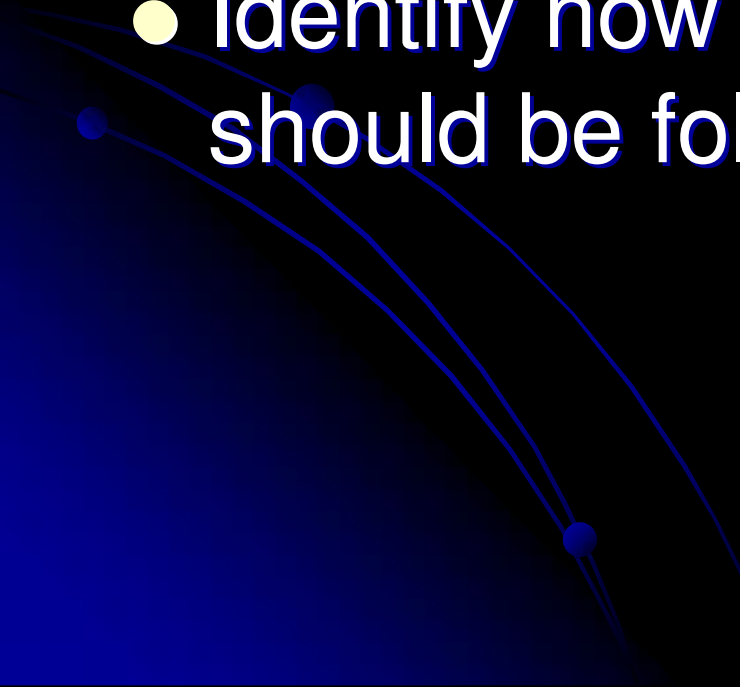


# Mitral valve disease

David Stultz, MD, FACC  
Southwest Cardiology, Inc.  
September 28, 2010

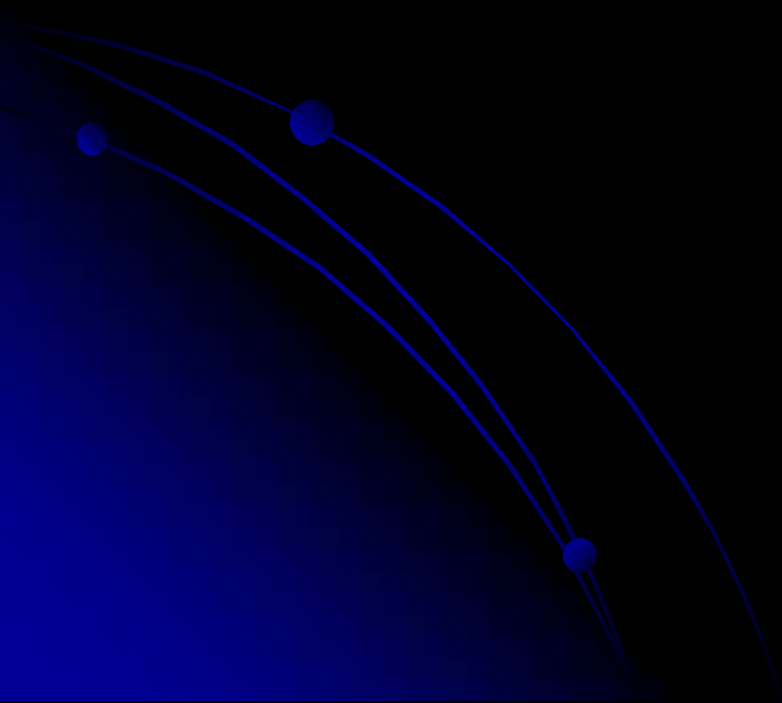


# Objectives

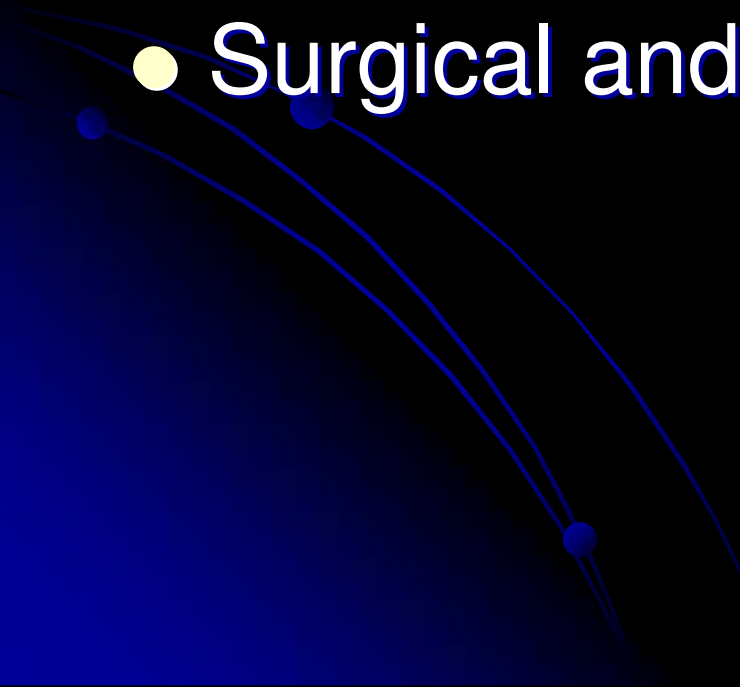
- Identify the principle cause of mitral stenosis
  - Name several mechanisms of mitral regurgitation
  - Identify how often mitral regurgitation should be followed by echocardiogram
- 

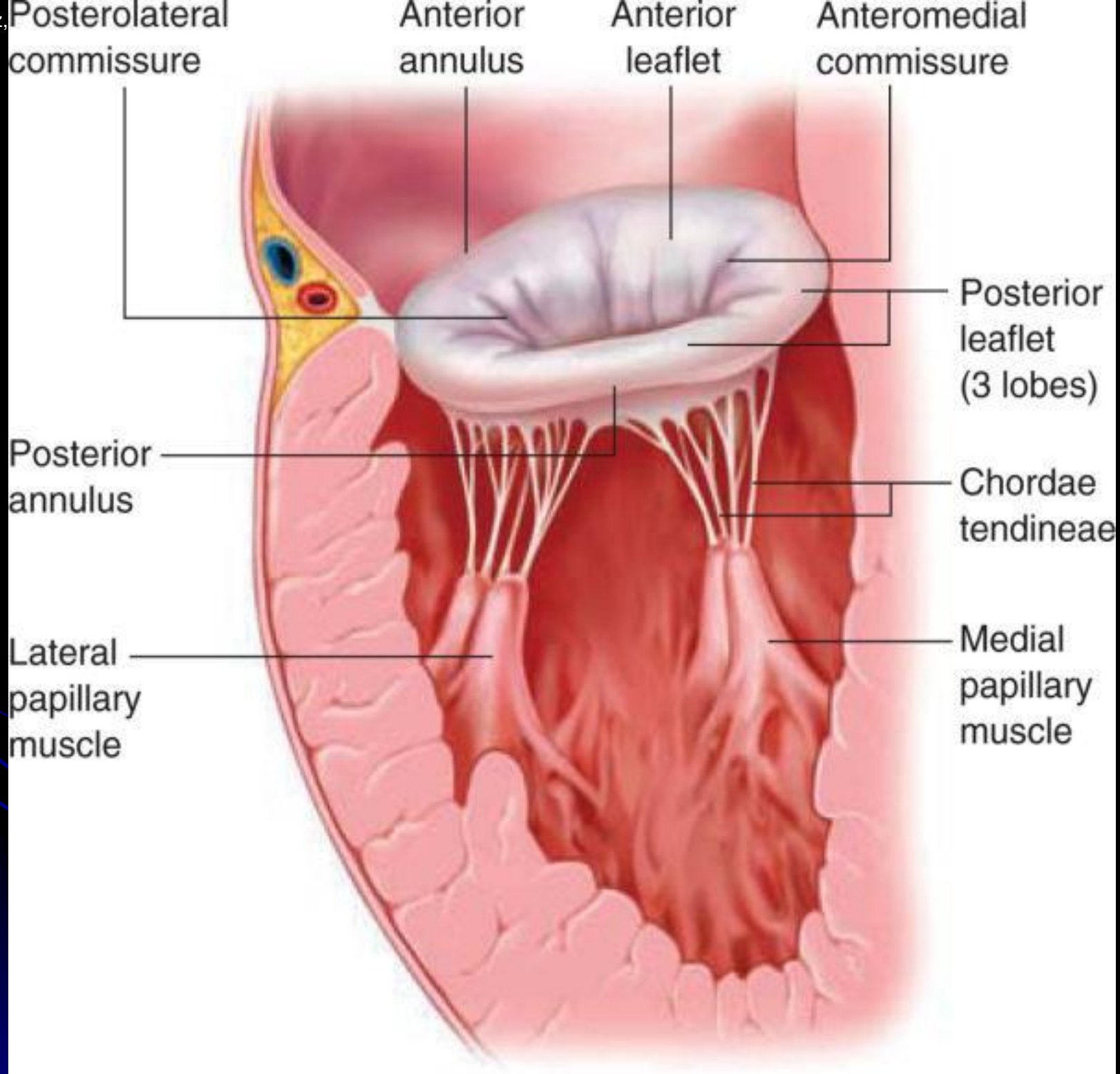
# This Conference is an Overview

- Many aspects cannot be covered in a 1 hour conference
- This is meant to serve as a framework for further knowledge

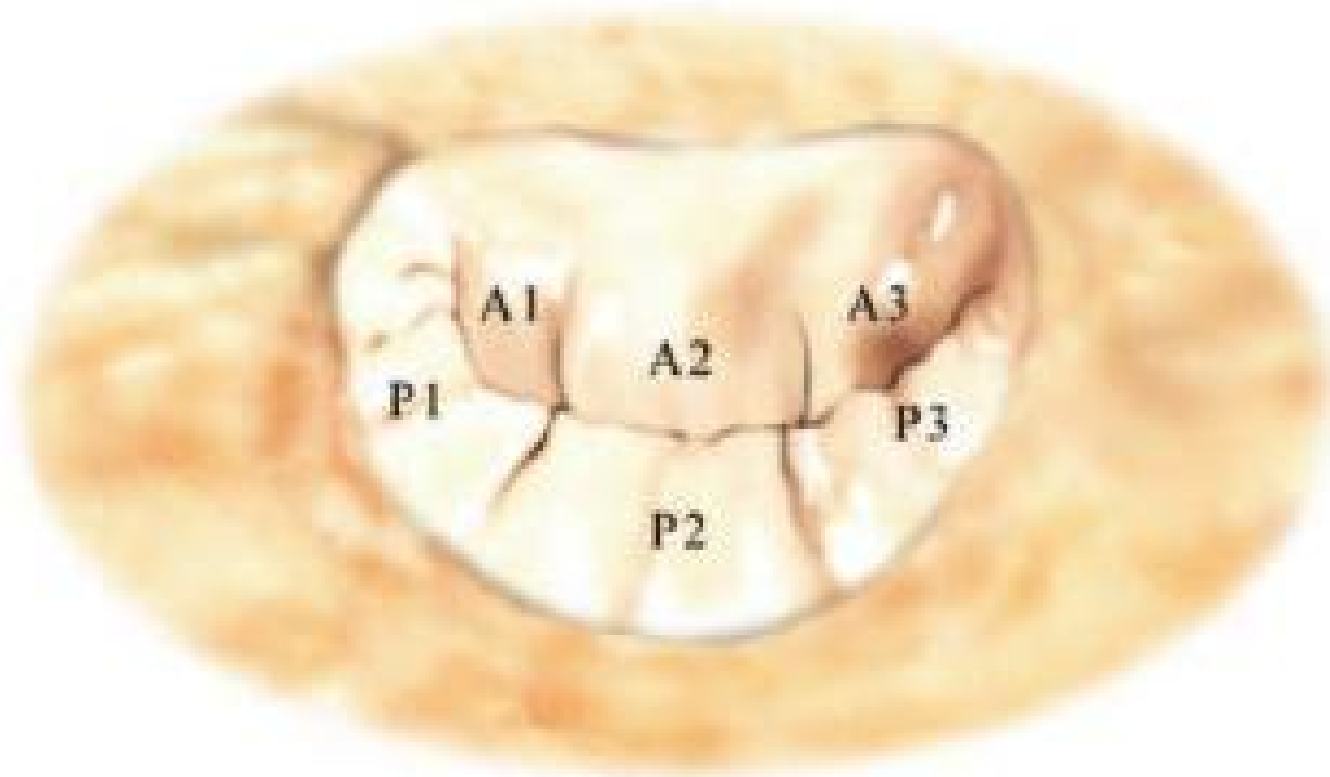


# Outline of conference

- Mitral Stenosis
  - Mitral regurgitation
  - Mitral valve prolapse
  - Surgical and endovascular repair
- 



# Surgical Anatomy



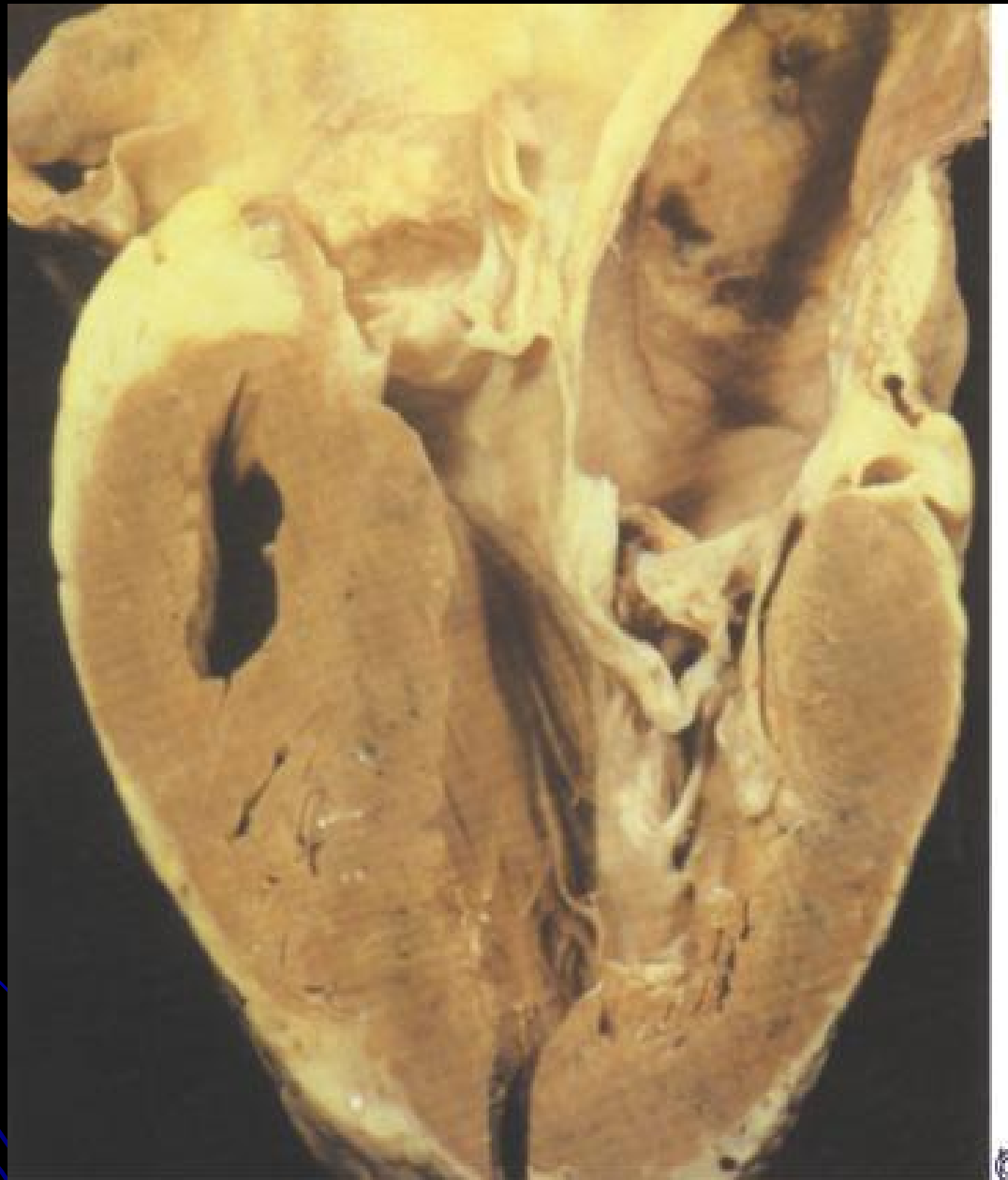
**Figure 2.** The posterior leaflet is divided into 3 scallops or segments (lateral, middle, and medial scallops) identified as P1, P2, and P3. The corresponding segments of the anterior leaflet are labeled A1, A2, and A3.

# Mitral Stenosis

- Narrowing of the mitral valve orifice
- Restricts flow from left atrium to left ventricle during diastole
  - Rheumatic fever almost always the cause
  - Senile calcific (annular calcification)
  - Anorectic drugs, carcinoid
- Mitral valve area normally 4-6cm<sup>2</sup>
  - 2cm<sup>2</sup> is mild stenosis
  - <1cm<sup>2</sup> is critical stenosis

Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr., Faxon DP, Freed MD, Gaasch WH, Lytle BW, Nishimura RA, O'Gara PT, O'Rourke RA, Otto CM, Shah PM, Shanewise JS. 2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Develop Guidelines for the Management of Patients With Valvular Heart Disease). *J Am Coll Cardiol* 2008;52:e1-142.

Carabello BA. Modern management of mitral stenosis. *Circulation*. 2005 Jul 19;112(3):432-7.



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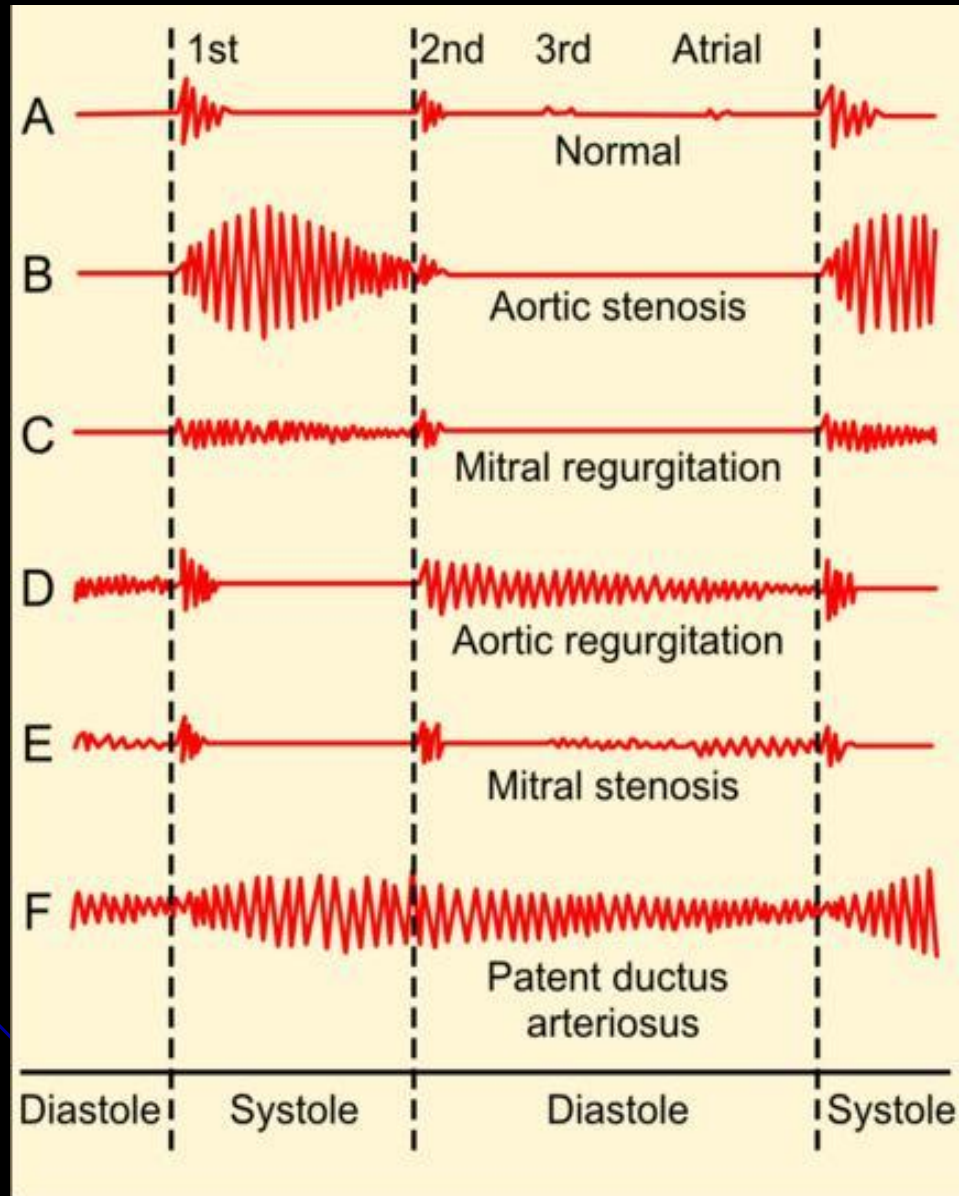
# Symptoms of Mitral Stenosis

- Exertional dyspnea
- Hemoptysis
- Chest pain
- Systemic embolization
  - Mostly due to atrial fibrillation

# Physical Examination for MS

- Diastolic murmur
  - Low pitched rumble at apex with bell
  - Best heard in left lateral decubitus position
- Prominent S1 (If leaflets are pliable)
- Opening snap
  - Caused by a tension on the valve leaflets when the valve opens
  - Audible at apex, with bell of stethoscope
  - Follows  $A_2$  by 40-120ms
  - **Shorter  $A_2$ -OS interval = more severe MS**

# Phonocardiograms

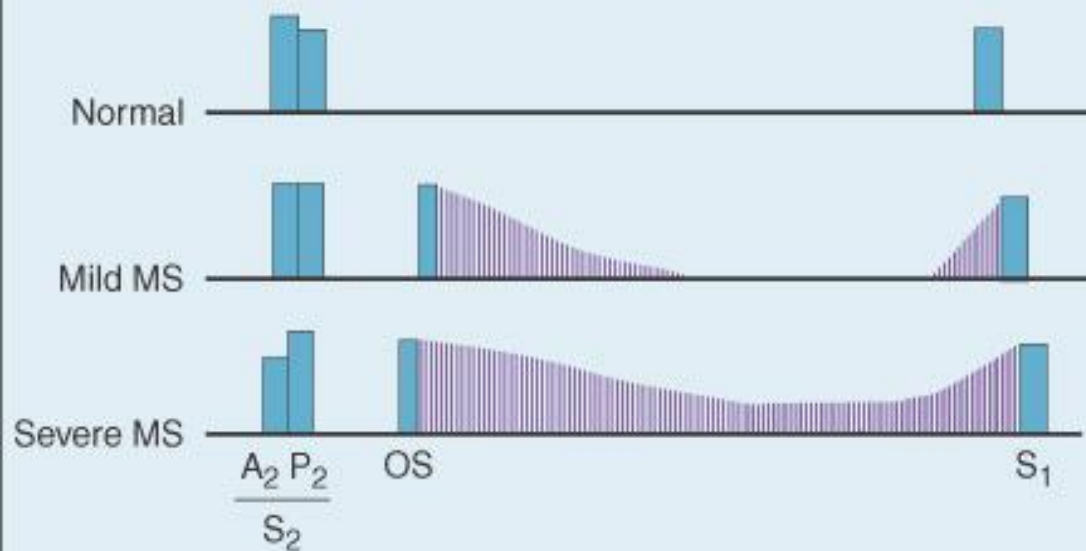
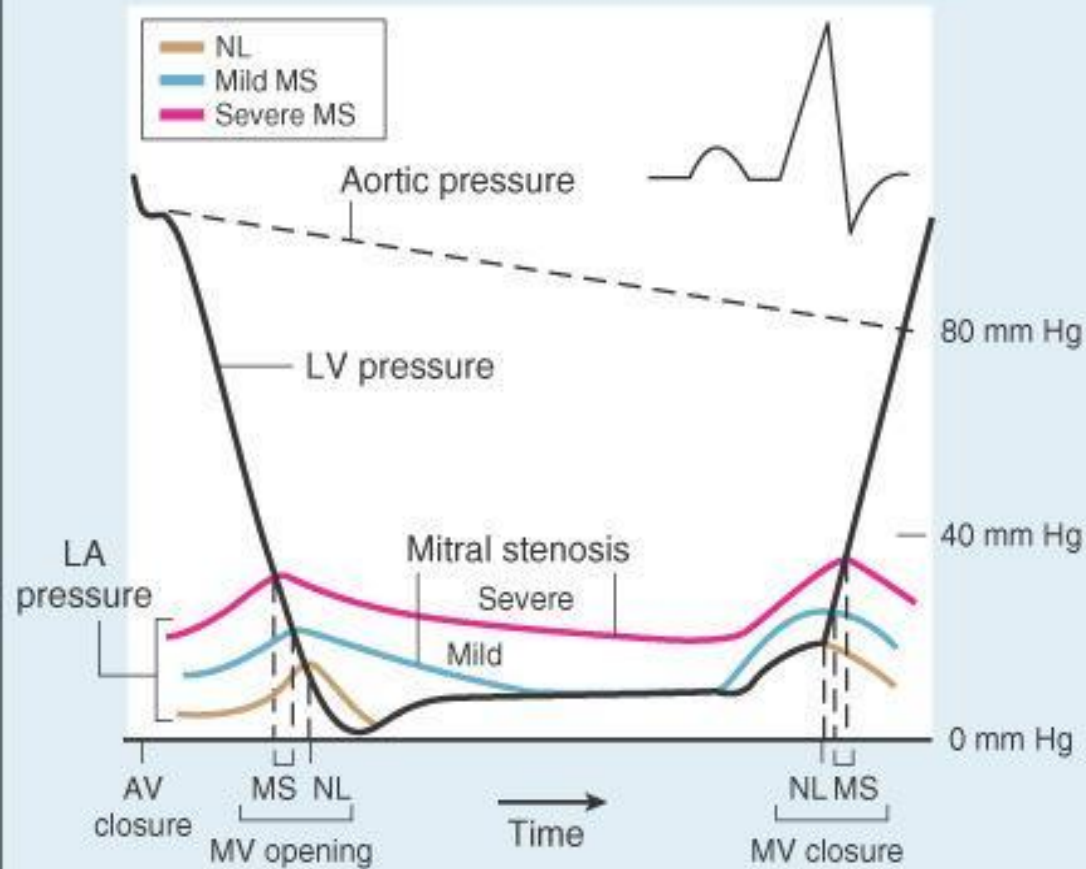


Phonocardiograms from normal and abnormal heart sounds

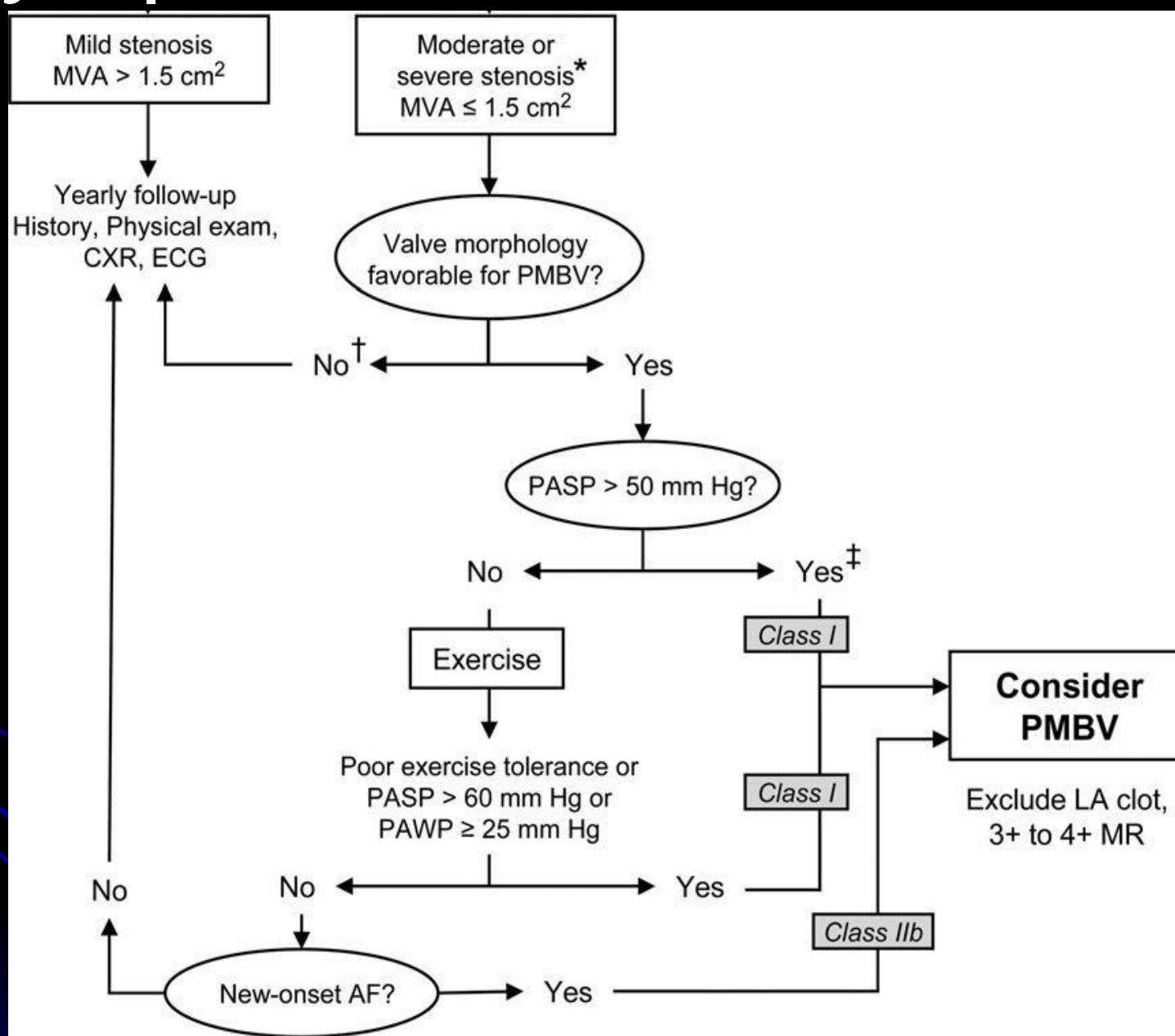
# Severity of Mitral Stenosis

Severity	MVA cm <sup>2</sup>	Gradient mmHg	PAP	Symptoms	Signs	Therapy
Mild	>1.8	2-4	Normal	Usually absent	S <sub>2</sub> -OS > 120ms; normal P <sub>2</sub>	
Moderate	1.2-1.6	4-9	Normal	Class II	S <sub>2</sub> -OS 100-120ms; normal P <sub>2</sub>	Diuretics
Moderate to Severe	1.0-1.2	10-15	Mild pulmonary HTN	Class II-III	S <sub>2</sub> -OS 80-100ms; P <sub>2</sub> increase	BMV if applicable or surgery if more than mild Sx
Severe	<1.0	15	Mild to severe pulmonary HTN	Class II-IV	S <sub>2</sub> -OS <80ms; P <sub>2</sub> increase; RV lift	BMV or surgery

# MS Auscultation



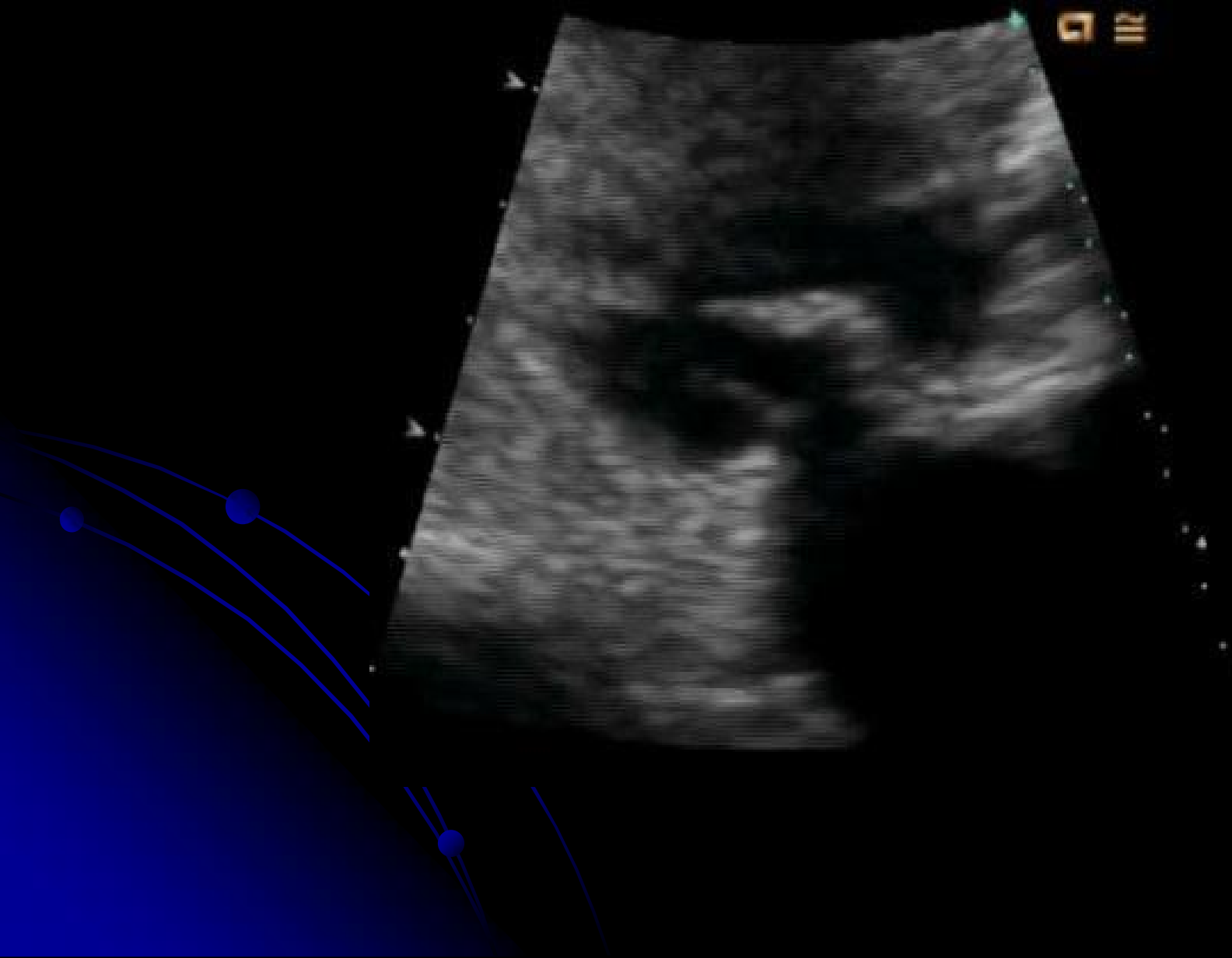
# Asymptomatic Mitral Stenosis



# Medical Management

- Diuretics
- Salt restriction
- Anticoagulation if indicated
  - Atrial fibrillation
- Treatment of atrial fibrillation

# Mitral Stenosis “Hockey Stick”

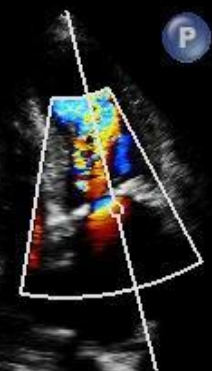




# Mean Pressure Gradient Mitral Stenosis

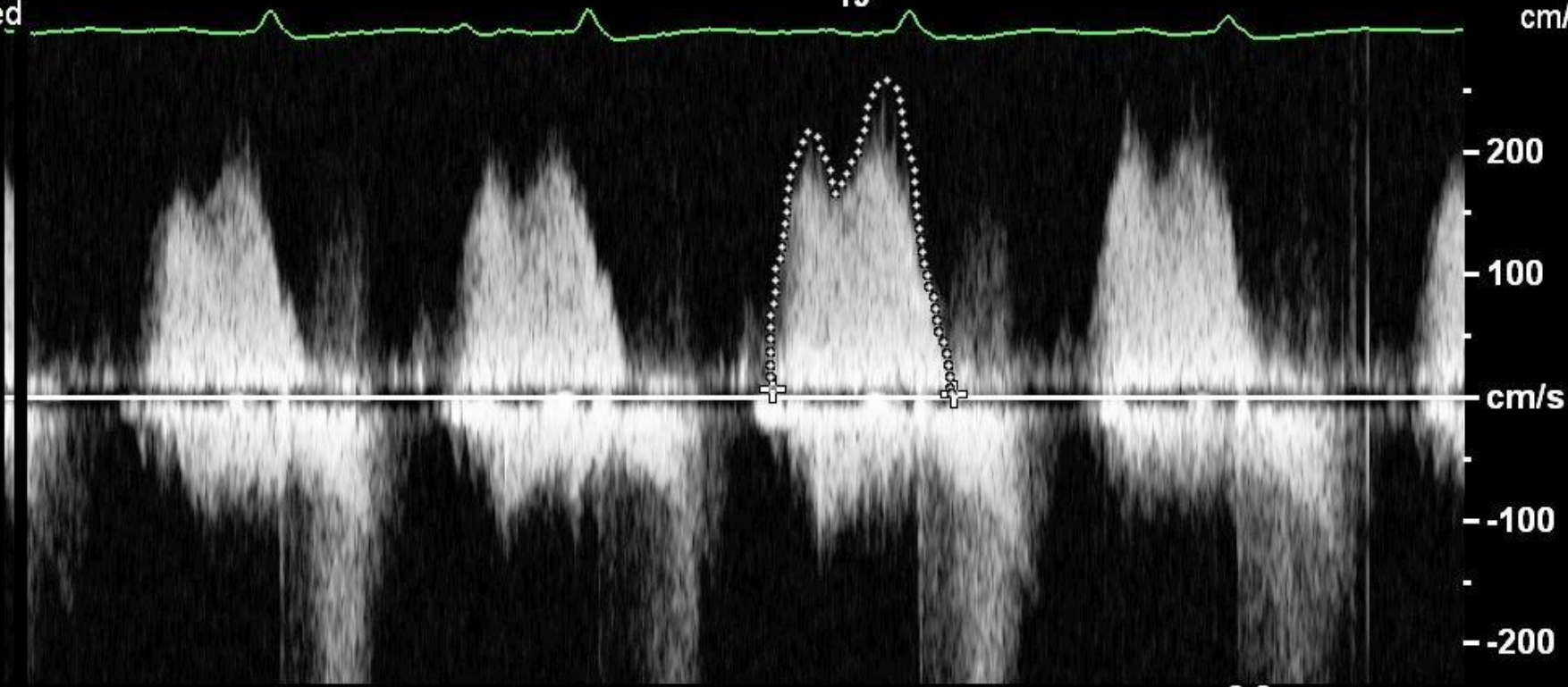
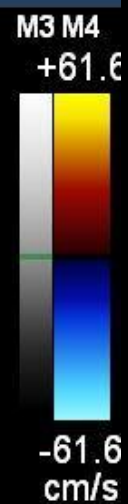
FR 14Hz  
RP

2D  
58%  
C 50  
P Low  
HGen  
CF  
66%  
4000Hz  
WF 399Hz  
Med



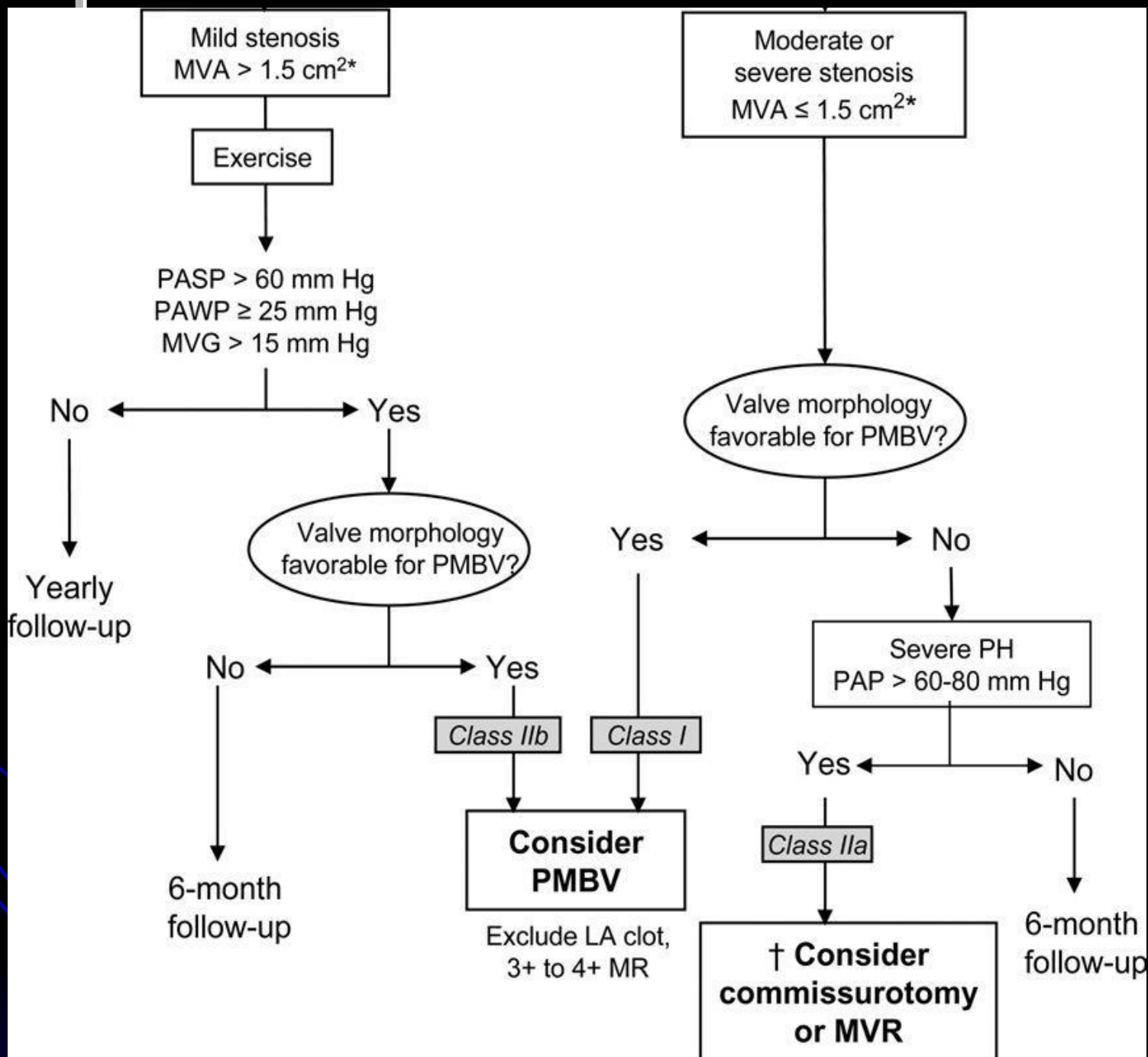
+ MV VTI  
Vmax 258 cm/s  
Vmean 175 cm/s  
Max PG 27 mmHg  
Mean PG 14 mmHg  
VTI 69.3 cm

$\frac{N}{F}$  225Hz  
8%  
 $\frac{N}{F}$  8MHz

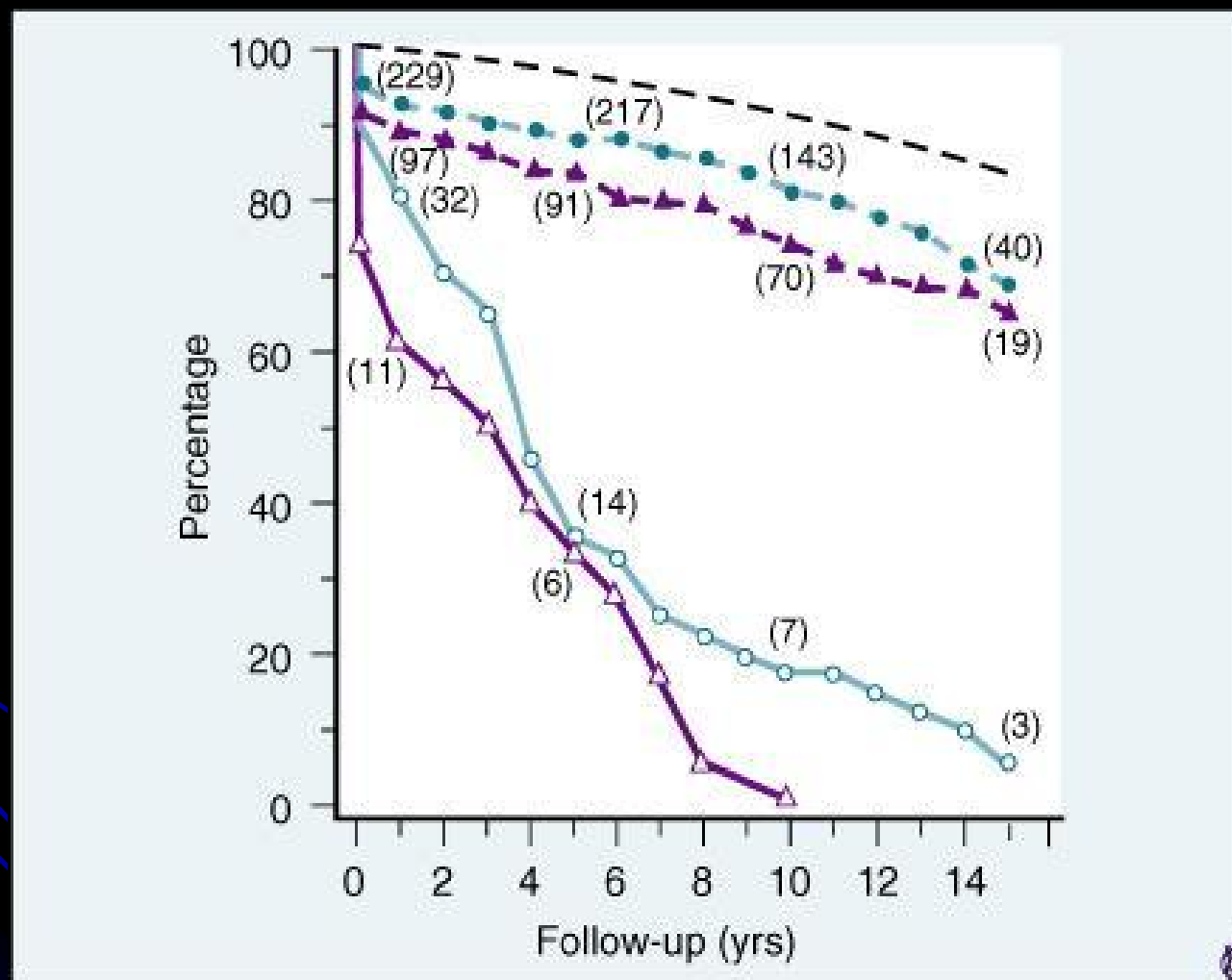


87bpm

# Symptomatic Mitral Stenosis



# Natural History of Mitral Valve disease (1991)



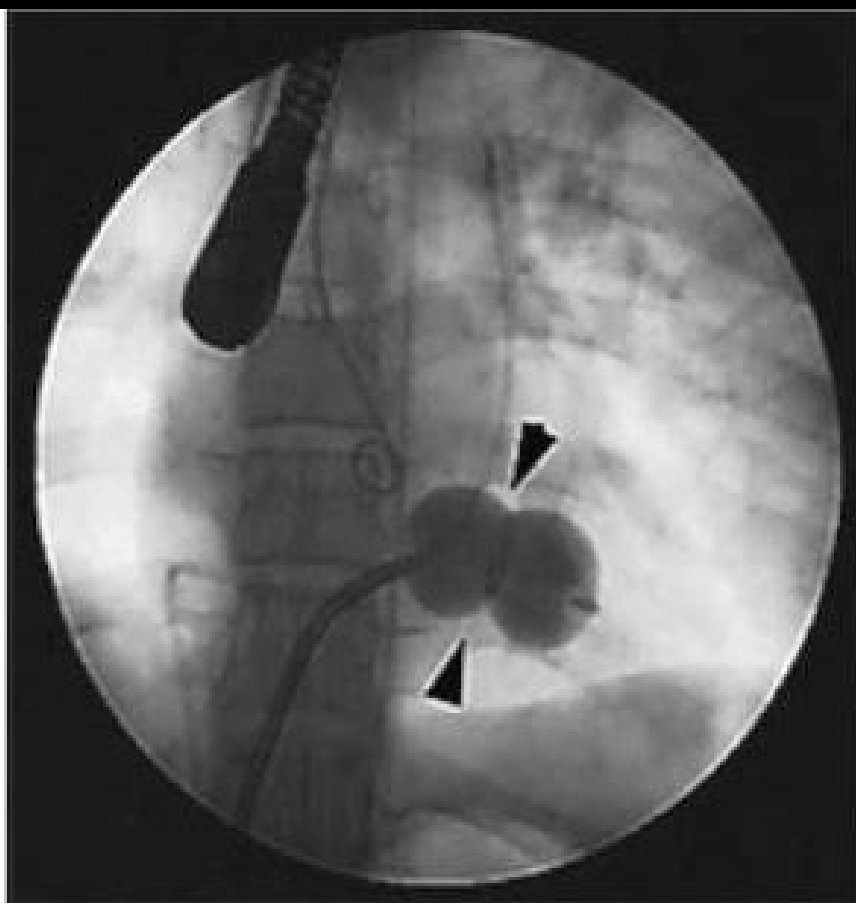
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Blue = Mitral Stenosis; Purple = Mitral Regurgitation  
Solid = Medical Management; Dashed = Surgical Management

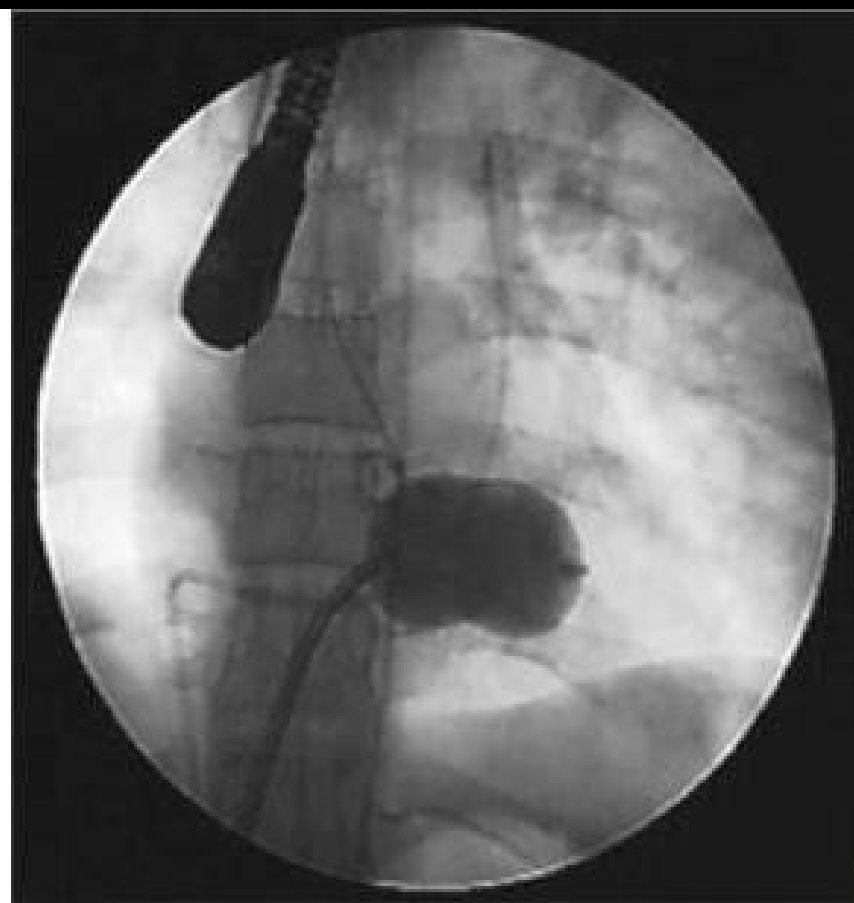
# Surgical Management

- Indicated for
  - Moderate (NYHA Class 2) symptoms
  - PA pressure >60mmHg
  - PCWP pressure >25mmHg
- Percutaneous balloon valvotomy
  - Favored if echo shows
    - High leaflet mobility
    - Low calcification, thickening, and subvalvular thickening
- Open/Closed Surgical valvotomy
- Mitral Valve replacement

# Inoue method of balloon mitral valvotomy (transseptal approach)



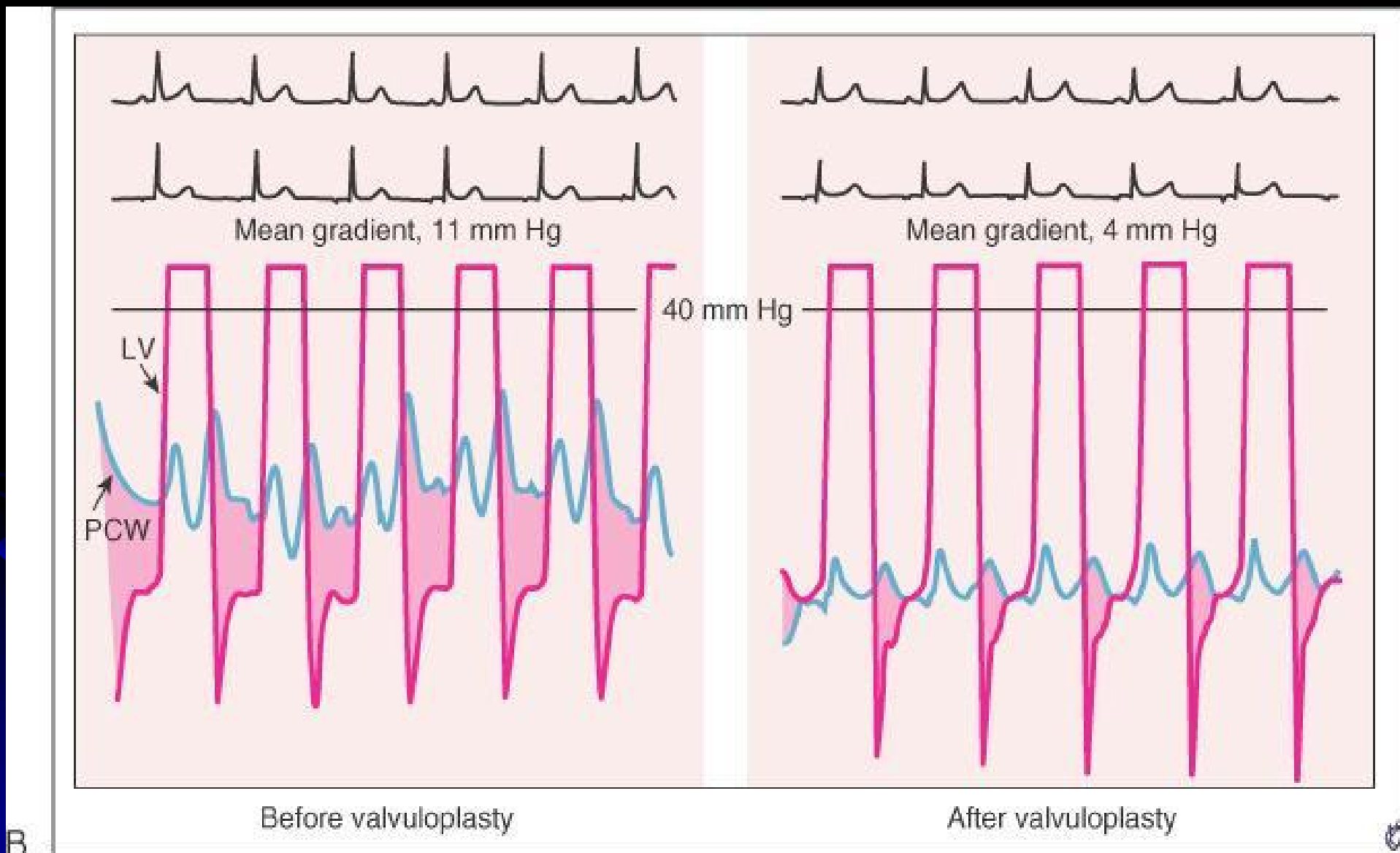
A  
Early inflation



Full expansion

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# Mean pressure gradient across Mitral Valve Pre- and Post- Balloon Valvotomy




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# Why is mitral regurgitation so complicated?

- Variable etiologies
- Variable symptoms
  - Generally slow onset
  - Symptoms often overlap with deconditioning and aging
- Variable comorbidities
  - Cardiac
    - Role of coronary & myocardial disease
  - Systemic
- Guidelines often based on specific numerical cutoffs for various measurements

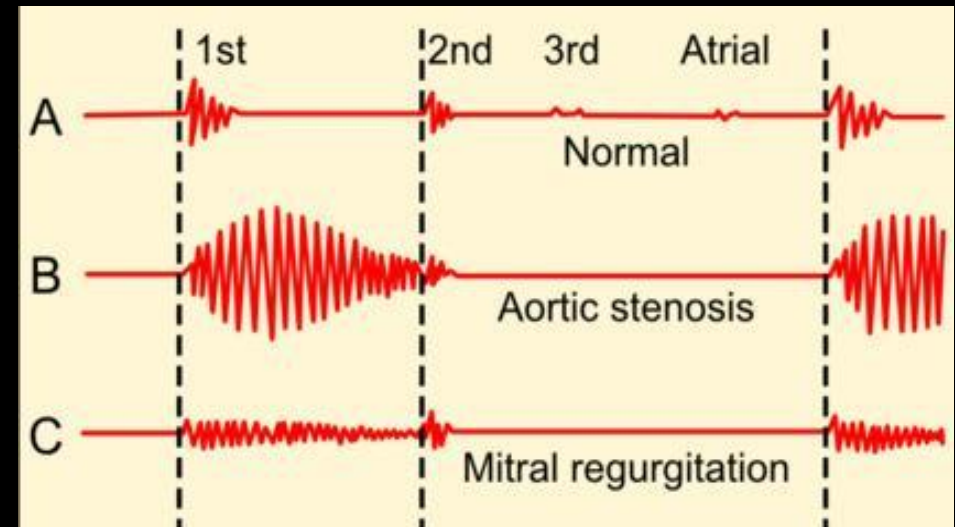
# Symptoms of MR

- Typically develop over a longer time frame than mitral stenosis
  - Shortness of breath
  - Weakness/fatigue
  - Development of atrial fibrillation
- 



# Physical Examination for MR

- **Systolic murmur**
  - Holosystolic
  - Constant intensity
  - Blowing, high pitch
  - Loudest at apex, radiates to axilla



# Causes of Chronic MR

- **Inflammatory**
  - Rheumatic heart disease
  - Systemic lupus erythematosus
  - Scleroderma
- **Degenerative**
  - **Myxomatous degeneration of mitral valve leaflets** (Barlow click-murmur syndrome, prolapsing leaflet, mitral valve prolapse)
  - Marfan syndrome
  - Ehlers-Danlos syndrome
  - Pseudoxanthoma elasticum
  - Calcification of mitral valve annulus
- **Infective**
  - Infective endocarditis affecting normal, abnormal, or prosthetic mitral valves
- **Structural**
  - Ruptured chordae tendineae (spontaneous or secondary to myocardial infarction, trauma, mitral valve prolapse, endocarditis)
  - Rupture or dysfunction of papillary muscle (ischemia or myocardial infarction)
  - **Dilation of mitral valve annulus and left ventricular cavity** (congestive cardiomyopathies, aneurysmal dilation of the left ventricle)
  - Hypertrophic cardiomyopathy
  - Paravalvular prosthetic leak
- **Congenital**
  - Mitral valve clefts or fenestrations
  - Parachute mitral valve abnormality in association with:
    - Endocardial cushion defects
    - Endocardial fibroelastosis
    - Transposition of the great arteries
    - Anomalous origin of the left coronary artery

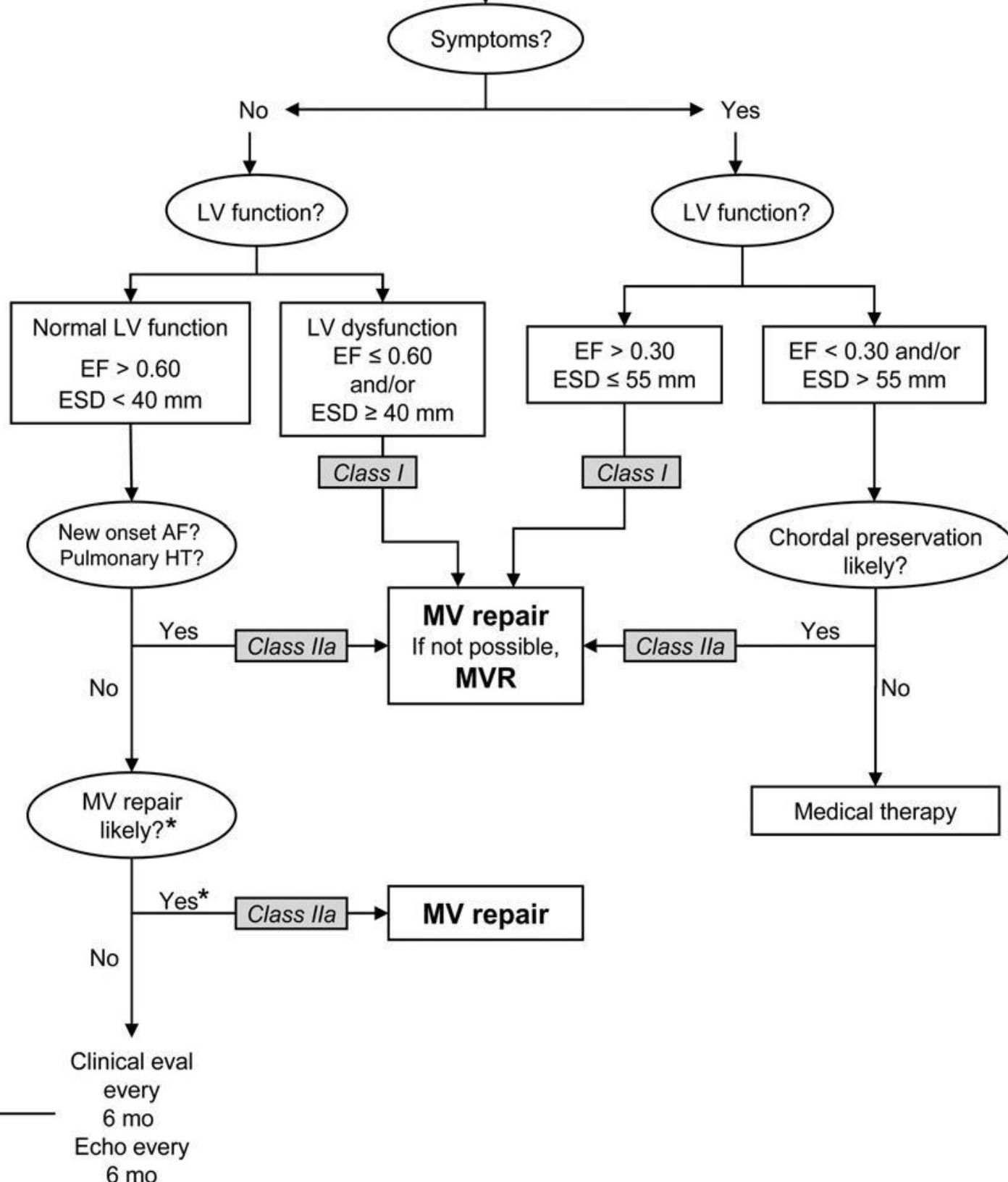
# How often should I get an echo?

- Moderate to Severe MR (Asymptomatic)
  - Every 6-12 months
- Moderate MR
  - Not specified in Guidelines or appropriateness criteria
- Asymptomatic Mild MR
  - Not routinely recommended
- Echo is recommended for change in symptoms

Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr., Faxon DP, Freed MD, Gaasch WH, Lytle BW, Nishimura RA, O'Gara PT, O'Rourke RA, Otto CM, Shah PM, Shanewise JS. 2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Develop Guidelines for the Management of Patients With Valvular Heart Disease). *J Am Coll Cardiol* 2008;52:e1-142.

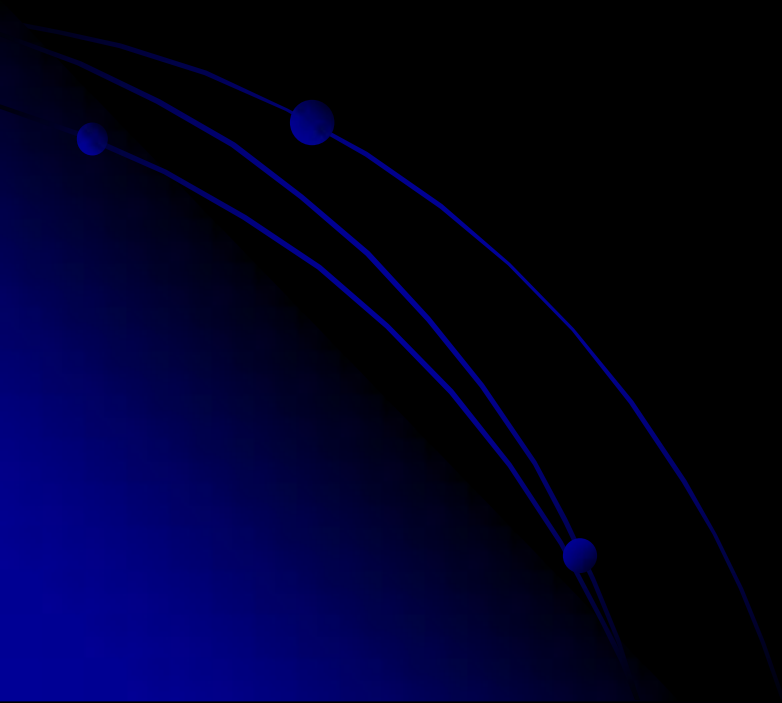
Douglas PS, Khandheria B, Stainback RF, Weissman NJ. ACCF/ASE/ACEP/ASNC/SCAI/SCCT/SCMR, 2007 appropriateness criteria for transthoracic and transesophageal echocardiography. *J Am Coll Cardiol* 2007.

# Managing Chronic Severe MR

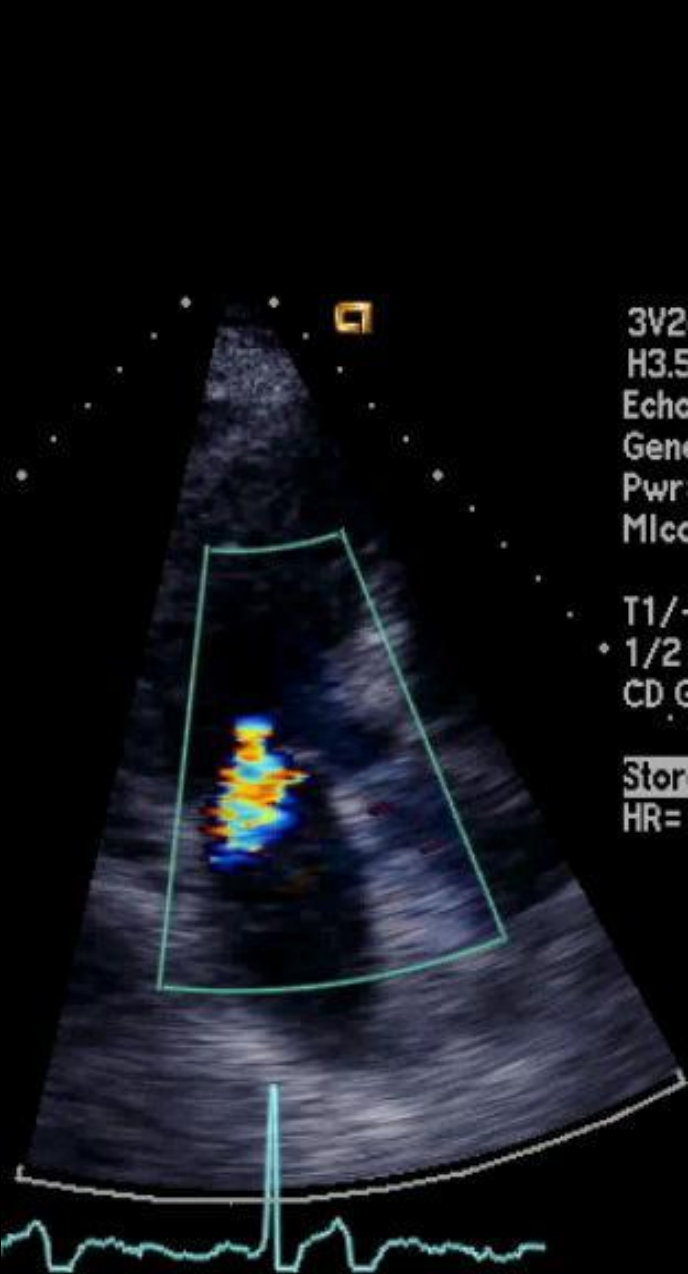
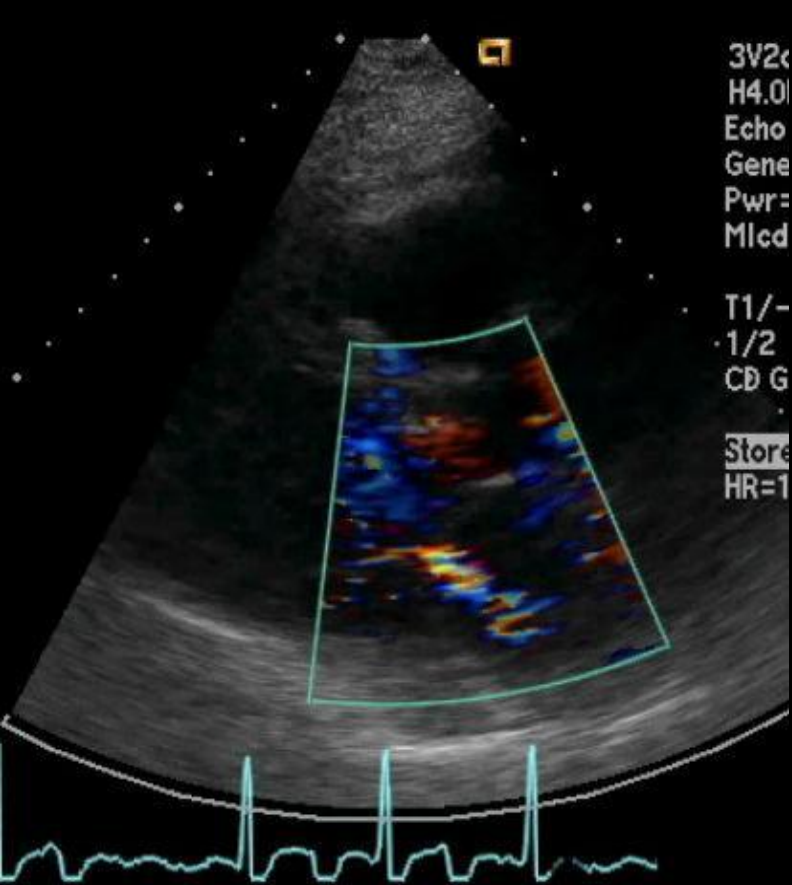


# Echocardiography

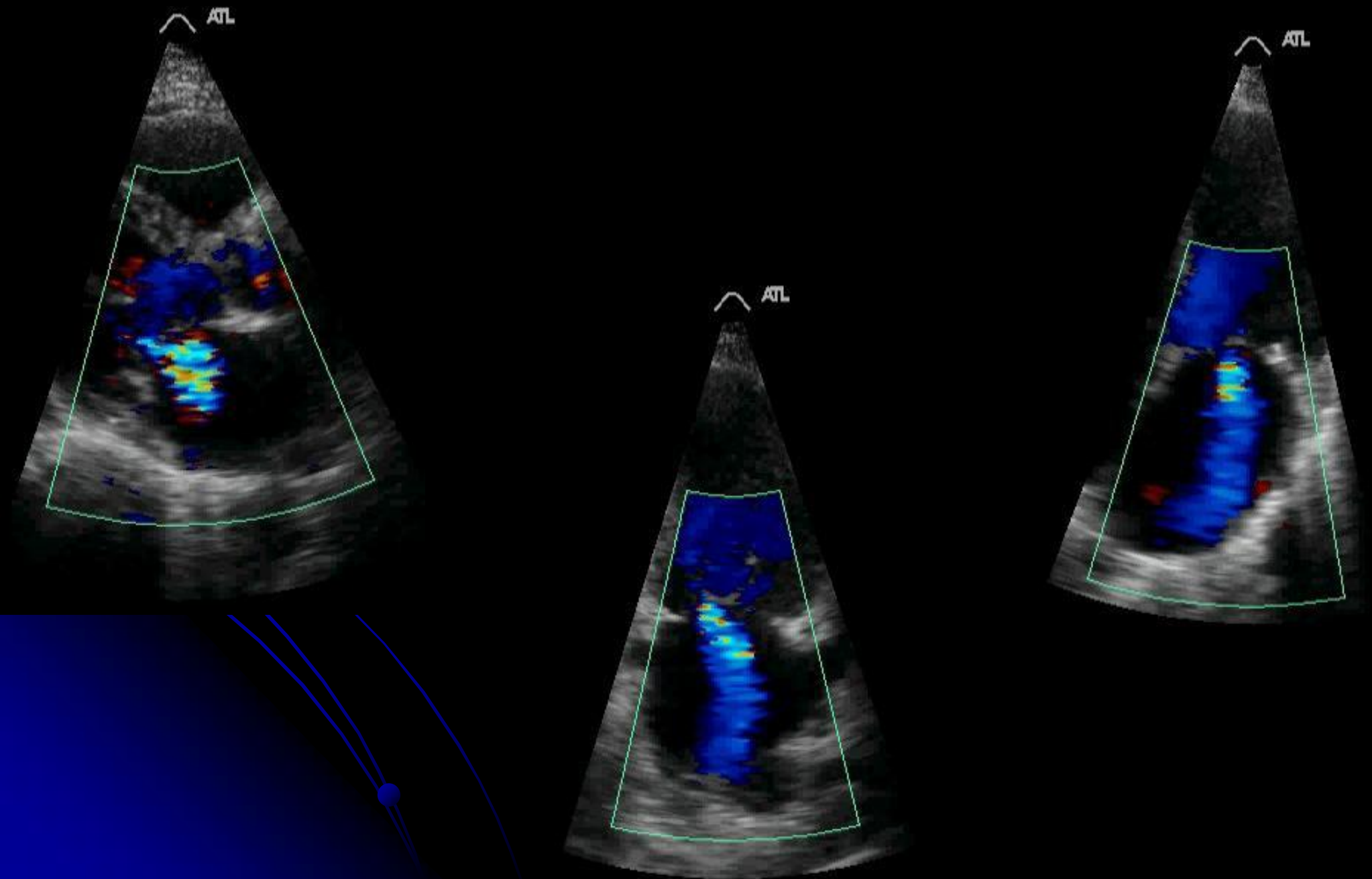
- Primary tool for assessing severity of Mitral regurgitation



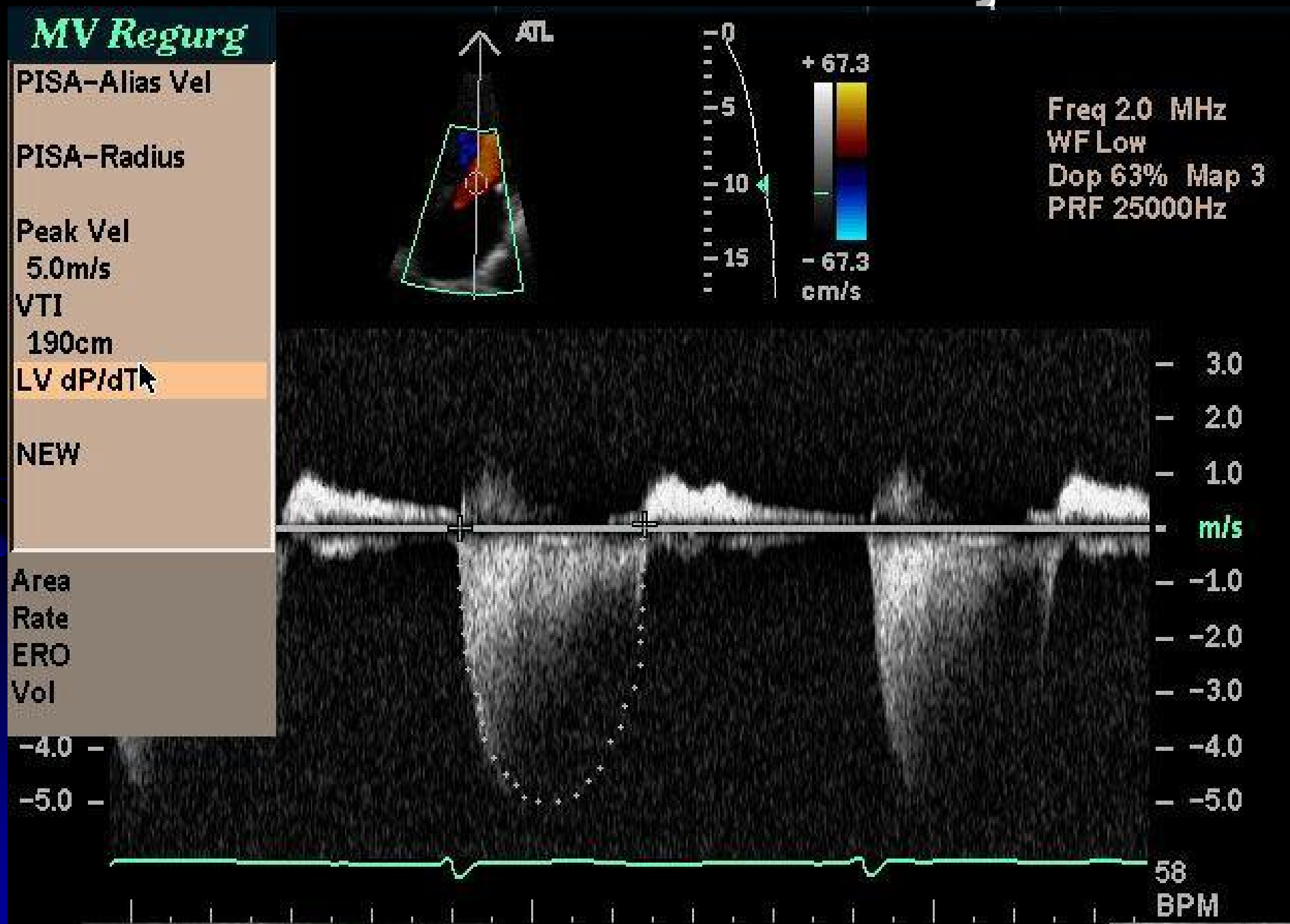
# Mild Mitral Regurgitation



# Moderate Mitral Regurgitation



# Moderate MR CW jet

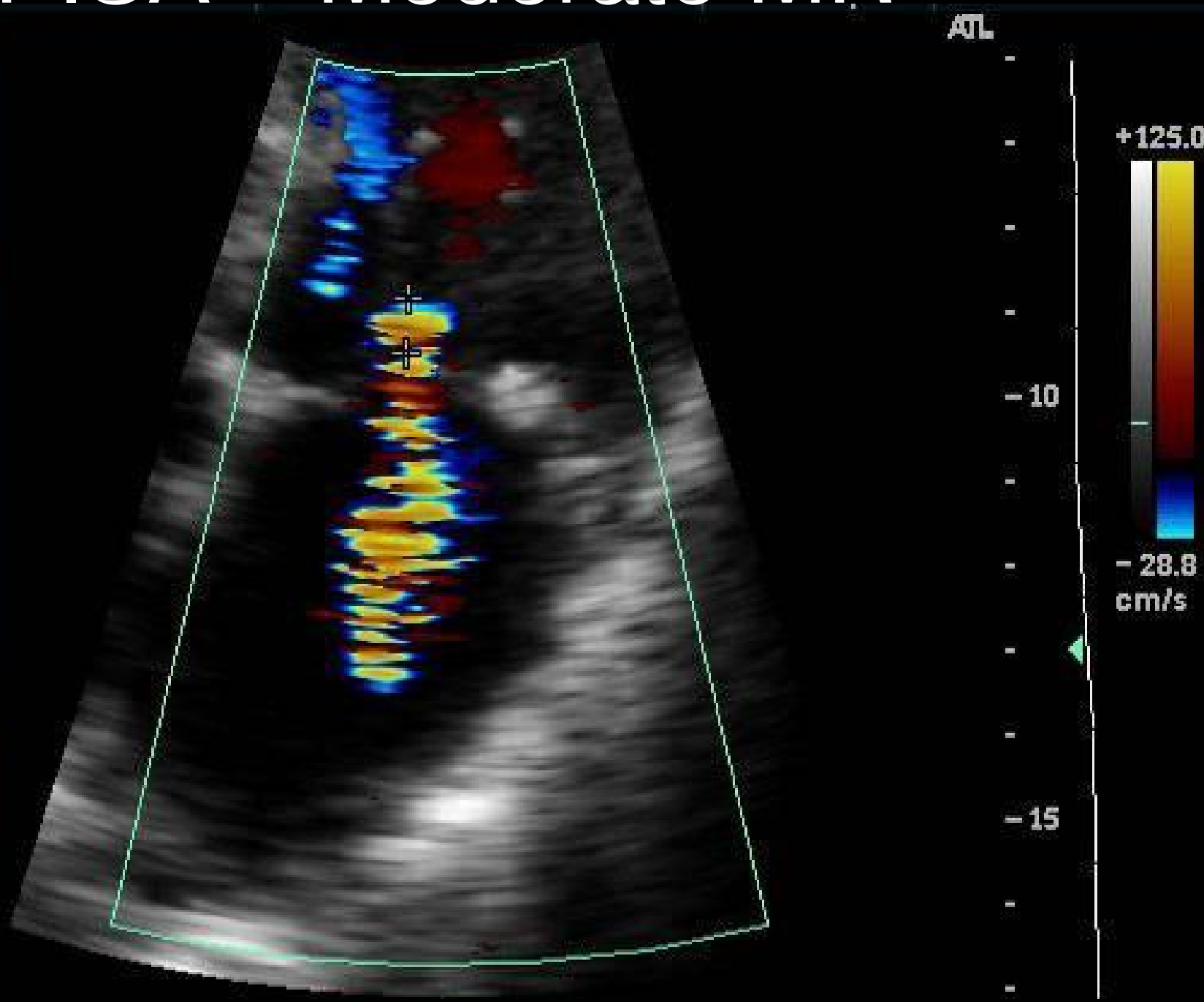




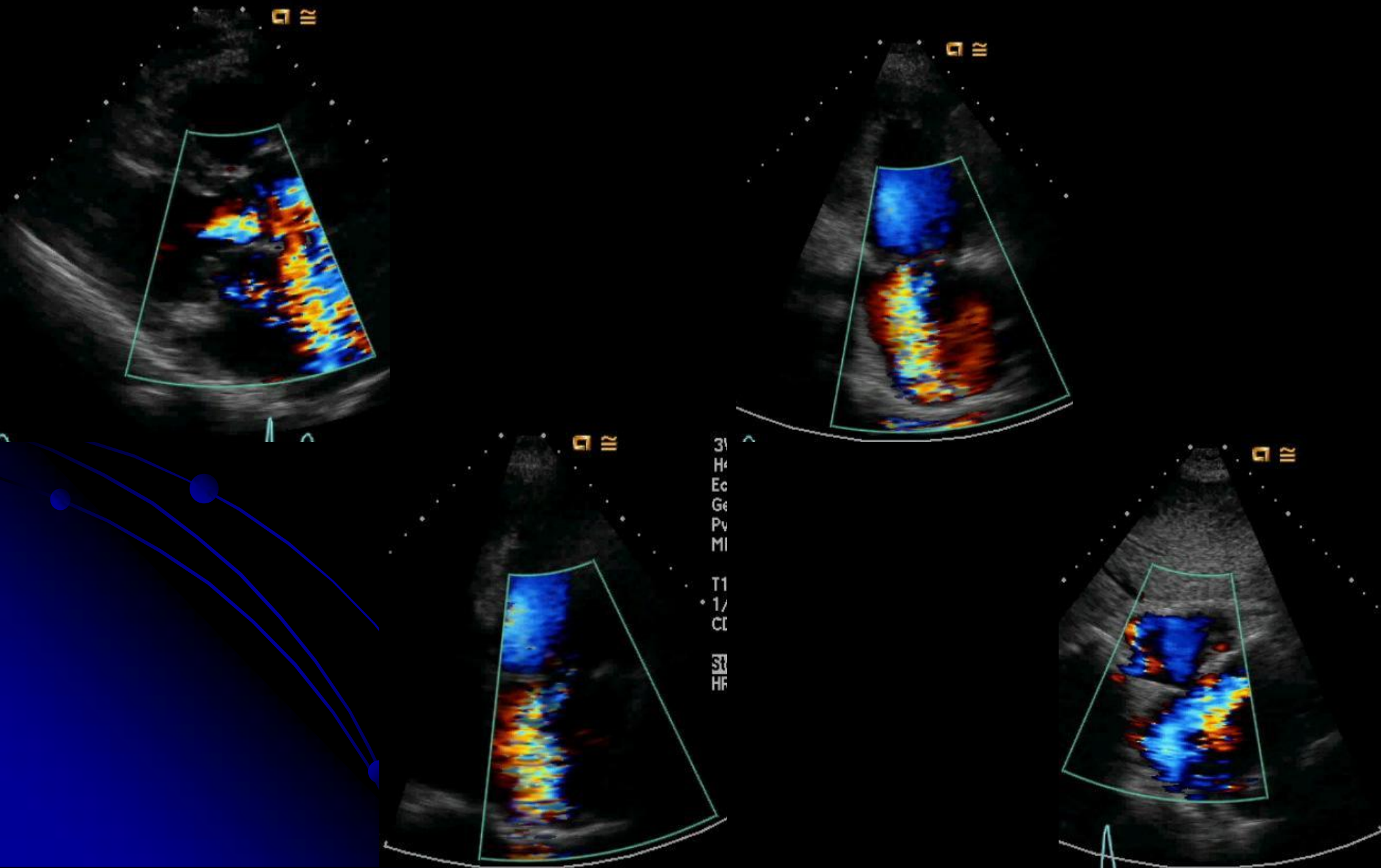
# PISA – Moderate MR

**MV Regurg**

PISA-Alias Vel	28.8cm/s
PISA-Radius	0.7cm
Peak Vel	5.0m/s
VTI	190cm
LV dP/dT	
NEW	
Area	3.1cm <sup>2</sup>
Rate	89ml/sec
ERO	0.2cm <sup>2</sup>
Vol	38ml



# Severe Mitral Regurgitation



# Etiology of Mitral Regurgitation

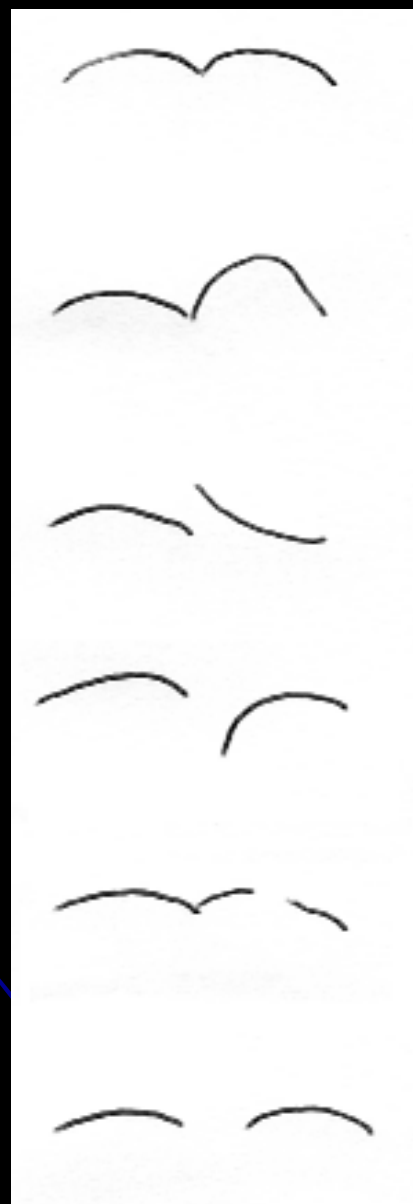
- Primary

- Flail leaflet
- Mitral valve prolapse
- Perforation (endocarditis)
- Chordal rupture

- Secondary

- Annular dilatation
- Ischemic mitral regurgitation
  - Remodeling of papillary muscle

# Simplified Mechanisms of Mitral Regurgitation



Normal

Prolapse

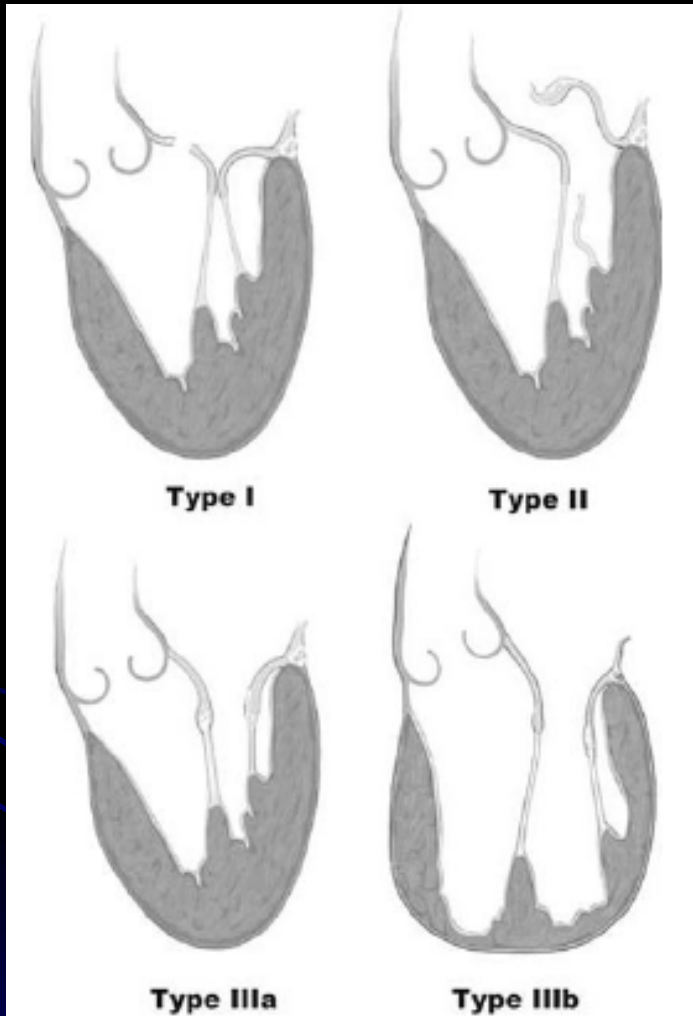
Flail leaflet

Restricted leaflet motion

Perforated leaflet

Annular dilatation

# Carpentier Classification



Type I - normal leaflet length and motion but with either annular dilation or leaflet perforation

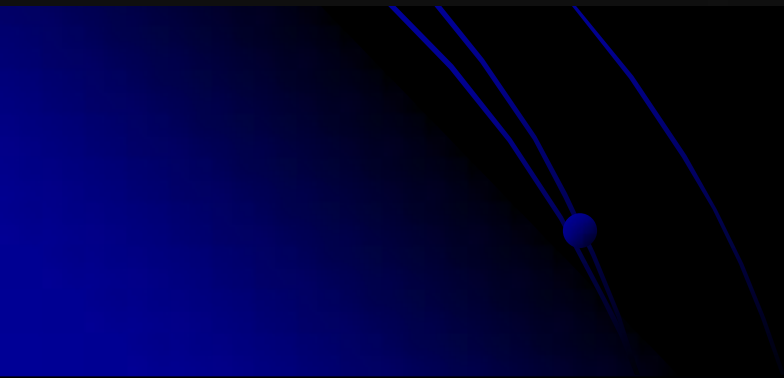
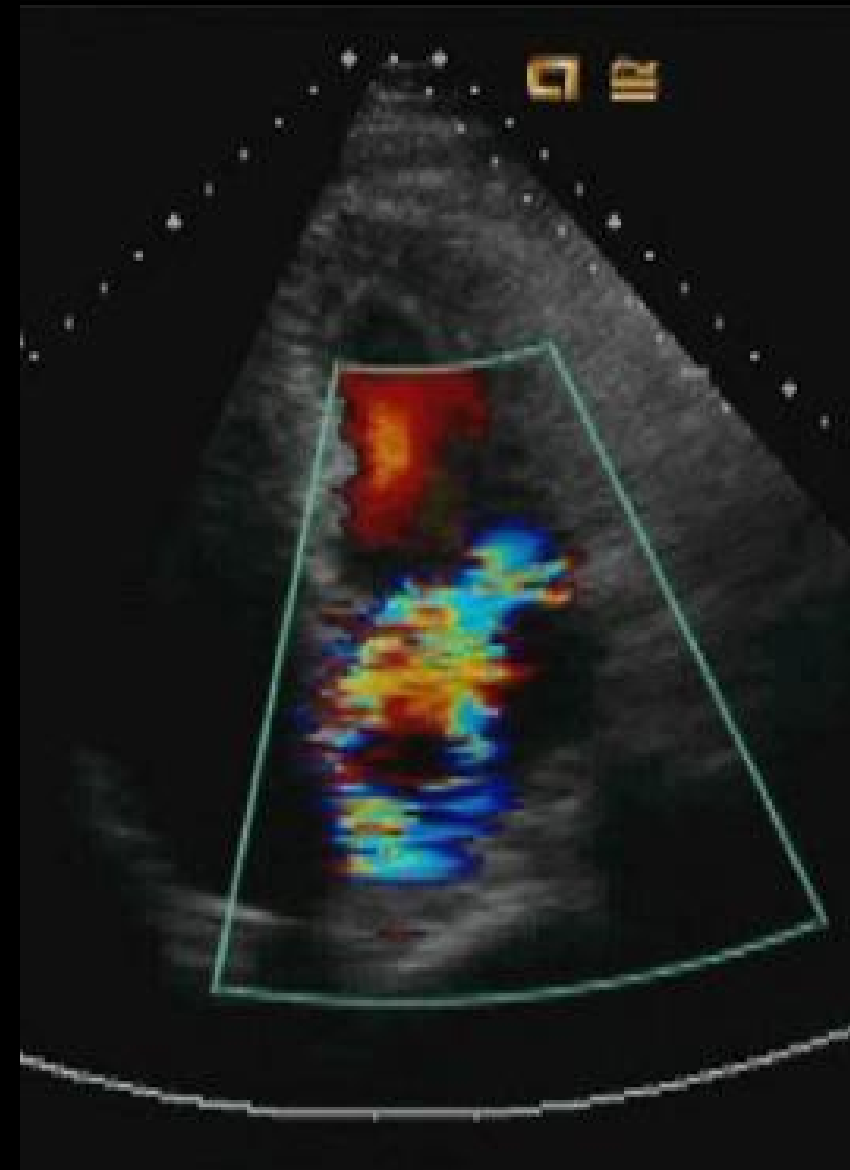
Type II MR is caused by leaflet prolapse or by papillary muscle rupture or elongation.

Type III MR is caused by restricted leaflet motion.

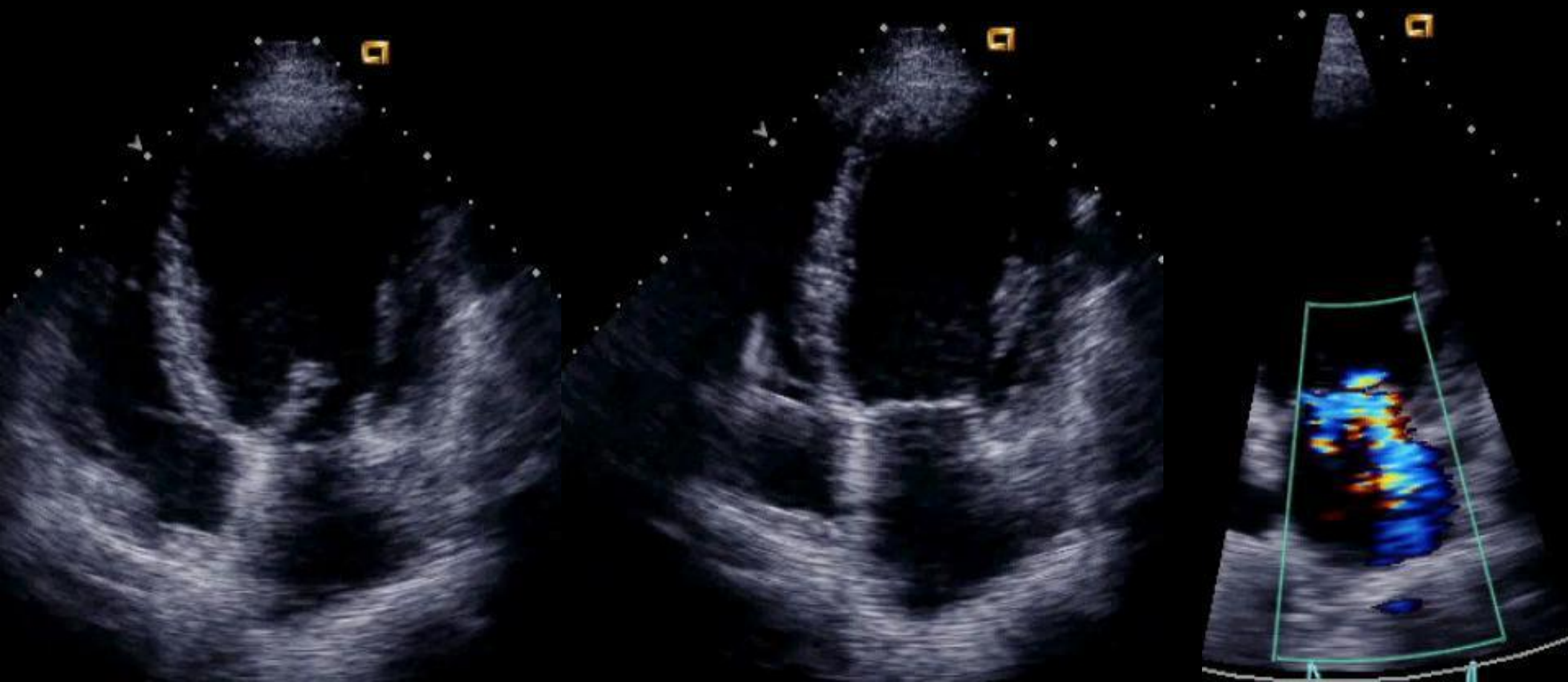
Type IIIa - rheumatic disease with subvalvular involvement.

Type IIIb – tethered and restricted leaflet motion due to ischemic or idiopathic cardiomyopathy with ventricular dilation.

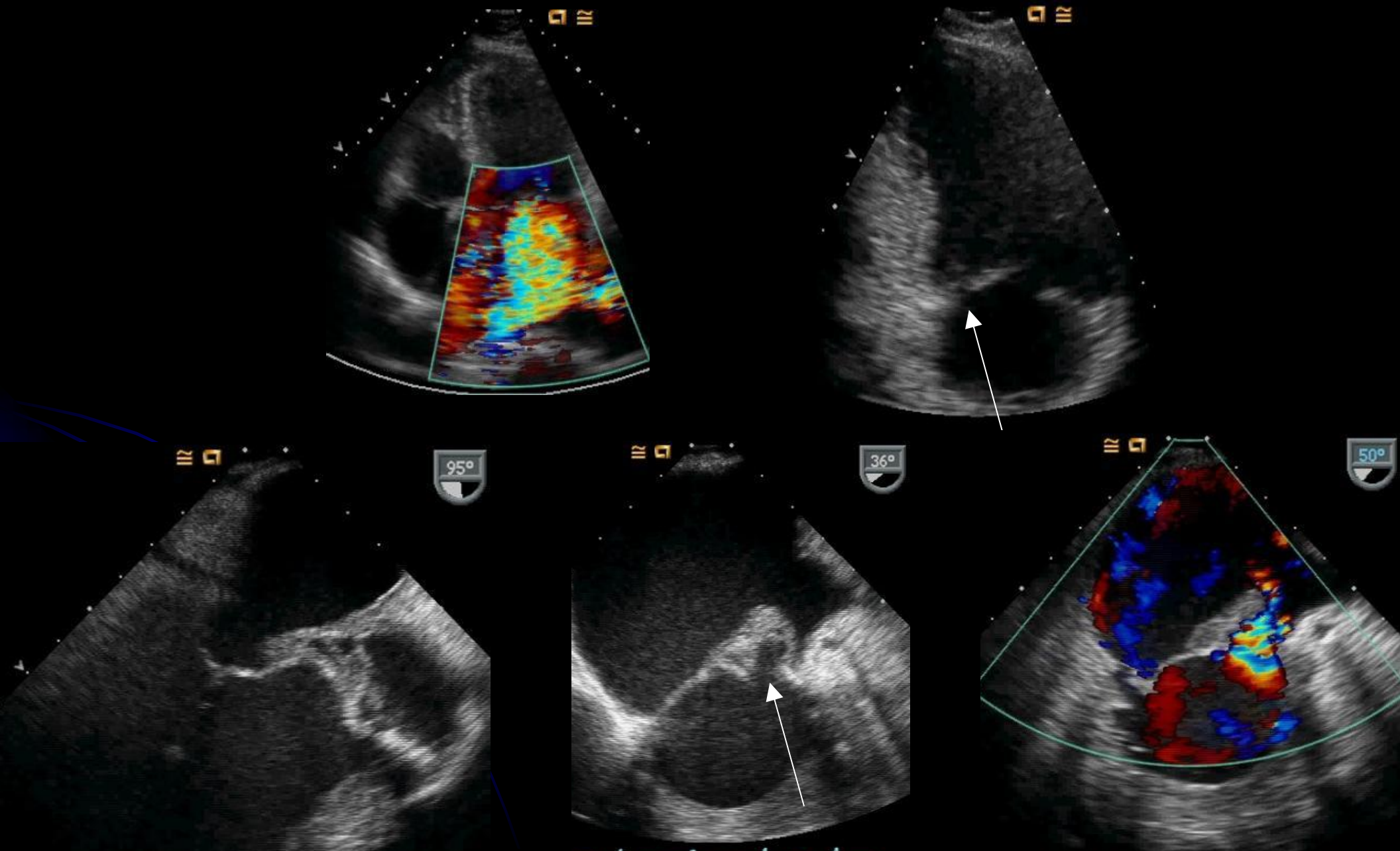
# Flail posterior leaflet tip



# Ischemic Mitral Regurgitation

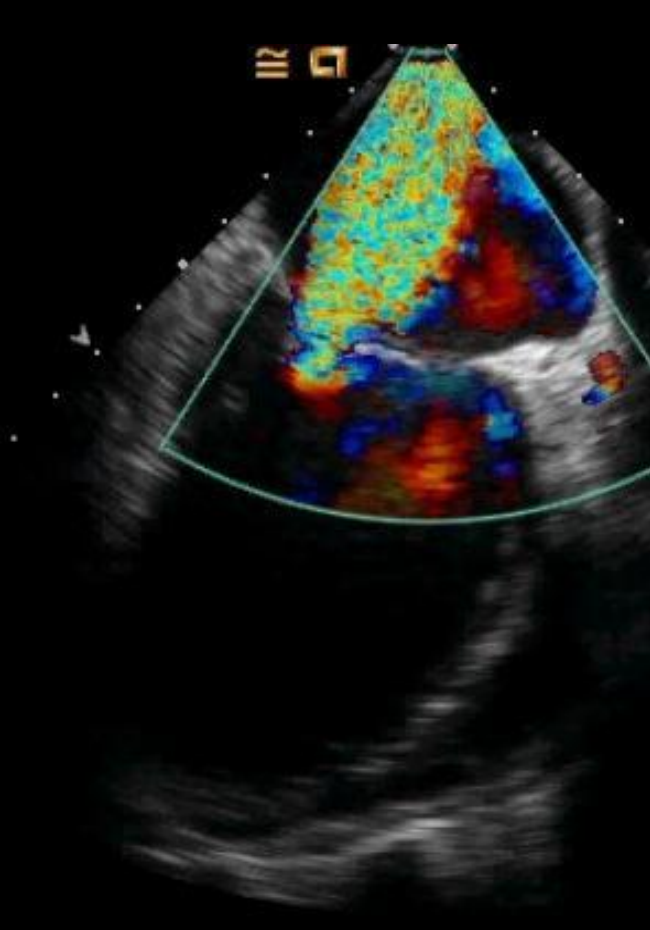


# Mitral valve leaflet perforation Endocarditis





# Dilated Cardiomyopathy (Nonischemic)



End Systole  
Failure of coaptation



End Diastole

# Mitral Valve Prolapse

- Defined as billowing of the mitral valve leaflet 2mm beyond the annular plane in the parasternal long axis view
- Myxomatous degeneration in younger patients
- Fibroelastic tissue deficiency in elderly
- 1-2.5% prevalence
- Heterogenous natural history
- 5-10% progress to severe mitral regurgitation

# Myxomatous mitral valve



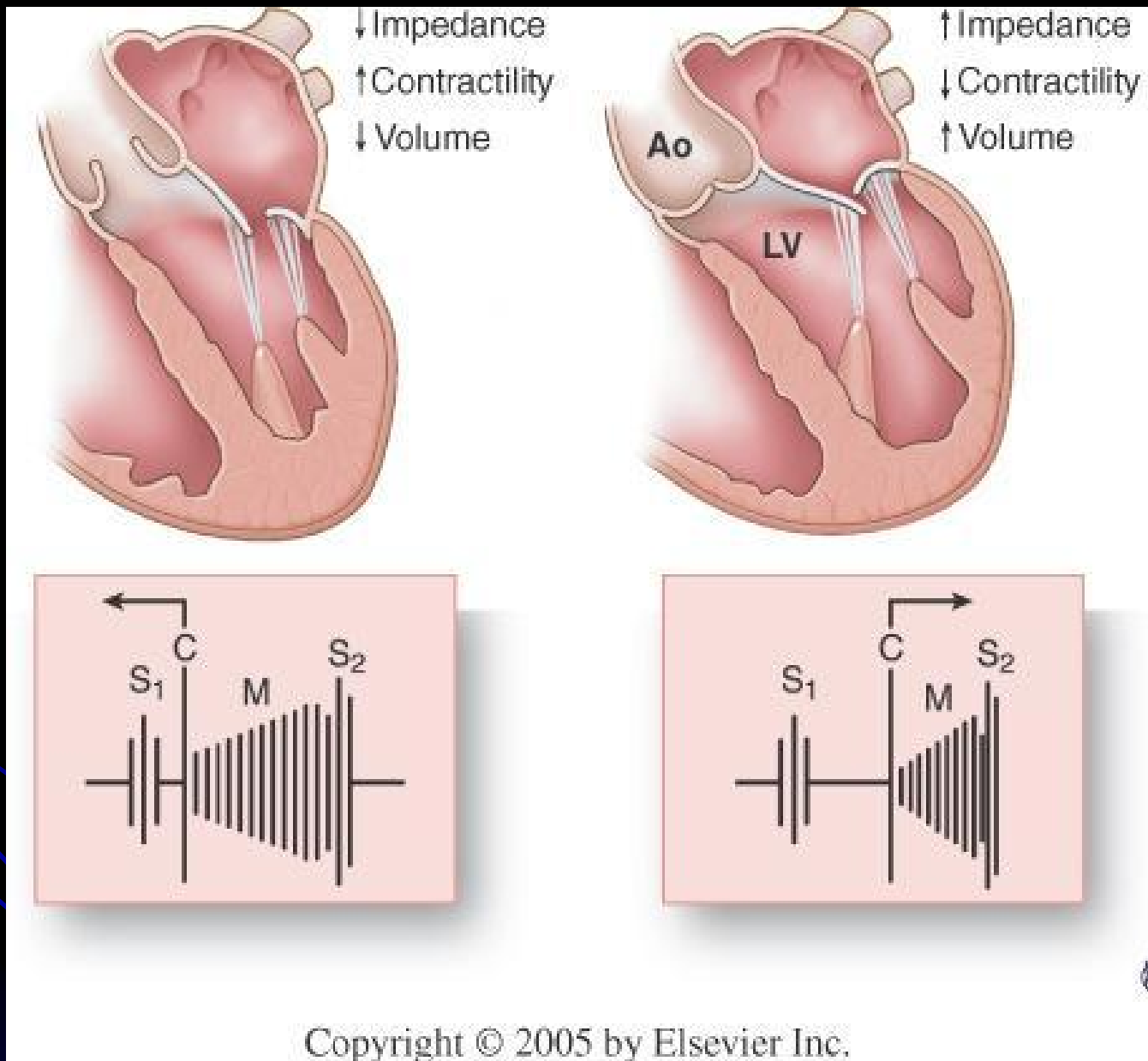
A

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# Physical Exam in MVP

- **Systolic Click**
  - Best heard with diaphragm
  - Occurs at least 140ms after S1
  - Caused by sudden tensing of chordae during systole
  - Maneuvers that decrease LV volume move click closer to S1
  - Maneuvers that increase LV volume move click away from S1 and lower intensity



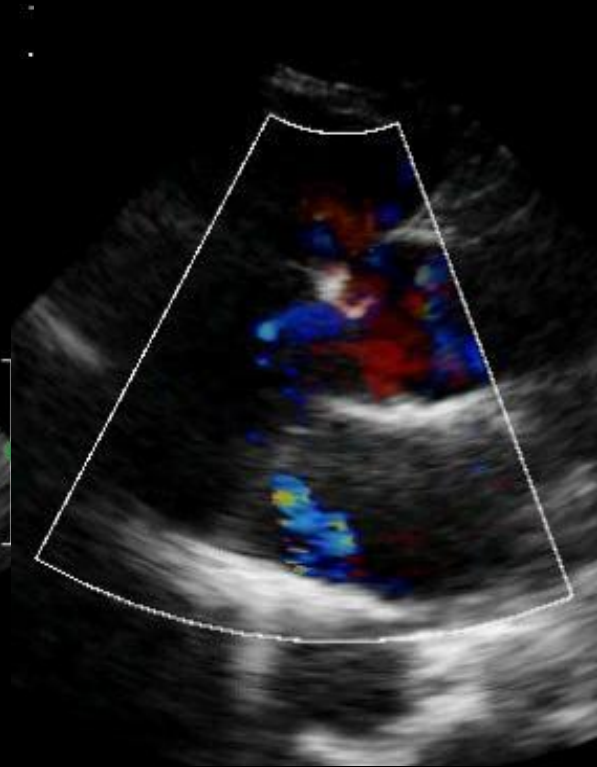
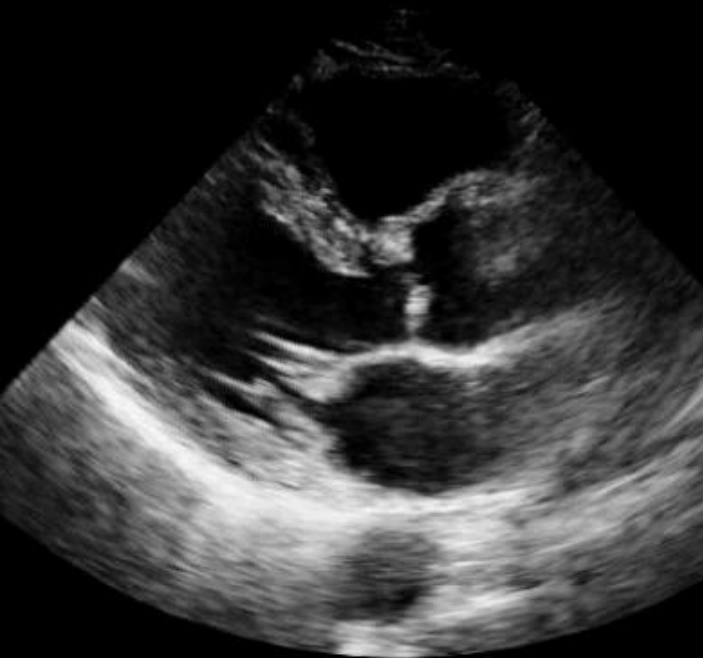


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# Mitral Valve Prolapse Syndrome

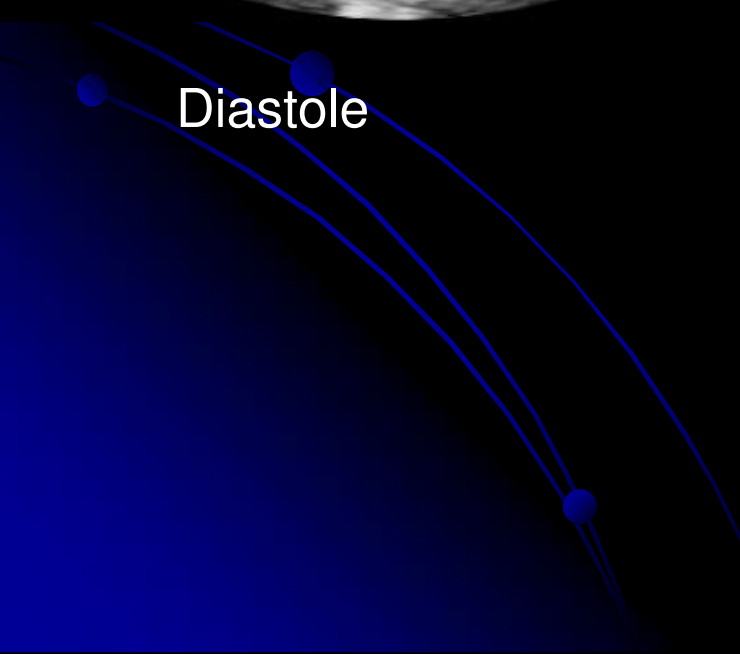
- Cluster of symptoms
  - Palpitations
  - Chest pain
  - TIA symptoms
- Guidelines base treatment on
  - Cerebrovascular event
  - Atrial fibrillation
  - Severity of Mitral regurgitation

# Mild MVP

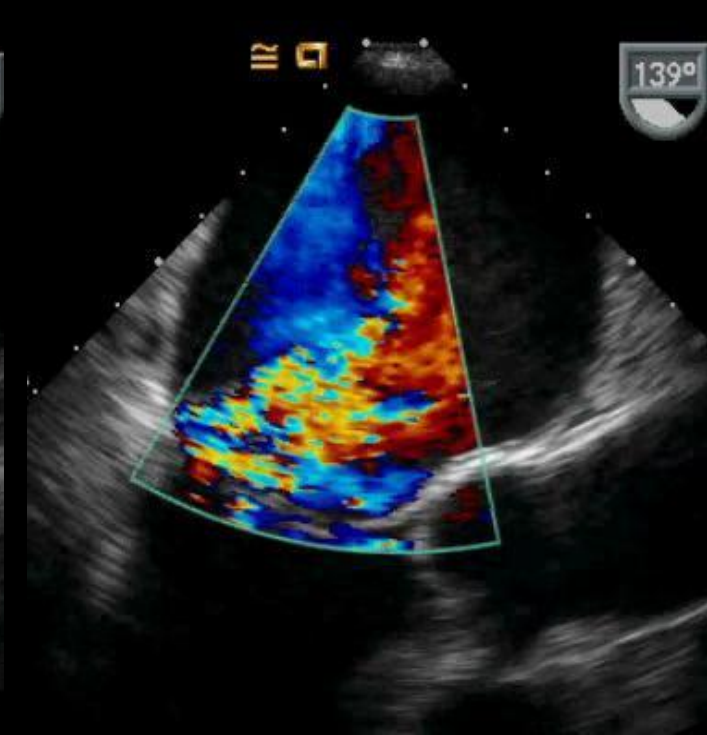
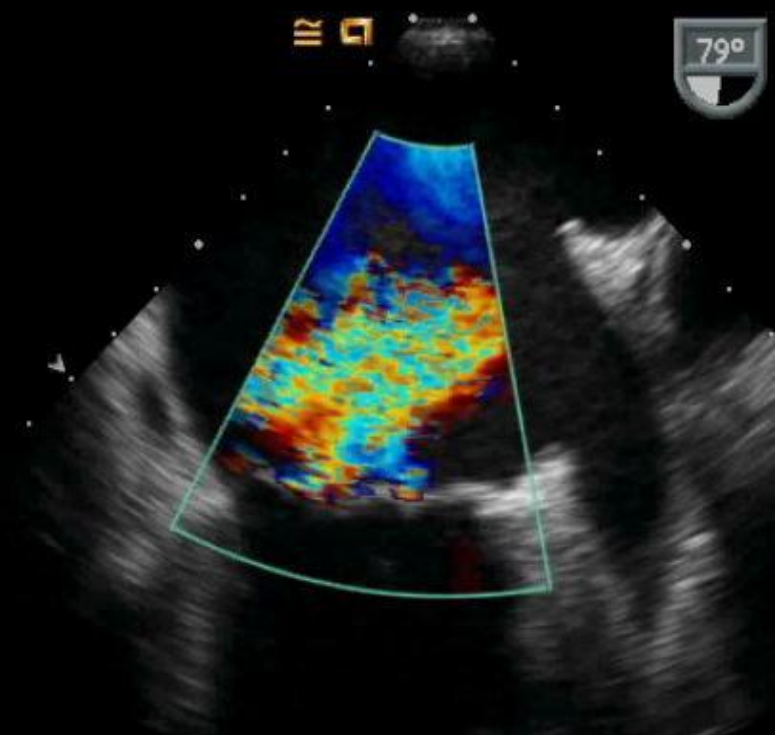


Diastole

Systole

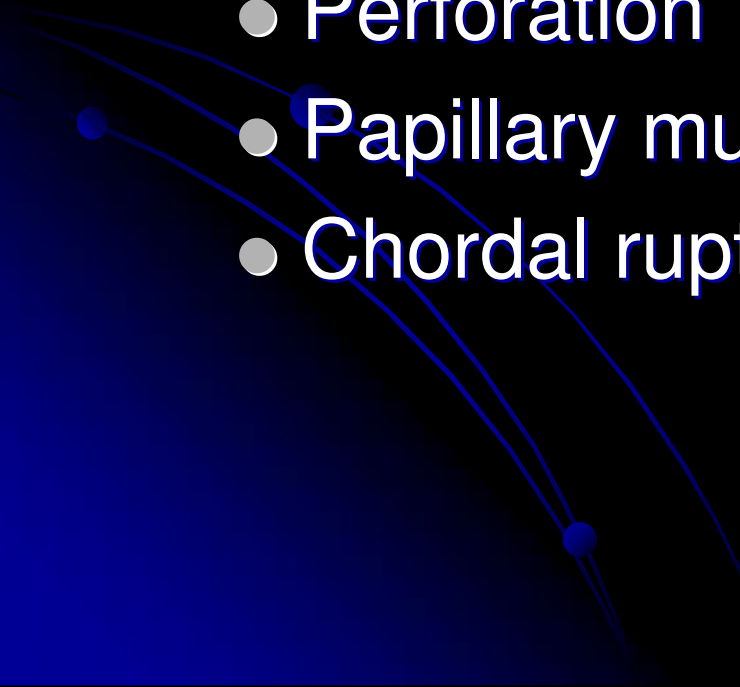


# Severe MVP





# Acute Severe Mitral Regurgitation

- Usually Significant Symptoms
    - Shortness of Breath
    - Hypotension
  - Sudden change in valvular function
    - Perforation
    - Papillary muscle dysfunction
    - Chordal rupture
- 

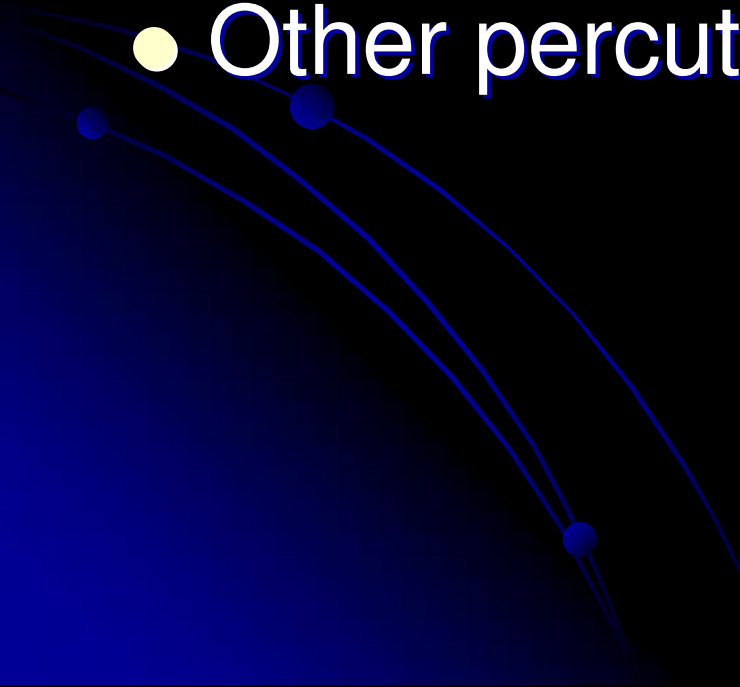
# Causes of Acute MR

- **Mitral Annulus Disorders**
  - Infective endocarditis (abscess formation)
  - Trauma (valvular heart surgery)
  - Paravalvular leak caused by suture interruption (surgical technical problems or infective endocarditis)
- **Mitral Leaflet Disorders**
  - **Infective endocarditis (perforation or interference with valve closure by vegetation)**
  - **Trauma** (tear during percutaneous balloon mitral valvotomy or penetrating chest injury)
  - Tumors (atrial myxoma)
  - Myxomatous degeneration
  - Systemic lupus erythematosus (Libman-Sacks lesion)
- **Rupture of Chordae Tendineae**
  - Idiopathic (e.g., spontaneous)
  - Myxomatous degeneration (mitral valve prolapse, Marfan syndrome, Ehlers-Danlos syndrome)
  - Infective endocarditis
  - Acute rheumatic fever
  - Trauma (percutaneous balloon valvotomy, blunt chest trauma)
- **Papillary Muscle Disorders**
  - **Coronary artery disease (causing dysfunction and rarely rupture)**
  - Acute global left ventricular dysfunction
  - Infiltrative diseases (amyloidosis, sarcoidosis)
  - Trauma
- **Primary Mitral Valve Prosthetic Disorders**
  - Porcine cusp perforation (endocarditis)
  - Porcine cusp degeneration
  - Mechanical failure (strut fracture)
  - Immobilized disc or ball of the mechanical prosthesis

# Diagnosis of Acute Severe MR

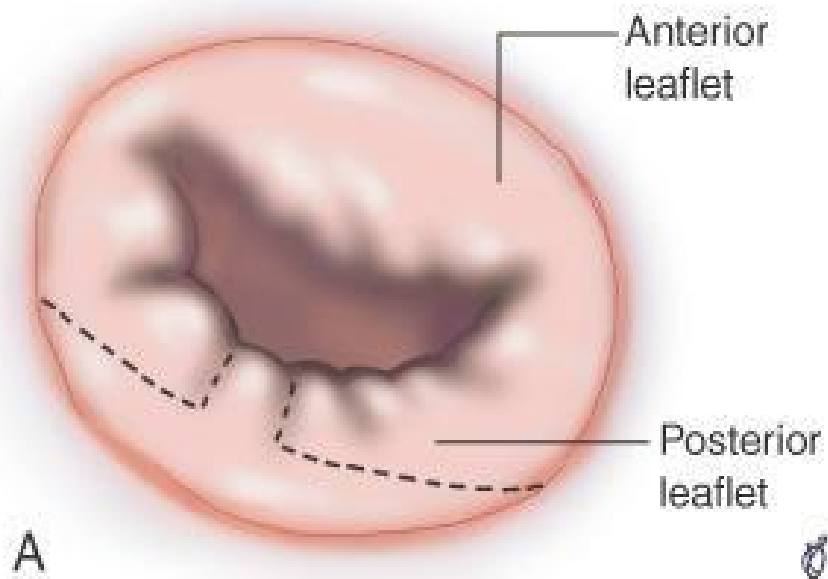
- Auscultation may not be remarkable
- Echocardiography is primary diagnostic modality
- Medical management limited
  - Nitroprusside for afterload reduction
- Surgical management usually indicated

# Surgical Repair

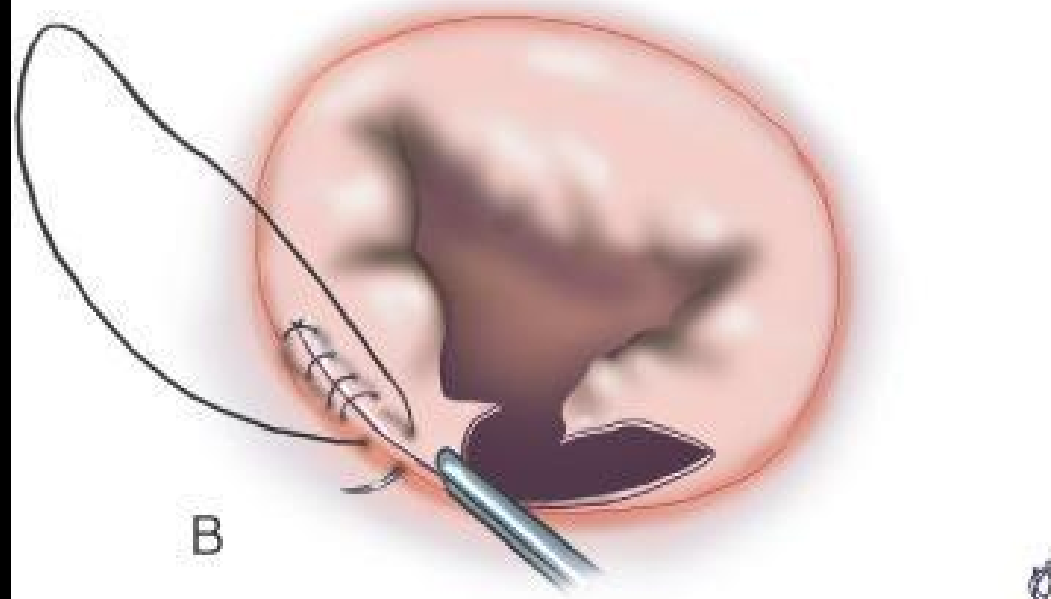
- Repair favored over valve replacement
  - New endovascular techniques promising
    - EVEREST 2 trial for MitraClip
  - Other percutaneous methods
- 

# Repair of Posterior MVP

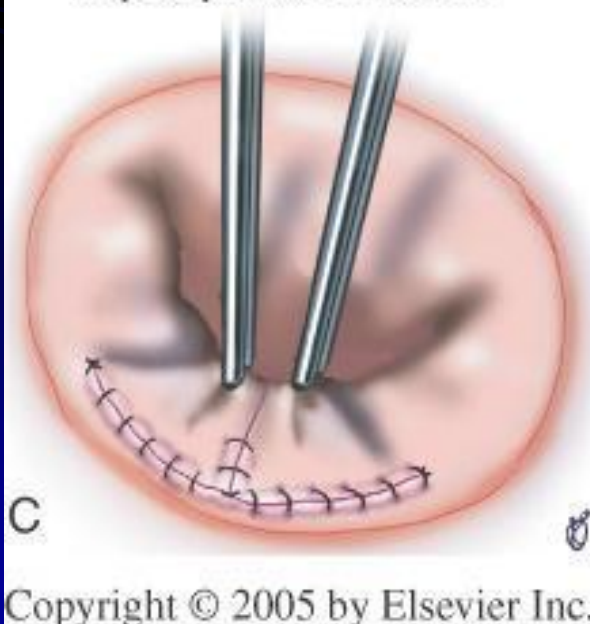
Reduction excision of posterior leaflet



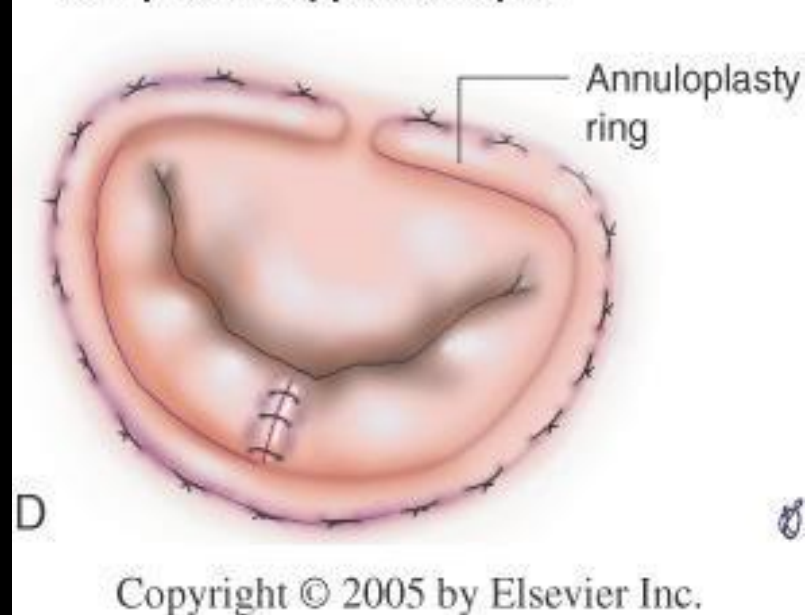
Reattach posterior leaflet (sliding valvuloplasty)



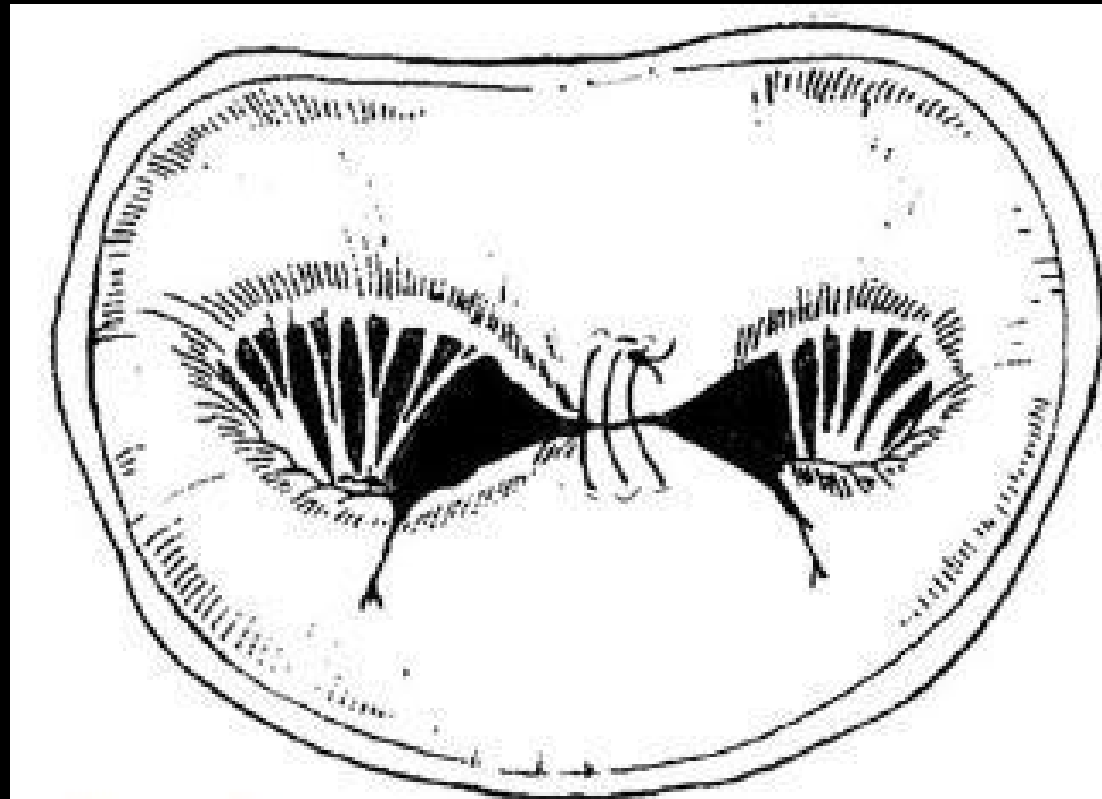
Repair posterior leaflet



Completed supported repair

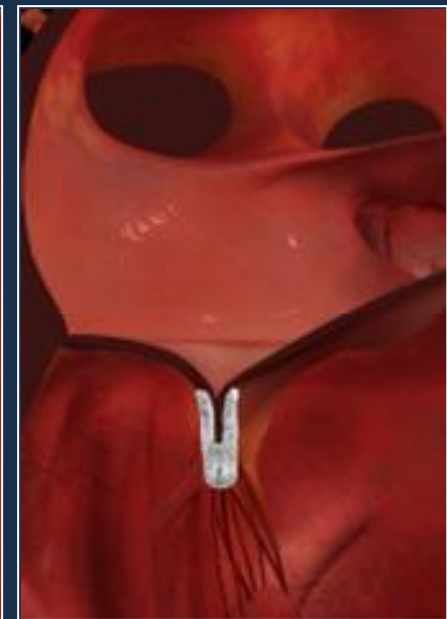
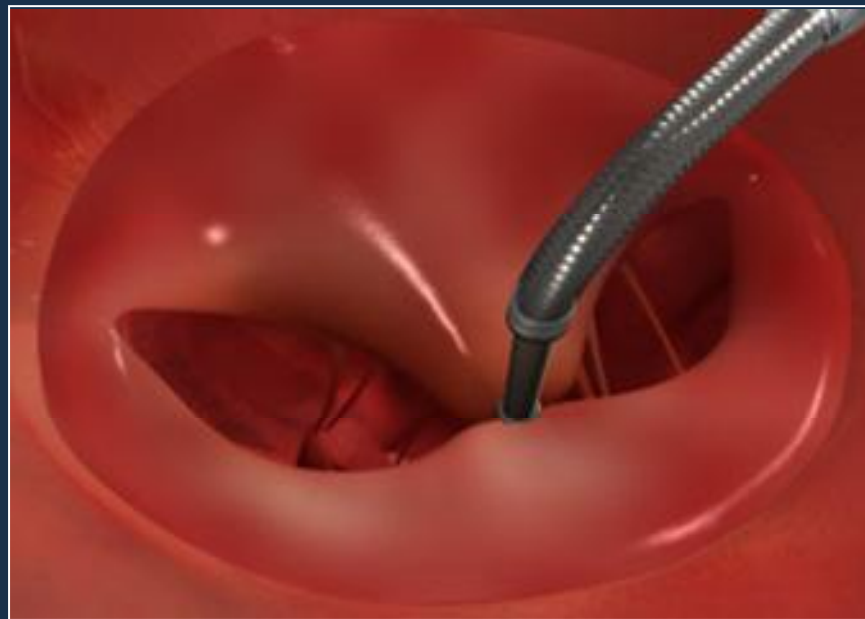
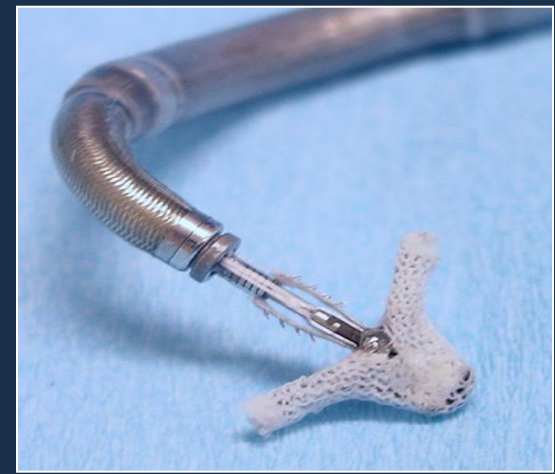
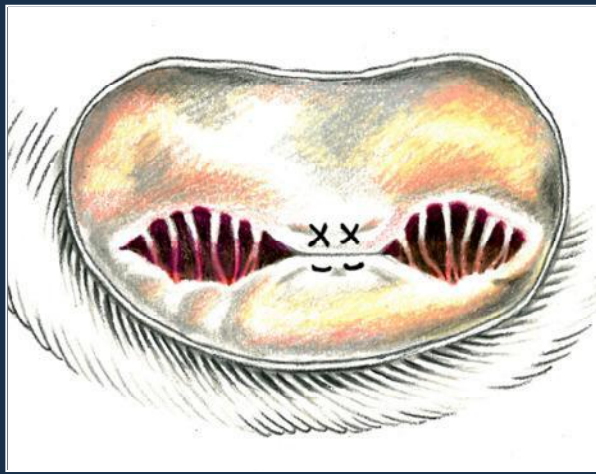


# Alferi Surgical Repair



**Figure 7.** The edge-to-edge approximation (Alferi repair) consists of suturing the anterior and posterior leaflets together to create a "double orifice" mitral valve. This can be performed either with sutures or with a clip implanted percutaneously. Reproduced with permission of the Gulf Heart Association from De Bonis M. The "edge-to-edge" technique in mitral valve repair. *Heart Views*. 2002;4:164-169.

# Catheter-Based Mitral Valve Repair MitraClip® System

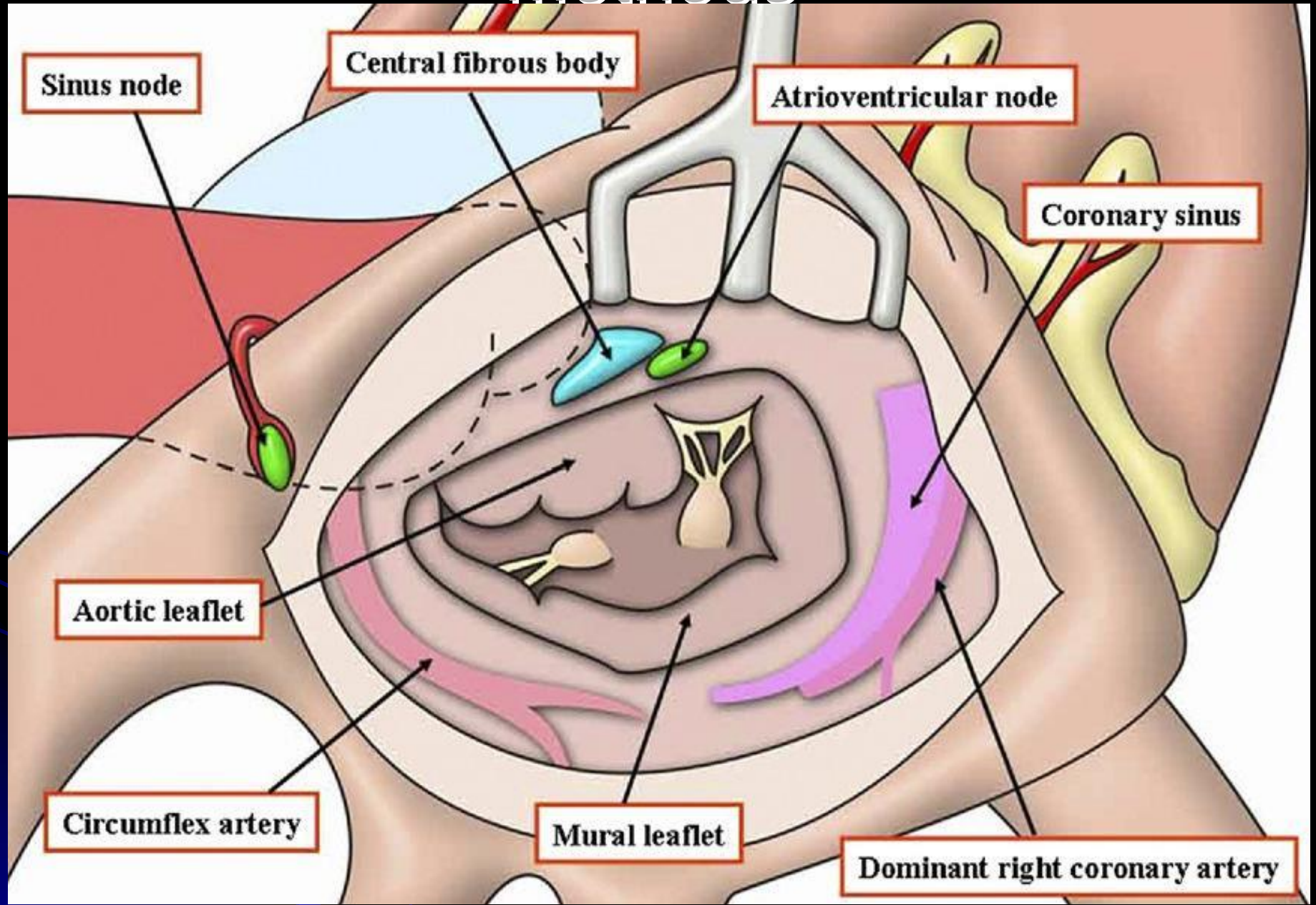


# EVEREST II RCT: Summary

- Safety & effectiveness endpoints met
  - Safety: MAE rate at 30 days
    - MitraClip device patients: 9.6%
    - MV surgery patients: 57%
  - Effectiveness: Clinical Success Rate at 12 months
    - MitraClip device patients: 72%
    - MV Surgery patients: 88%
- Clinical benefit demonstrated for MitraClip System and MV surgery patients through 12 months
  - Improved LV function
  - Improved NYHA Functional Class
  - Improved Quality of Life
- Surgery remains an option after the MitraClip procedure

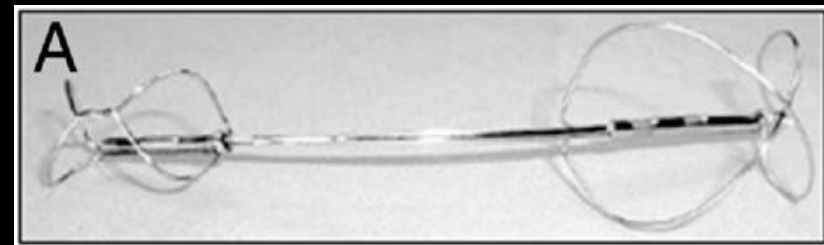


# Other investigational percutaneous methods

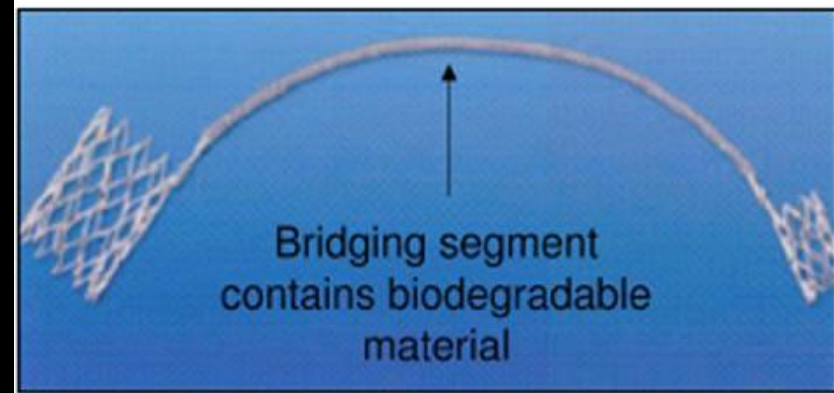


# Coronary Sinus Devices

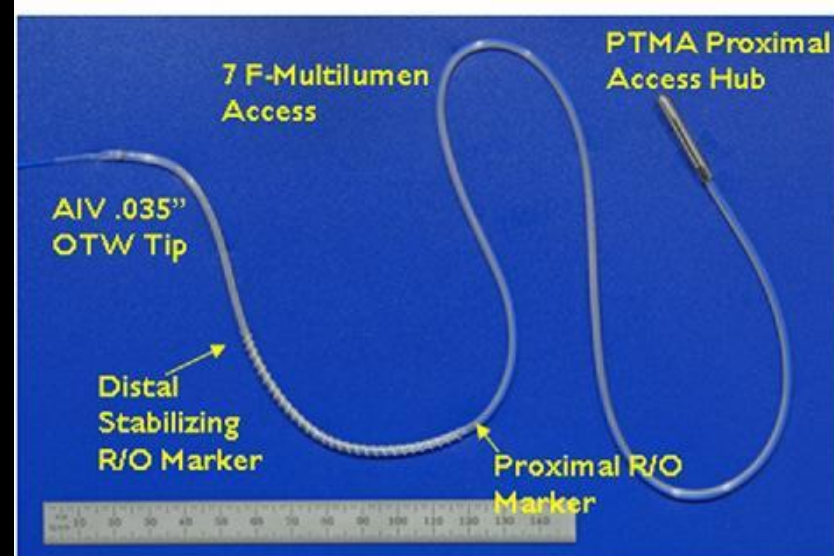
Carillon (Cardiac Dimensions, Inc., Kirkland, Washington)



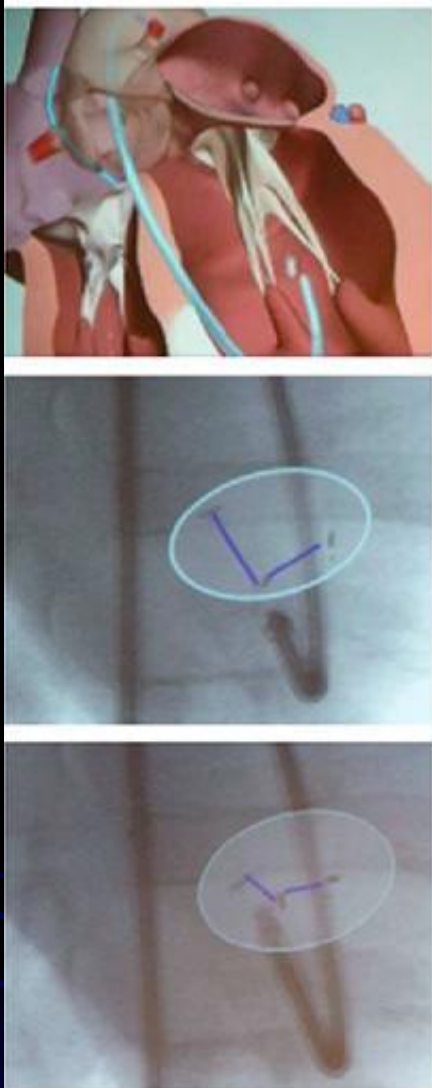
Edwards MONARC (Edwards Lifesciences, Irvine, California)



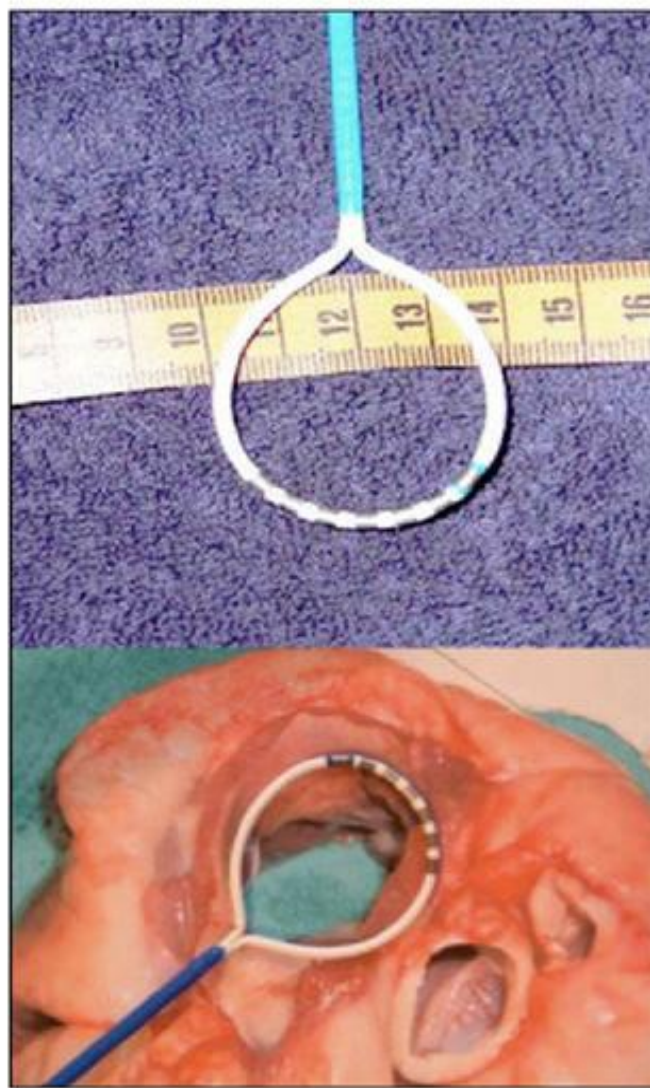
Percutaneous Transvenous Mitral Annuloplasty (PTMA) (Viacor, Inc., Wilmington, Massachusetts)



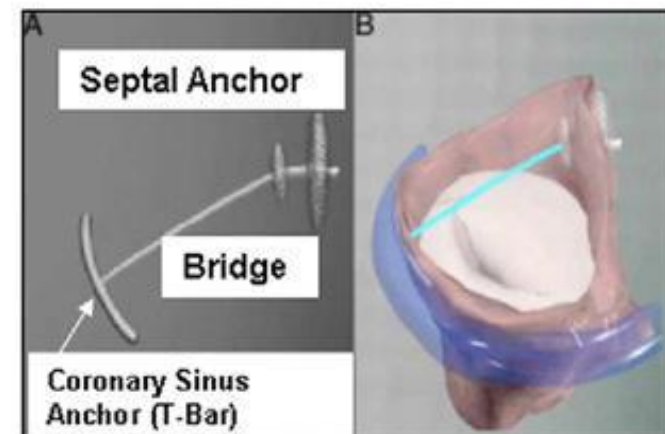
## B Mitralign



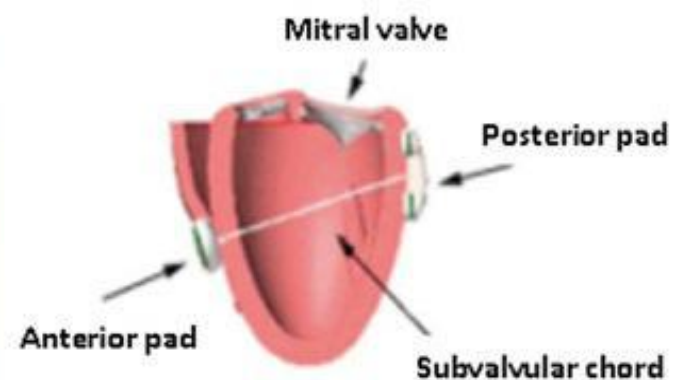
## Quantumcor



## Ample PS3



## iCoapsys



Mitralign – retrograde catheter in LV anchors to AV junction and cinches together  
 Quantumcor – thermal energy at AV junction to shrink orifice  
 Ample PS3 – Left atrial T bar anchored by septal occluder/coronary sinus  
 iCoapsys – Transventricular bridge to change LV geometry

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