

Author: Michael Shea, M.D., 2008

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Mitral Valve Disease

Michael Shea, MD

Fall 2008



Lecture Outline

Mitral Stenosis

Mitral Regurgitation

- Etiology
- Pathophysiology
- Clinical features
- Diagnostic testing
- Differential diagnosis
- Management

Mitral Stenosis: Pathophysiology

Etiology: rheumatic; female > male
by 6:1

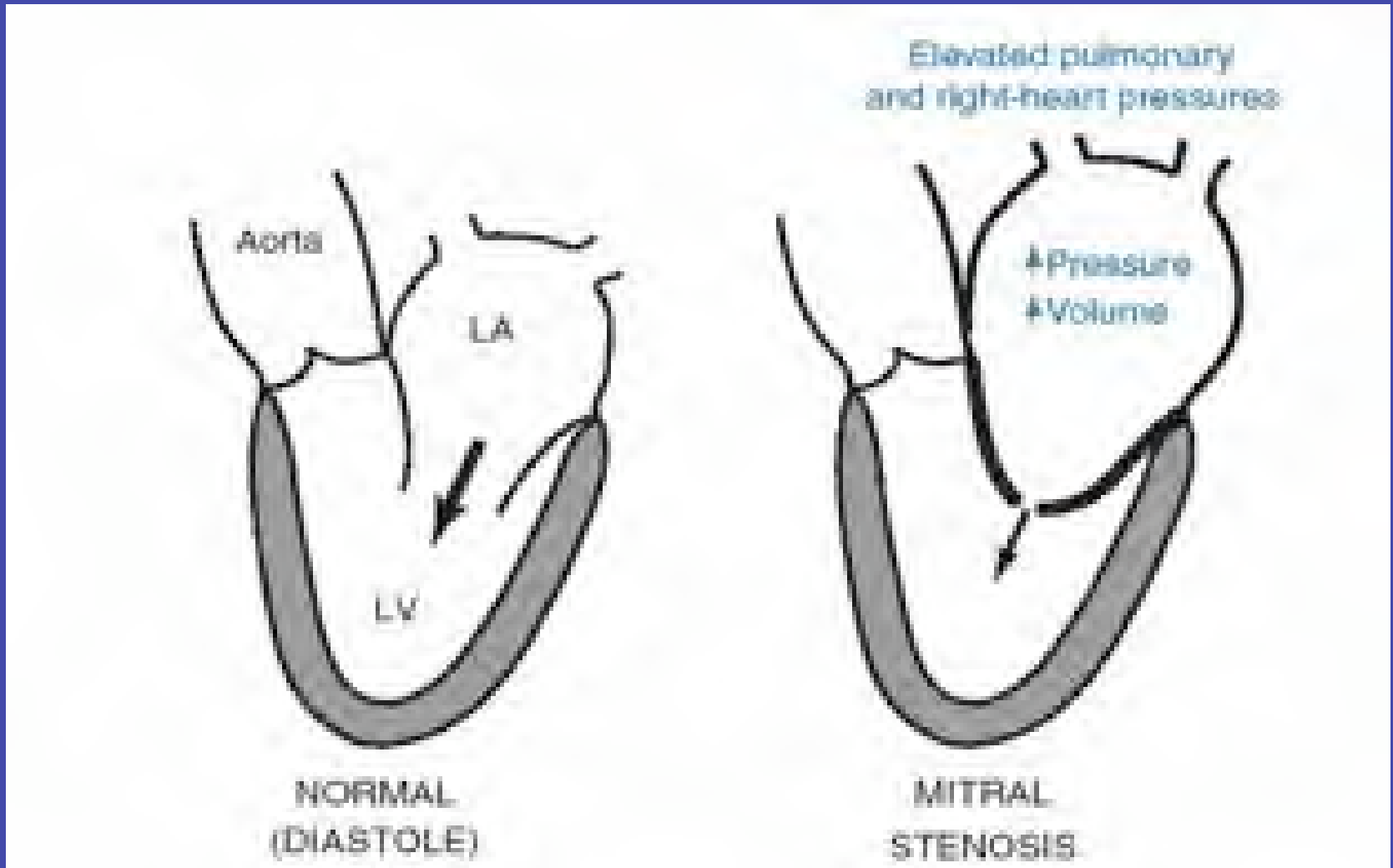
Mitral leaflets:

- Large anterior is contiguous to aorta
- Smaller posterior is contiguous to left atrial endocardium
- Normal area: 4-5cm²

Mitral Stenosis: Pathophysiology

- Fundamental problem: Inability to get blood from left atrium → left ventricle
- Stenotic process:
 - Scarring and fibrosis of leaflets and chordae tendineae
 - Commissural fusion
 - Leads to funnel-shaped orifice and pressure gradient across valve

Mitral Stenosis: Pathophysiology



Mitral Stenosis: Pathophysiology

- Consequences of ↑ left atrial pressure:
 - Left atrial enlargement, blood stasis may lead to atrial thrombus formation and embolism
 - Development of atrial fibrillation
- Consequences of ↑ pulmonary vein pressure
 - Leads to pulmonary artery HTN
 - Then RV hypertrophy and dilation

Mitral Stenosis: Pathophysiology

- Measuring severity: valve area
 - Severe: $\leq 1.0 \text{ cm}^2$
 - Moderate: $1.0\text{-}1.4 \text{ cm}^2$
 - Mild: $1.5\text{-}4.0 \text{ cm}^2$
- Symptoms unusual until area $\leq 1.5 \text{ cm}^2$ but... during unusual flows \uparrow (eg. exercise) or ...tachycardia which \downarrow left atrial filling time... dyspnea may occur
- Symptoms progress as valve narrows

Mitral Stenosis: Clinical Features

History

- Long course before sx onset
- Sx worsen with onset of atrial fibrillation
- Typically asx → then dyspnea with marked effort → then minimal effort → then orthopnea, paroxysmal nocturnal dyspnea

Mitral Stenosis: Clinical Features

History

- Fatigue is common → patient cannot augment cardiac output
- Hemoptysis
- Embolic stroke.... usually when patient is in atrial fibrillation

Mitral Stenosis: Clinical Features

Physical exam:

- Palpation – may be a parasternal lift (RV)
- Auscultation:
 1. Accentuated first heart sound (S_1)
 2. Opening snap → sudden stop in leaflet opening
 3. Diastolic rumble

Higher left atrial P^0 , shorter S_2 to OS interval

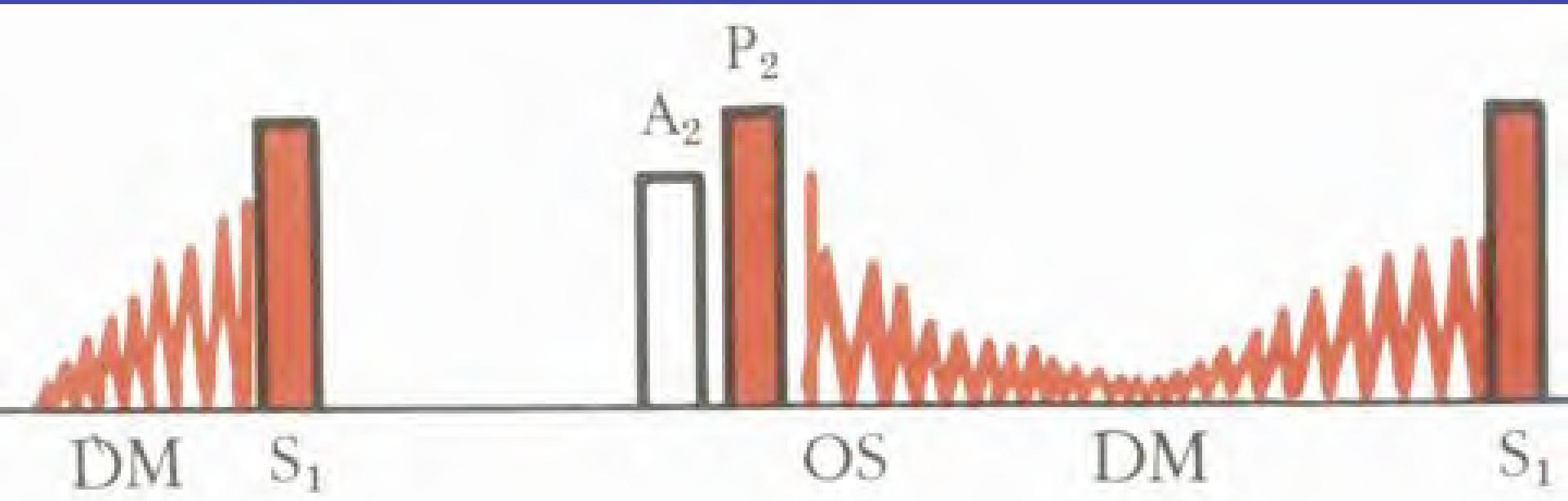
Mitral Stenosis: Clinical Features

Diastolic rumble:

- Low frequency murmur
- Occurs after opening snap (OS)
- Decrescendo contour

Pulmonary Hypertension:

- $\uparrow P_2$ component of S_2



Mitral Stenosis

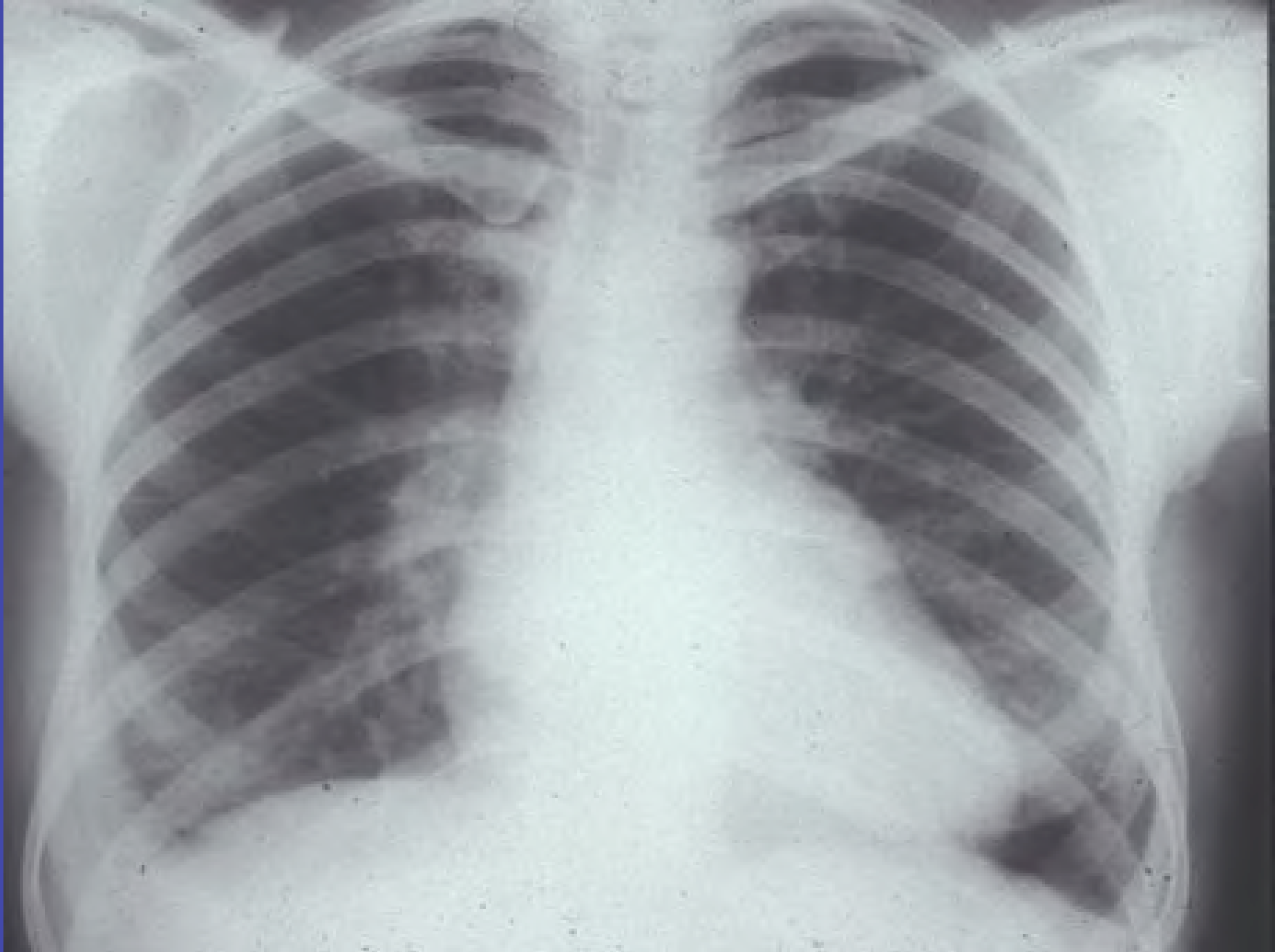
Diagnostic testing

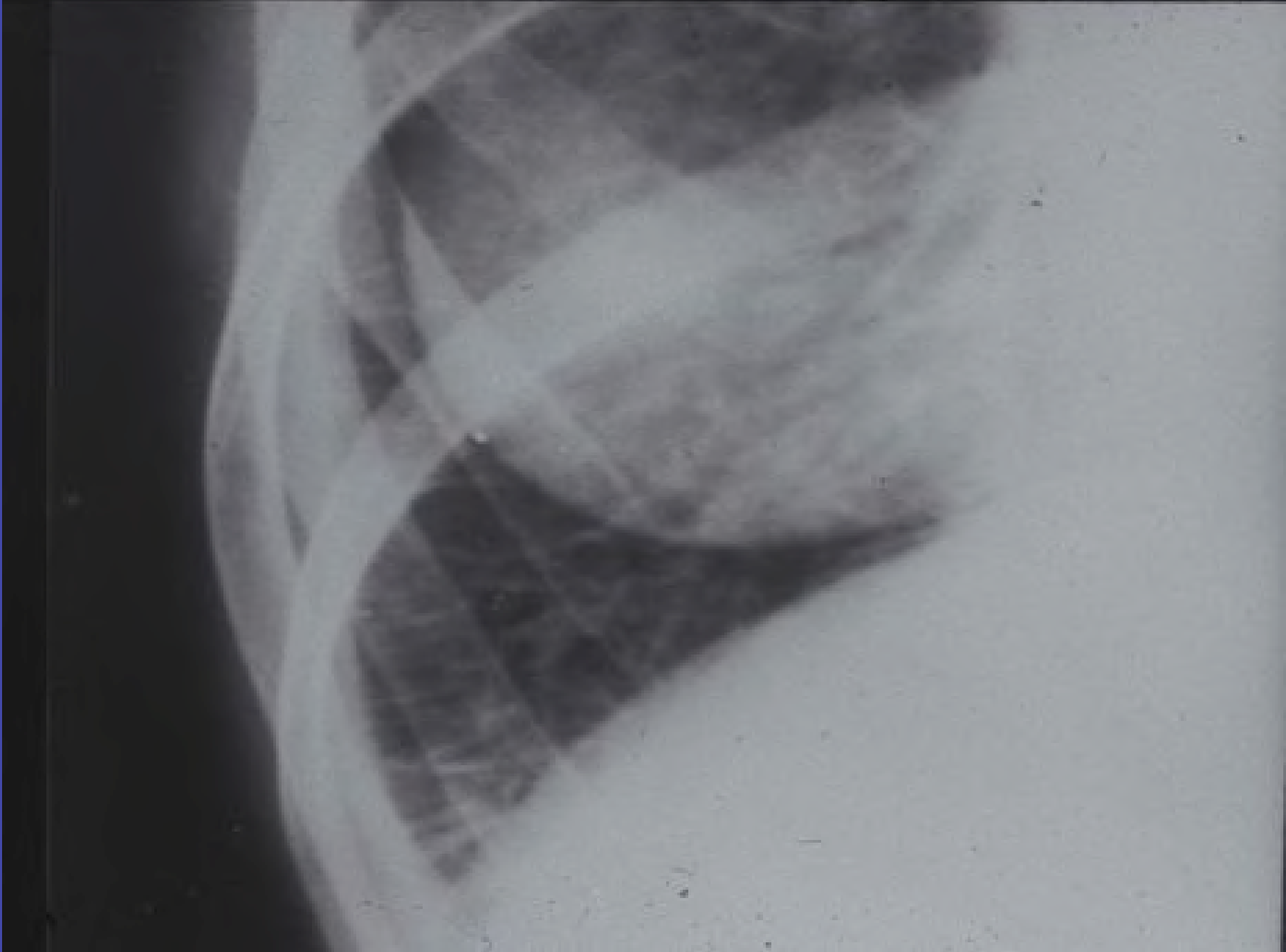
- Chest radiology
- Electrocardiography
- Echocardiography
- Cardiac catheterization

Mitral Stenosis: CXR findings

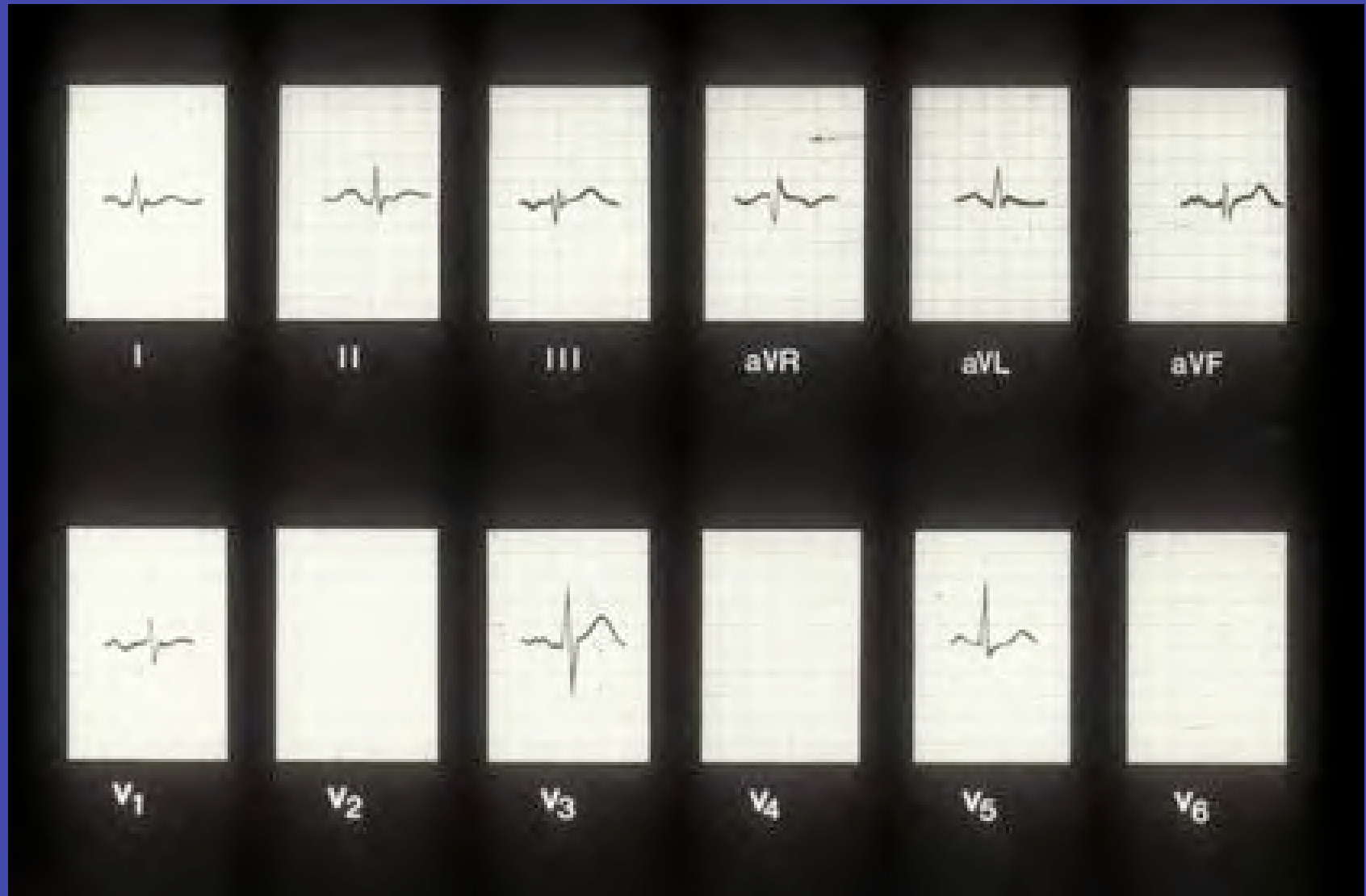
Reflect left atrial HTN

- Double density right cardiac border
- Convexity (LA appendage) just below left PA → 4 bump sign: aorta, pulm artery, atrial appendage, left ventricle
- Elevated left main bronchus
- Kerley lines





Mitral Stenosis: The ECG



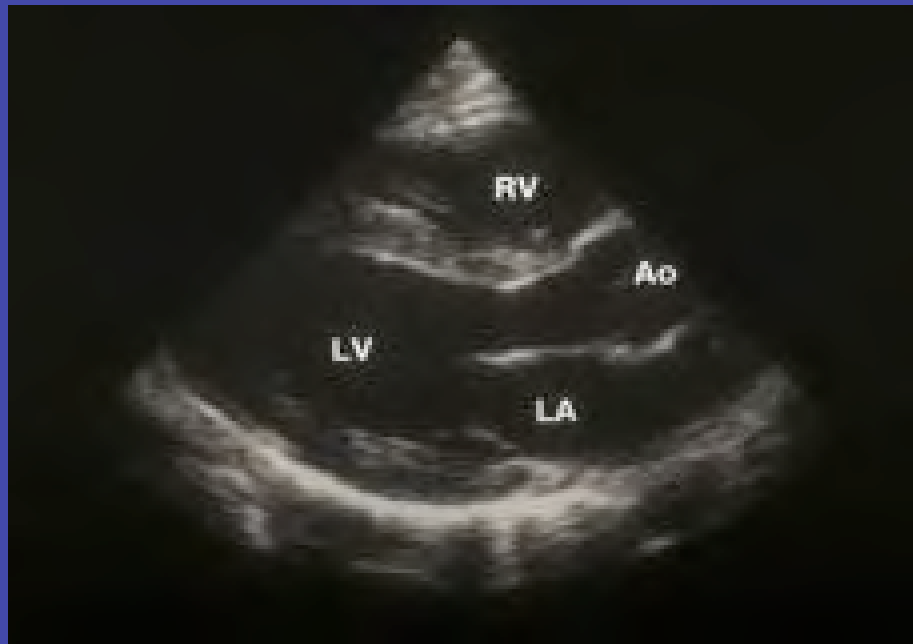
Mitral Stenosis

Diagnostic testing

- Chest radiology
- Electrocardiography
- Echocardiography
- Cardiac catheterization

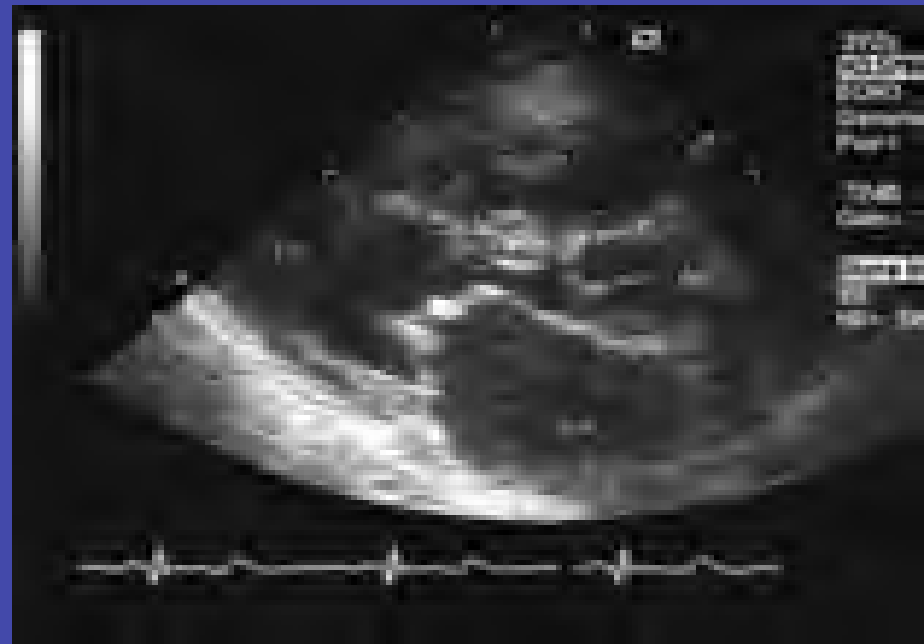
Echocardiography: Parasternal

Normal



PD-INEL Source Undetermined

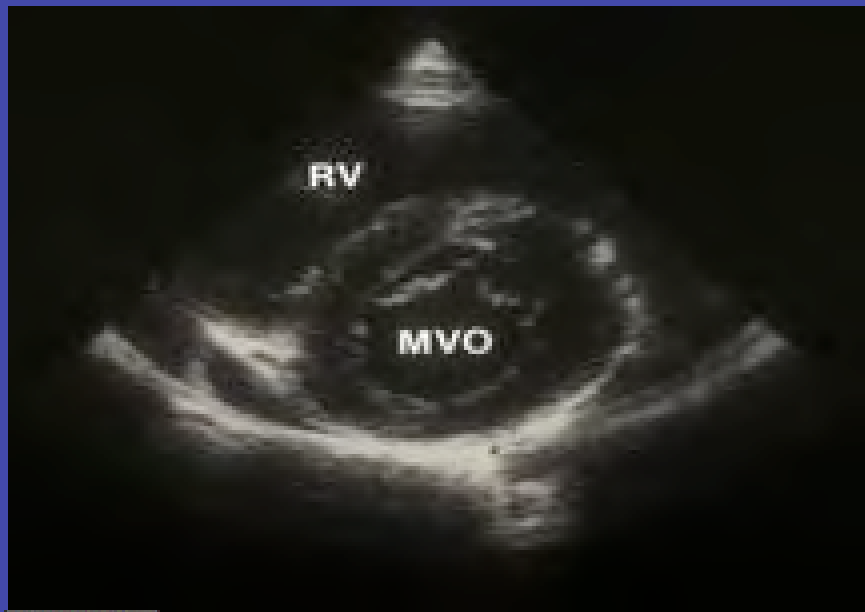
Mitral Stenosis



PD-INEL Source Undetermined

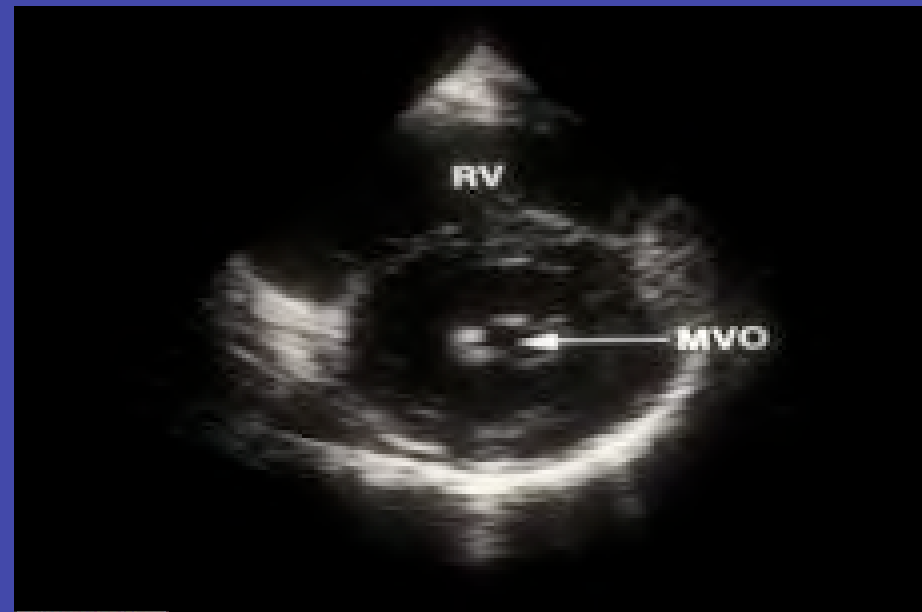
Echocardiography: Short Axis

Normal



PD-INEL Source Undetermined

Mitral Stenosis



PD-INEL Source Undetermined

Mitral Stenosis: Clinical Manifestations and Diagnosis

- Echo: 2D images
 - Increased LA size
 - Doming of valve leaflets
 - Valve stenosis
 - Valve area can be planimetered

Mitral Stenosis: Cardiac Catheterization

- Not required to establish dx in young patients – echo is sufficient
- Cath may be needed if:
 - Sx disproportionate to objective evidence
 - Other forms of heart disease suspected... eg. CAD
 - Mitral regurgitation of uncertain degree

Mitral Stenosis

Differential Diagnosis

- Atrial myxoma
- Cor triatriatum
- Congenital mitral stenosis

Mitral Stenosis: Management

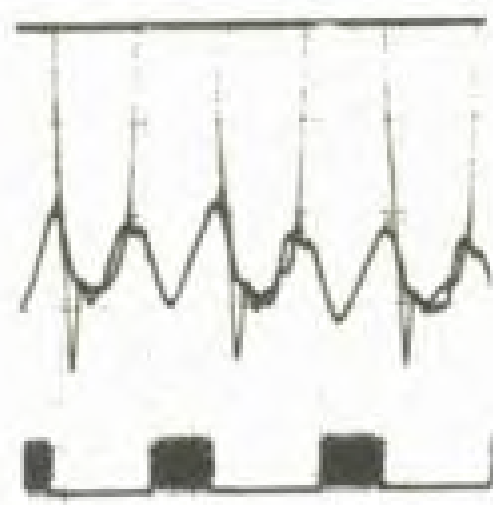
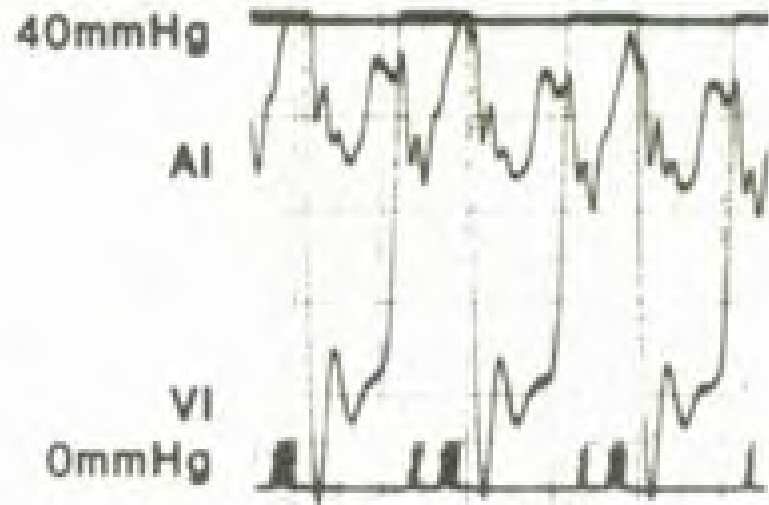
Medical

- 2° prevention: penicillin → years
- Rate control for atrial fibrillation:
beta-blockade, digoxin
- Anticoagulation
- Diuretics and rate control for congestion

Mitral Stenosis

Mechanical Relief

- Closed surgical commissurotomy
- Open surgical commissurotomy
- Valve replacement
- Balloon mitral commissurotomy





Mitral Regurgitation

Mitral Regurgitation: Etiology

Mitral annulus

- Annular calcification

Leaflets

- Myxomatous degeneration
- Rheumatic disease
- Endocarditis
- SAM (hypertrophic cardiomyopathy)

Chordae tendineae

- Rupture (idiopathic)
- Endocarditis

Papillary muscles

- Dysfunction or rupture

Left ventricle

- Cavity dilatation



Schematic
representation of
mitral valve
pathologies
removed

Mitral Regurgitation: Pathophysiology

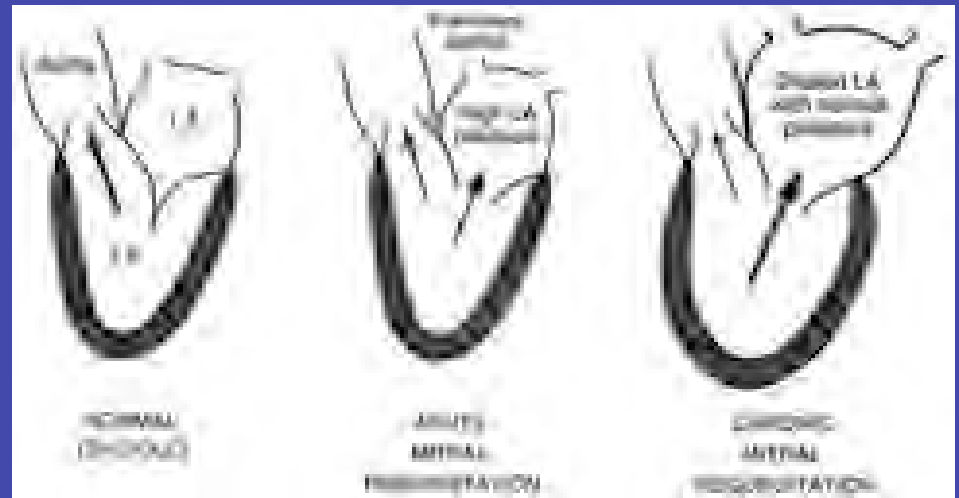
Acute Mitral Regurgitation:

Pulmonary Edema

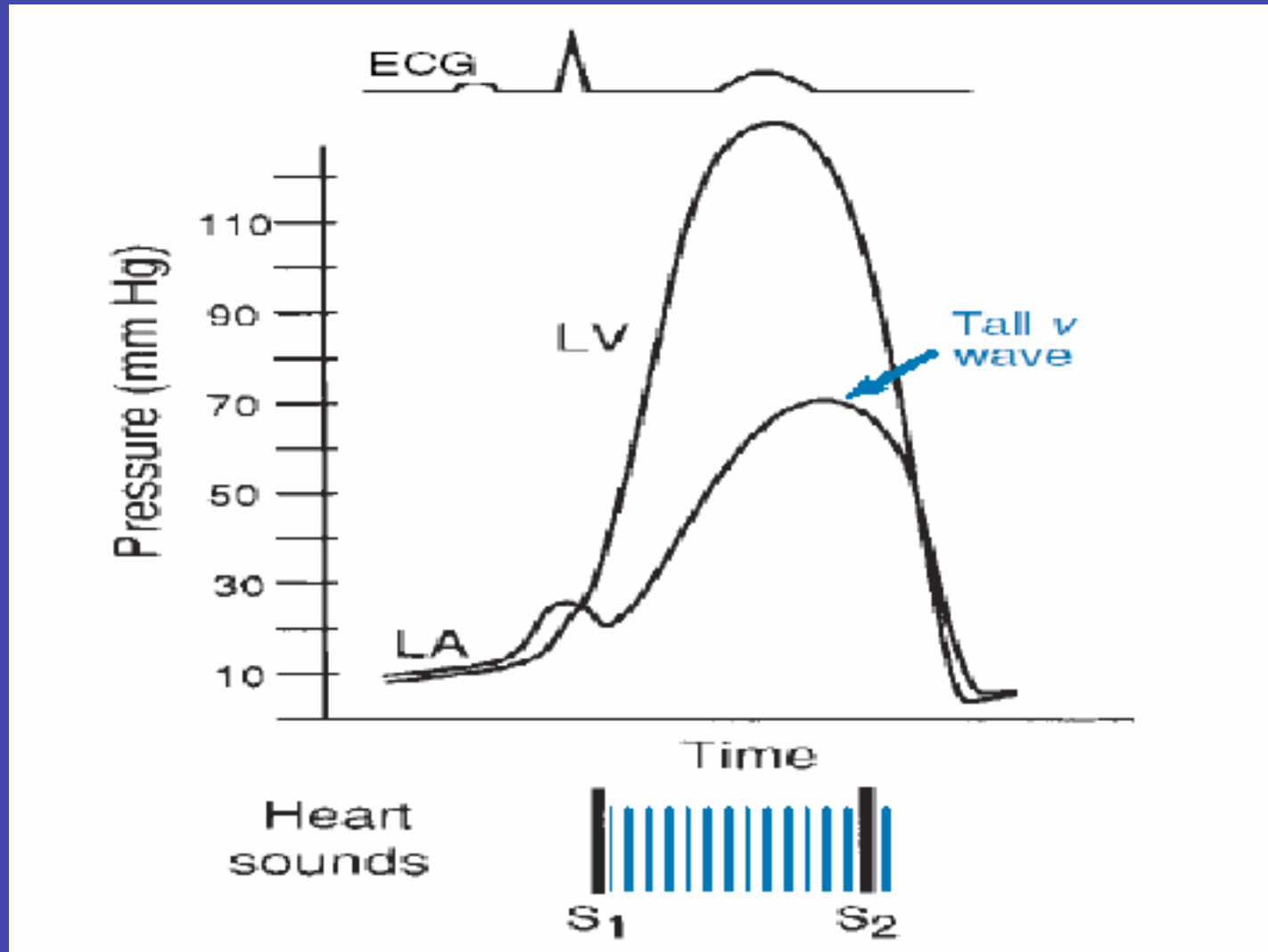
High LA Pressure

Chronic Mitral Regurgitation:

Dilated LA with less elevated pressure



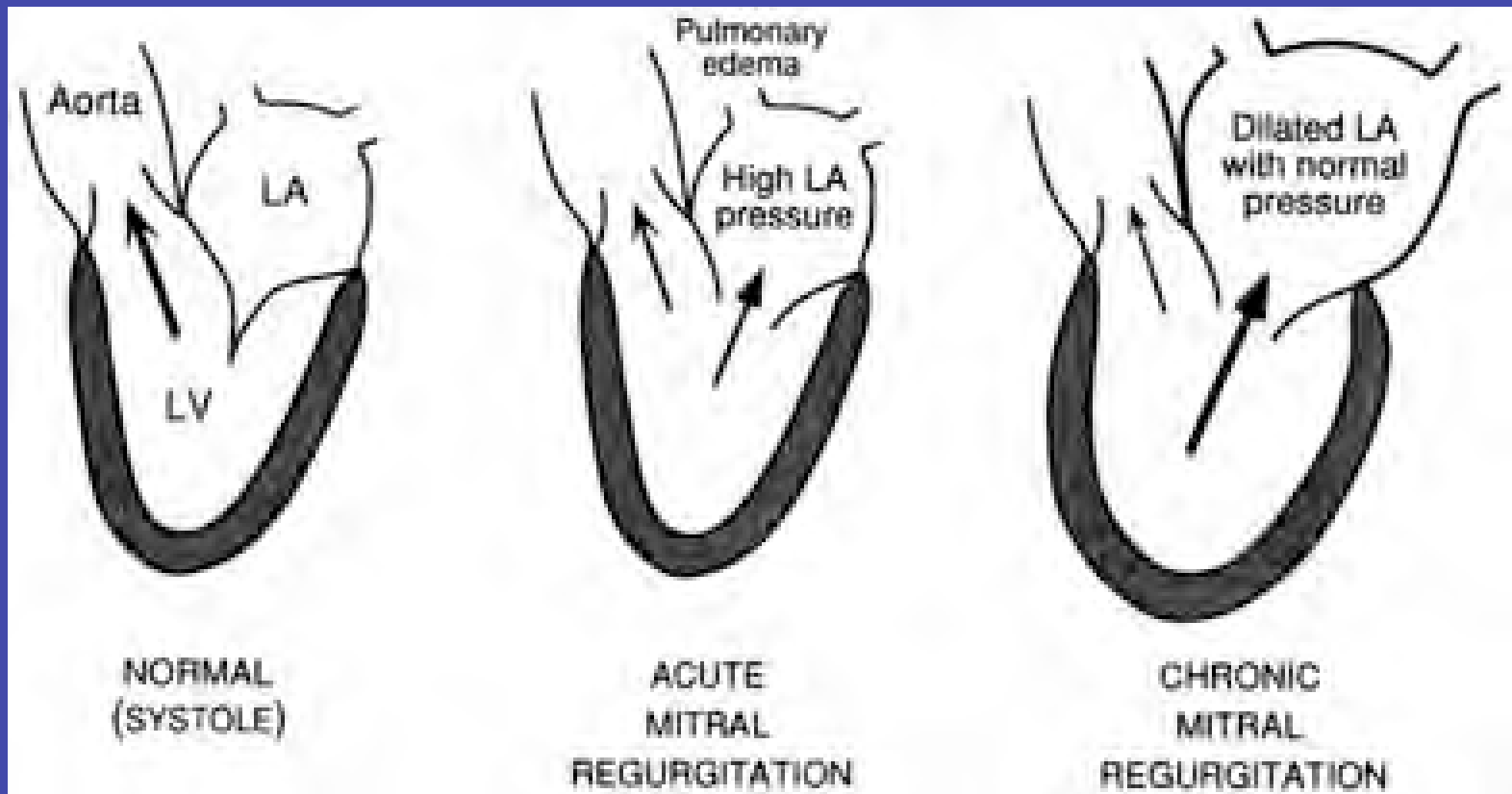
Mitral Regurgitation: Hemodynamics



Mitral Regurgitation: Pathophysiology

- May be acute or chronic
- Chronic MR:
 - Total stroke volume increases
 - Blood → LA to offload LV
 - LV enlarges (ventricular remodeling)

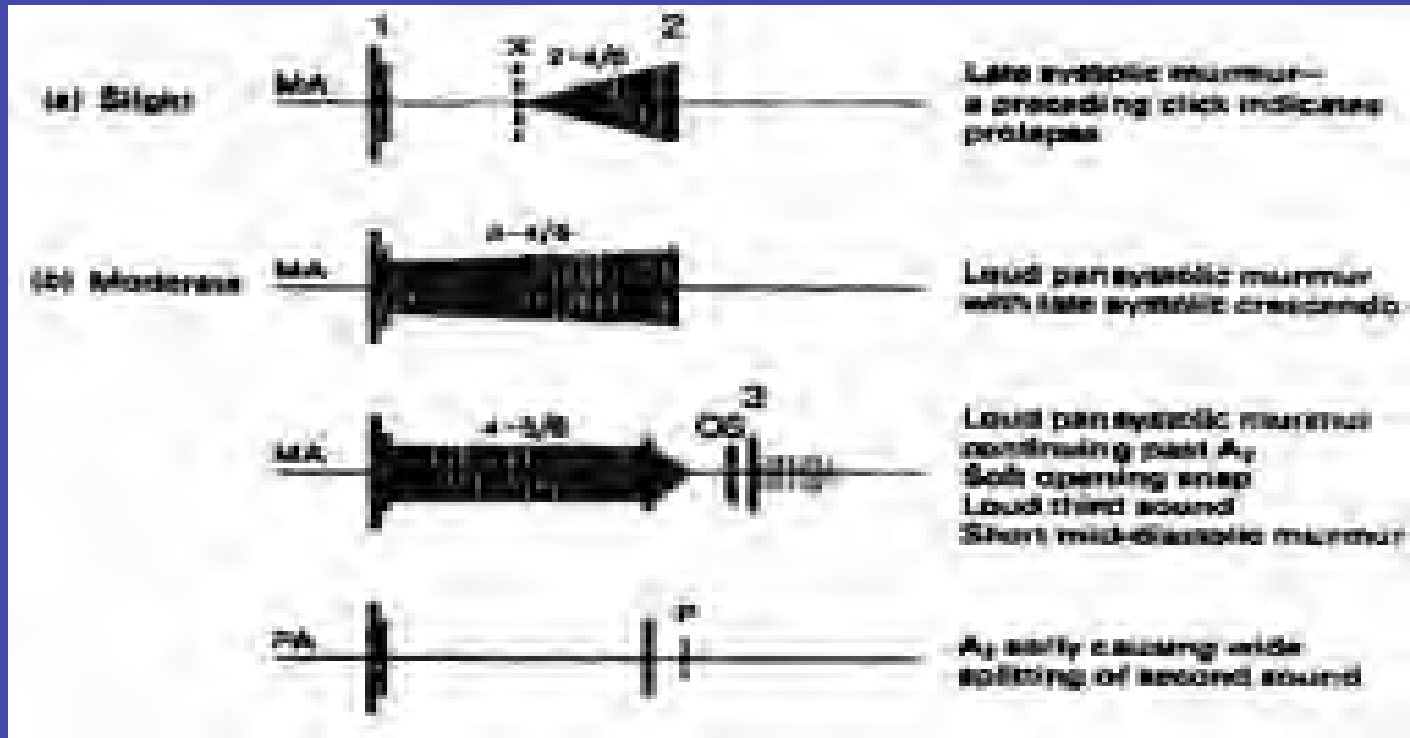
Mitral Regurgitation: Pathophysiology



Mitral Regurgitation: Clinical Features

- Mild MR → no sx
- When sx occur
 - Fatigue
 - Dyspnea
- Physical Exam:
 - Lateral; dynamic LV apex beat
 - Often diminished S¹ (leaflets don't coapt); S³ often present
 - Apical systolic murmur
 - Holosystolic murmur to axilla

Mitral Regurgitation: Auscultation

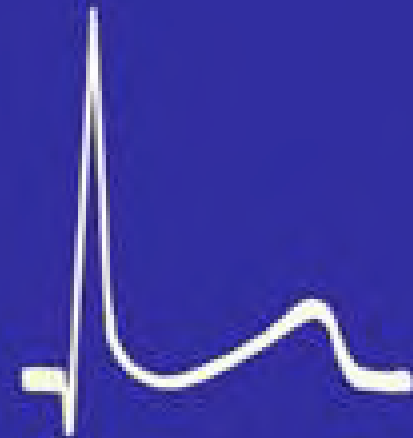


Mitral Regurgitation: Diagnostic Tests

- CXR: LA and LV enlargement
- ECG: Normal initially...then shows LV hypertrophy
- Echo:
 - LAE
 - LV enlargement
 - Doppler and color flow allow semi-quantitative estimate (1-4+)

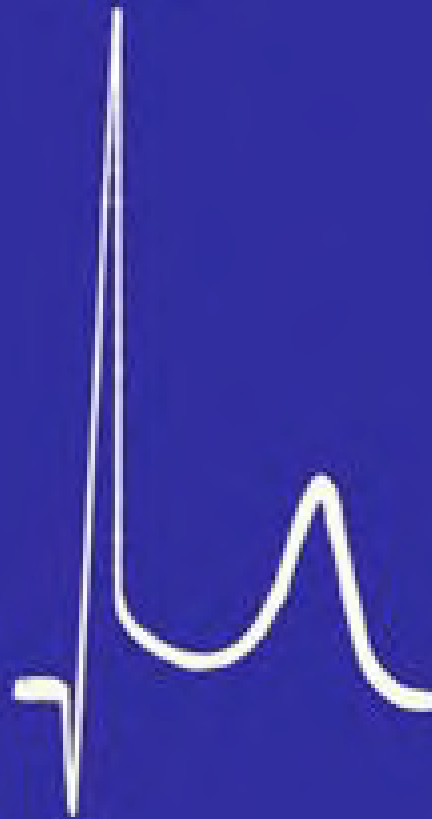


A



V6

B



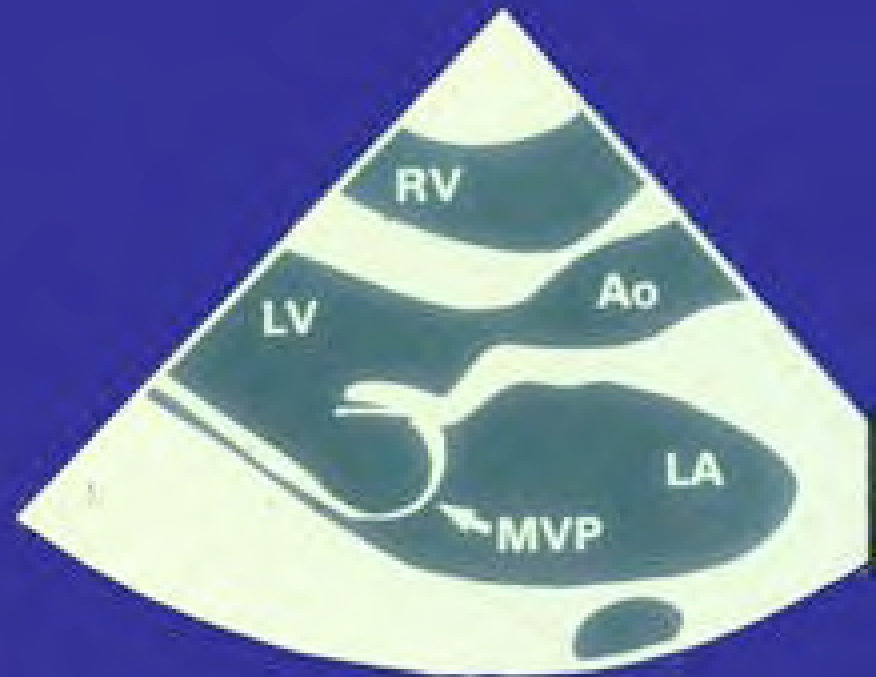
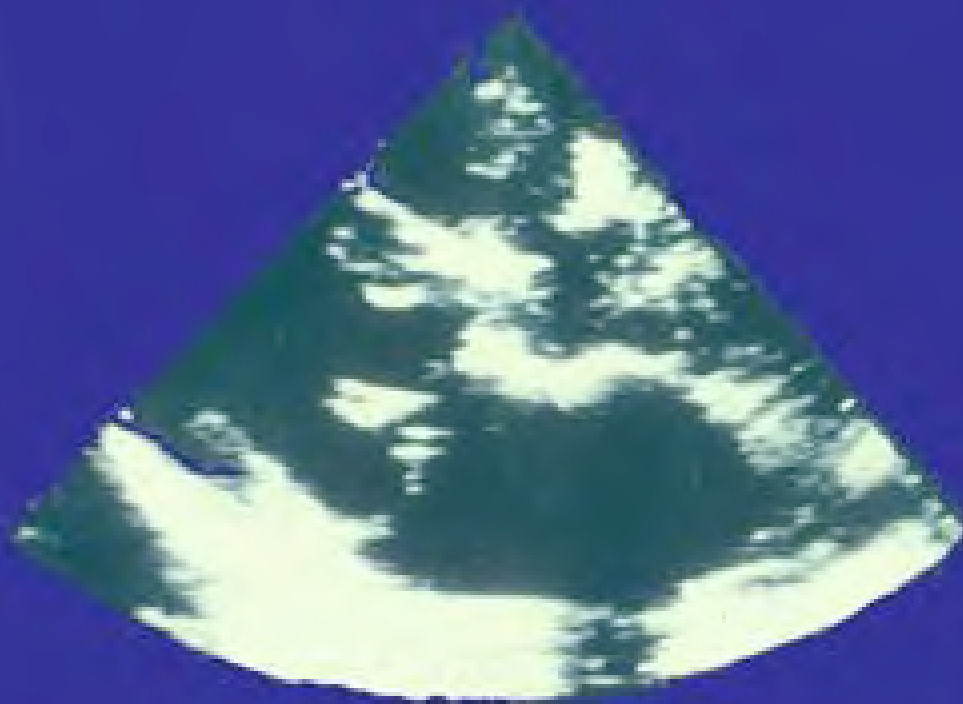
V6

C



V6

Mitral Regurgitation: Parasternal



Severity of Mitral and Tricuspid Regurgitation

Schematic
representation of
varying degrees of
severity of
regurgitation
removed

Mitral Regurgitation: Clinical Features

Mitral Valve Prolapse:

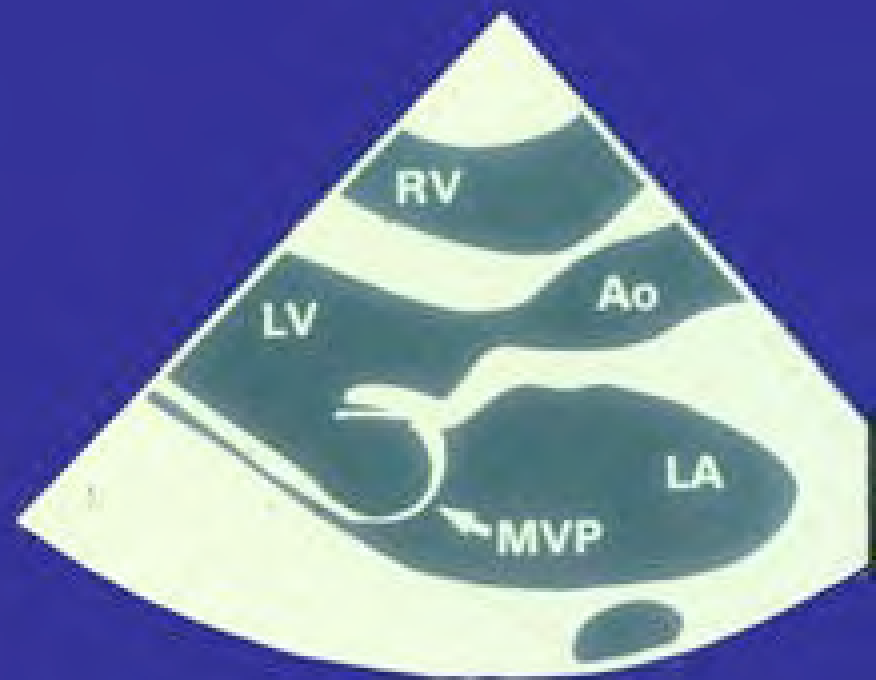
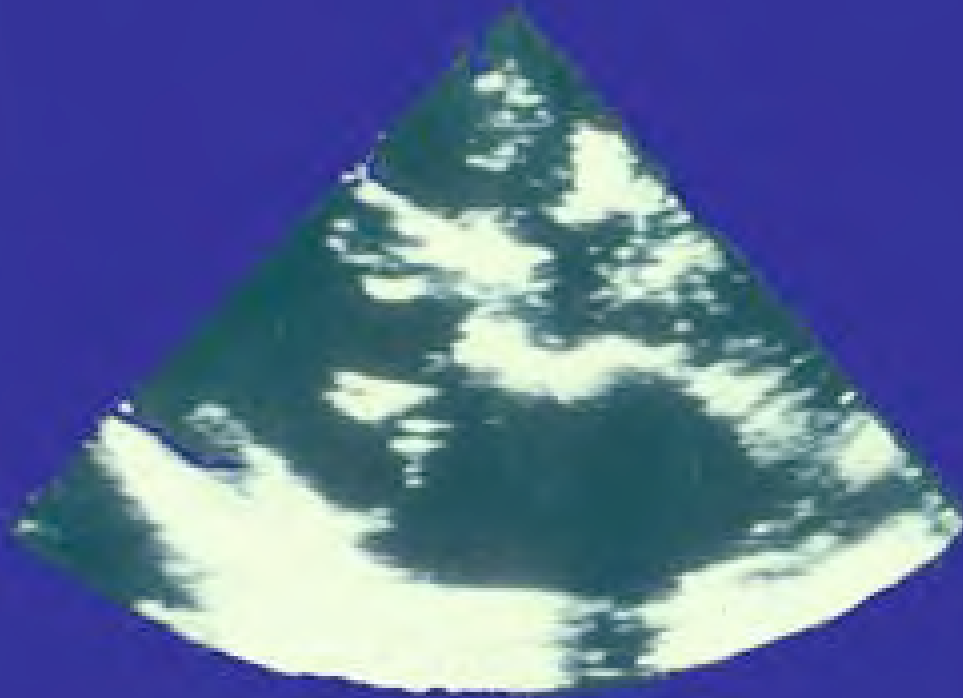
- Protrusion of MV leaflets into LA during systole; more common in women
- Valve changes → leaflets show...
 - voluminous
 - thickened
 - redundant
 - myxomatous
- Sx: palpitations, dyspnea if severe

Mitral Regurgitation: Mitral Prolapse

Exam:

- Skeletal changes – scoliosis, pectus excavatum; Marfan's in some
- Midsystolic click; may see late systolic murmur
- Echo: Mid to late systolic prolapse of posterior leaflet. Doppler or color echo reveals severity of MR

Mitral Regurgitation: Parasternal

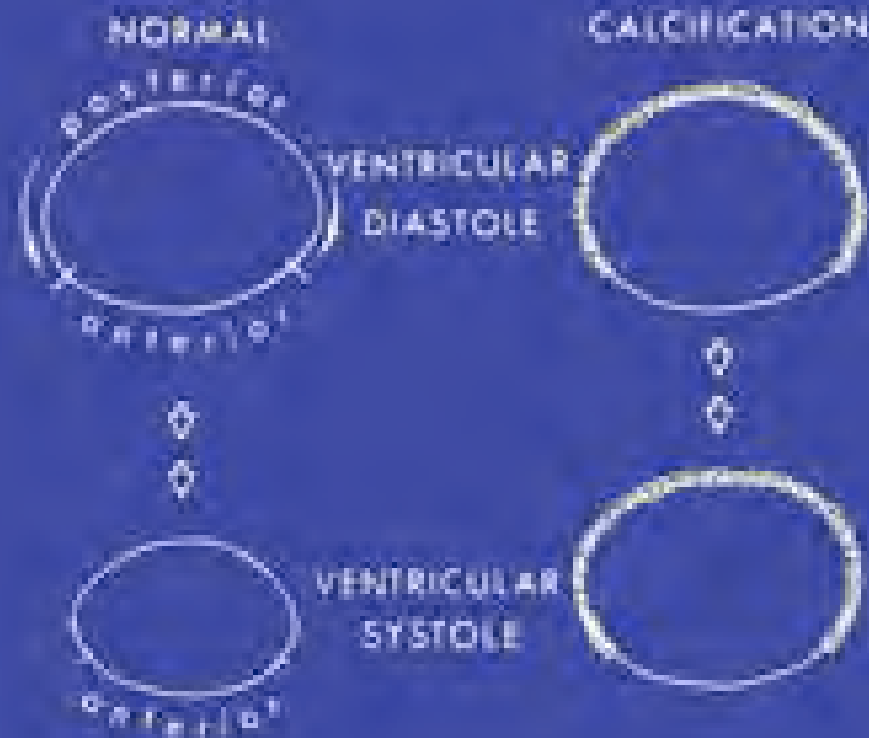


Mitral Regurgitation: Mitral Prolapse

Complications:

- Many patients go thru life without problems
- MR can progress
- Chordal rupture can lead to sudden, severe MR (esp. in men)
- Endocarditis in those with murmur
- TIA's rare → treat with ASA
- Sudden death – very rare

Mitral Annulus

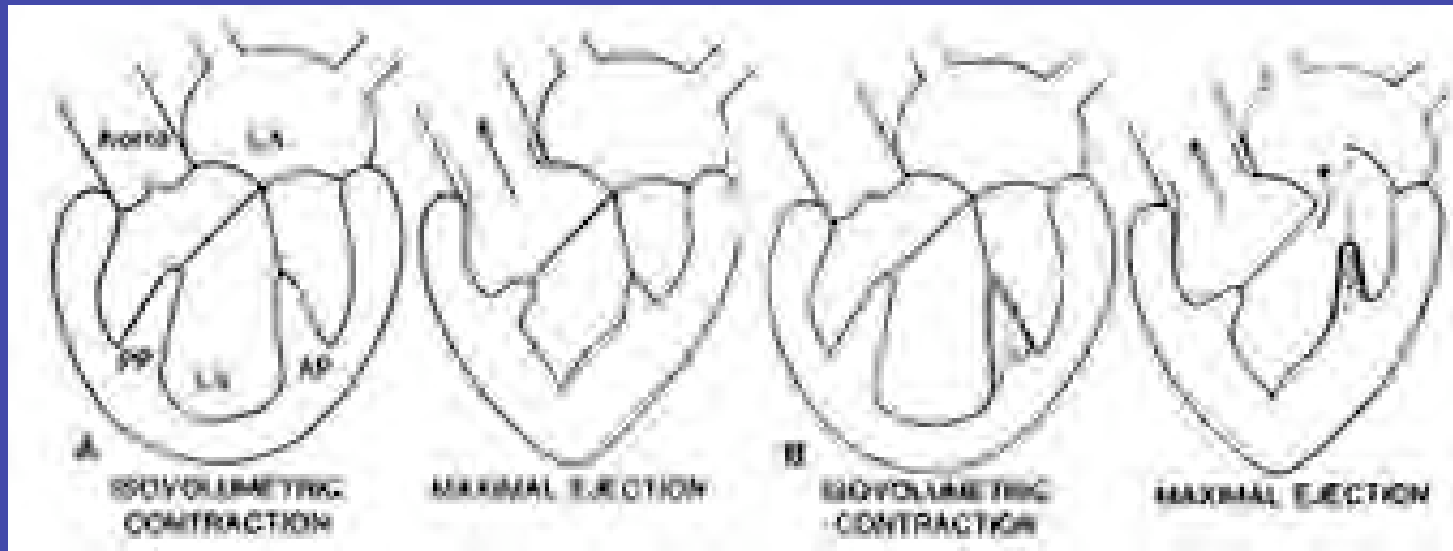


Mitral Regurgitation: Clinical Features

Papillary muscle dysfunction:

- Spectrum from intact but poorly functioning PM to acute rupture
- Frequently caused by:
 - Ischemia or infarction of papillary muscle or underlying LV myocardium
- Less frequently by LV dilation or infiltrative process

Mitral Regurgitation: Papillary Muscle Dysfunction



Mitral Regurgitation: Papillary Muscle Dysfunction



Mitral Regurgitation: Differential Diagnosis

Conditions with systolic murmur:

- VSD
- Aortic stenosis
- Tricuspid regurgitation
- Hypertrophic cardiomyopathy

Mitral Regurgitation: Management

Asymptomatic

- Follow serially with visits and echo
- Recommend repair/replacement if:
 - Clear sx develop
 - LV ejection fraction falls $< 60\%$

Mitral Regurgitation: Management and Prevention

MR caused by LV dilation from poor LV:FXN

- Diuretics
- Vasodilators
- B-Blockers
- Digitalis

Improves sx...

Symptomatic MR with preserved LV:

- Mitral repair or replacement before progressive LV dysfunction occurs

Schematic
representation of
mitral valve
removed

Aortic Valve Disease

Lecture Outline

Aortic Stenosis

Aortic Regurgitation

Etiology

Pathophysiology

Clinical Features

Diagnostic Testing

Differential Diagnosis

Management

Aortic Stenosis: Pathology

Normal



Congenital



Acquired



Aortic Stenosis

Pathophysiology

Aortic Stenosis: Pathophysiology

Measuring severity: valve area

- Severe $\leq 1.0 \text{ cm}^2$
- Moderate $1.0 - 1.4 \text{ cm}^2$
- Mild $> 1.5 \text{ cm}^2$

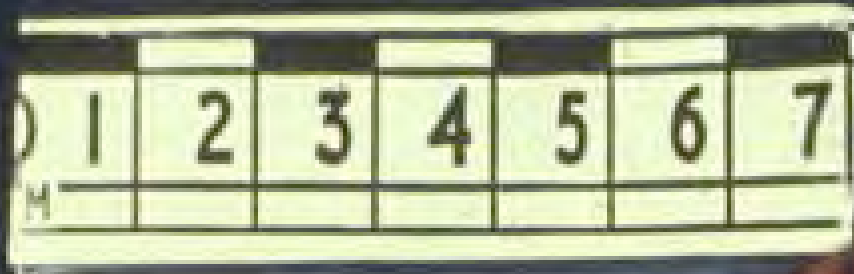
Left Ventricular Pressure Overload



Gradient between LV and Aorta

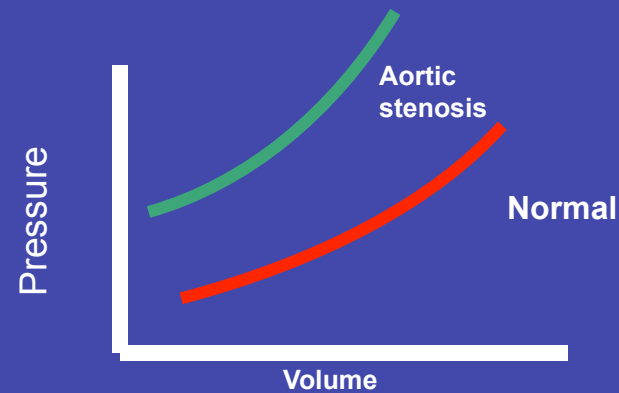
Global gene activation

Concentric hypertrophy



Aortic Stenosis: Clinical Findings

- Dyspnea

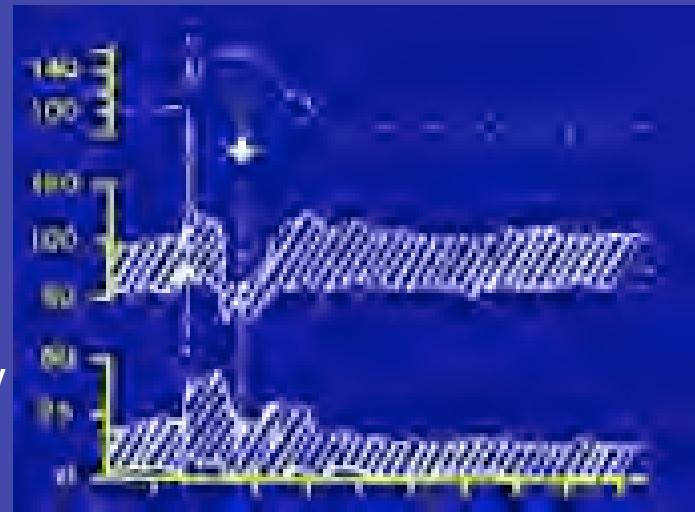


PD-INEL M. Shea

- Angina pectoris

- Syncope

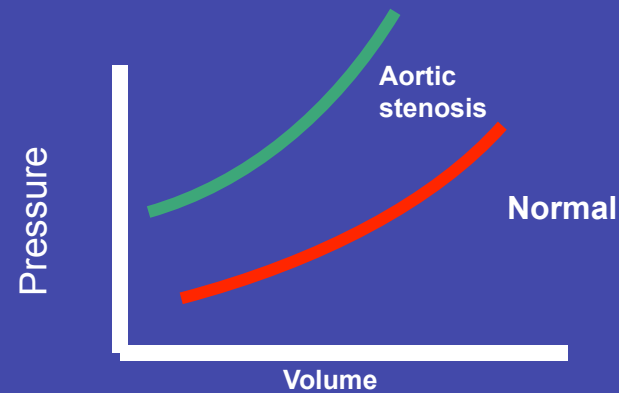
Heart Rate (bpm)
Systemic Arterial Pressure (mmHg)
Pulmonary Arterial Pressure (mmHg)



PD-INEL Source Undetermined

Aortic Stenosis: Clinical Findings

- Dyspnea

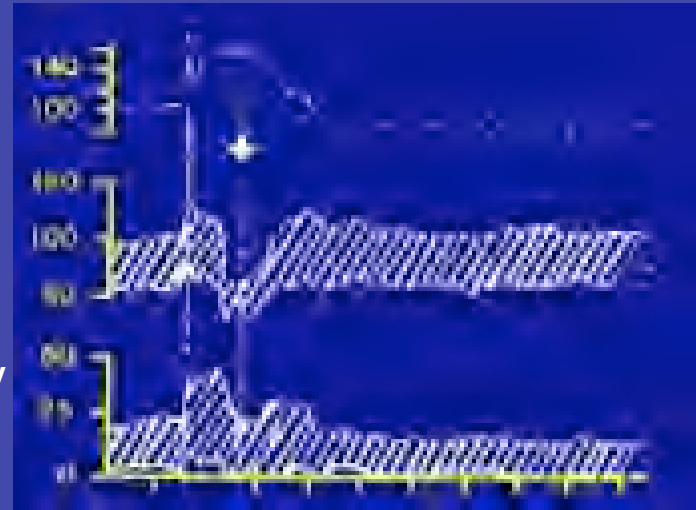


PD-INEL M. Shea

- Angina pectoris

- Syncope

Heart Rate (bpm)
Systemic Arterial Pressure (mmHg)
Pulmonary Arterial Pressure (mmHg)



PD-INEL Source Undetermined

Carotid Pulse

Normal



Parvus et tardus pulse



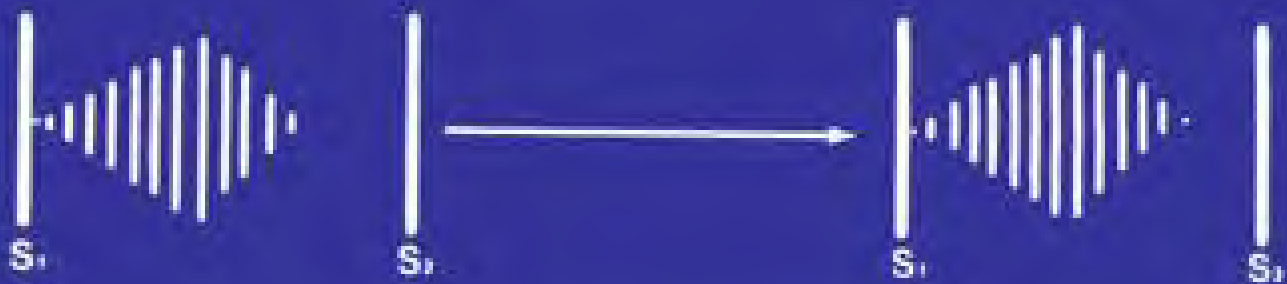
Expiration

Inspiration

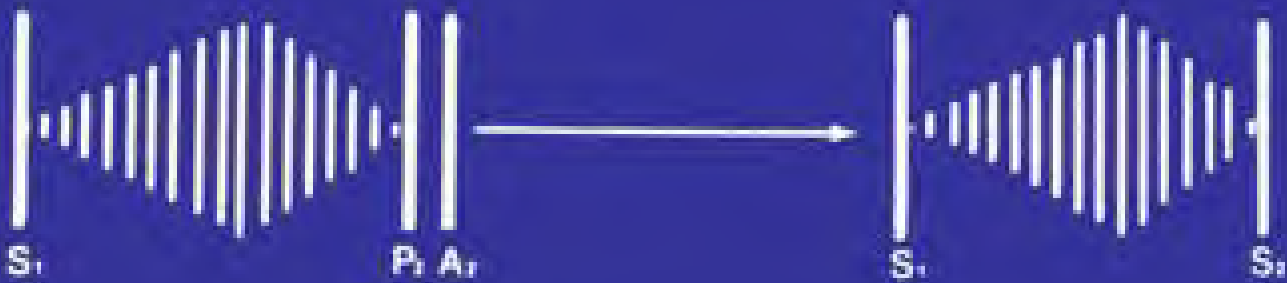
Mild



Moderate



Severe

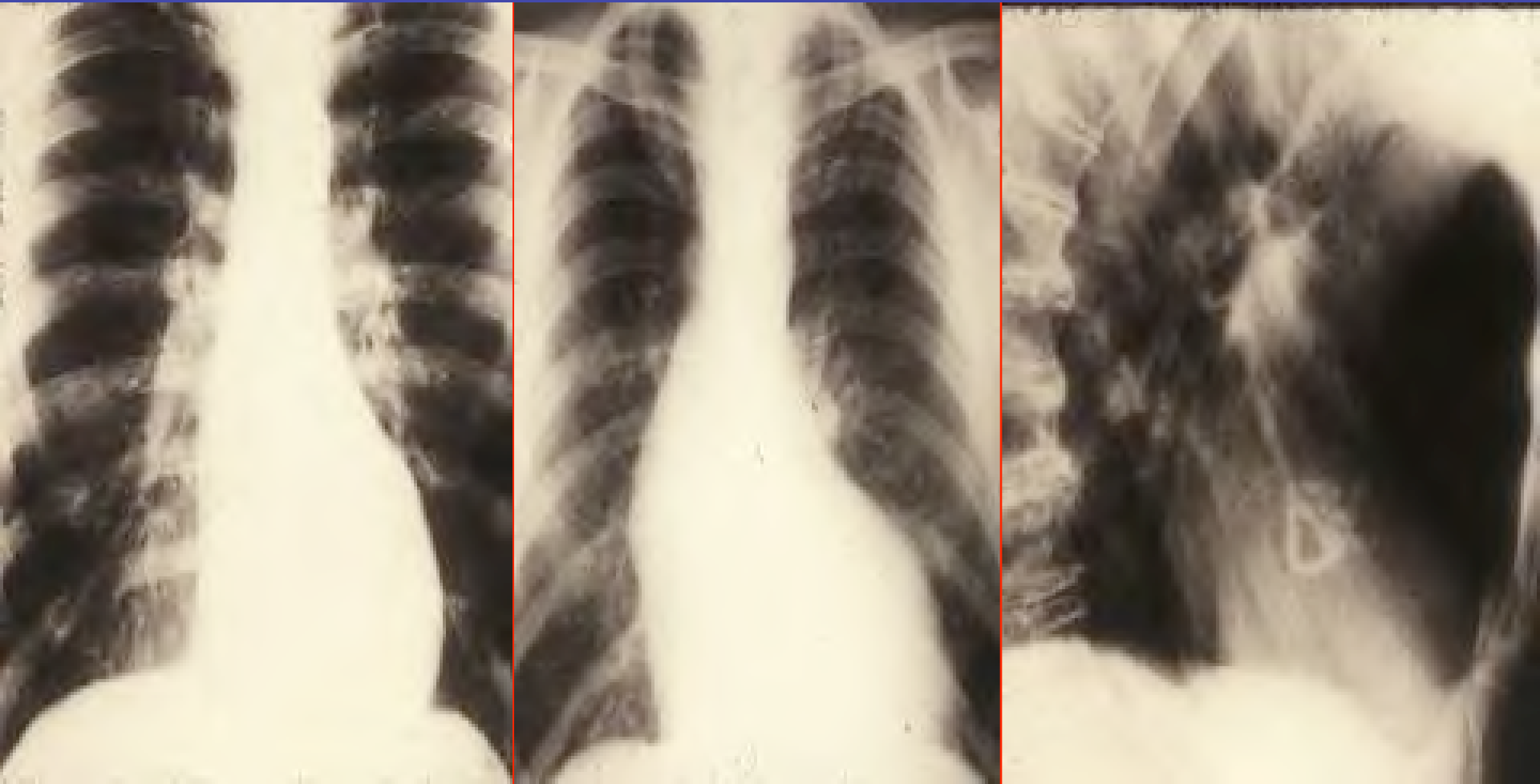


Aortic Stenosis

Laboratory Evaluation

- ❖ Chest radiology
- ❖ Electrocardiography
- ❖ Echocardiography
- ❖ Stress testing
- ❖ Catheterization

Aortic Stenosis: Chest radiology



The Electrocardiogram



I



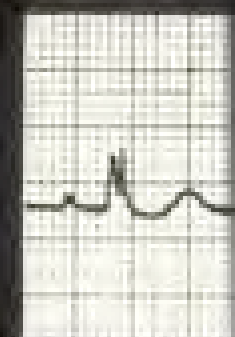
II



III



aVR



aVL



V₁



V₂



V₃



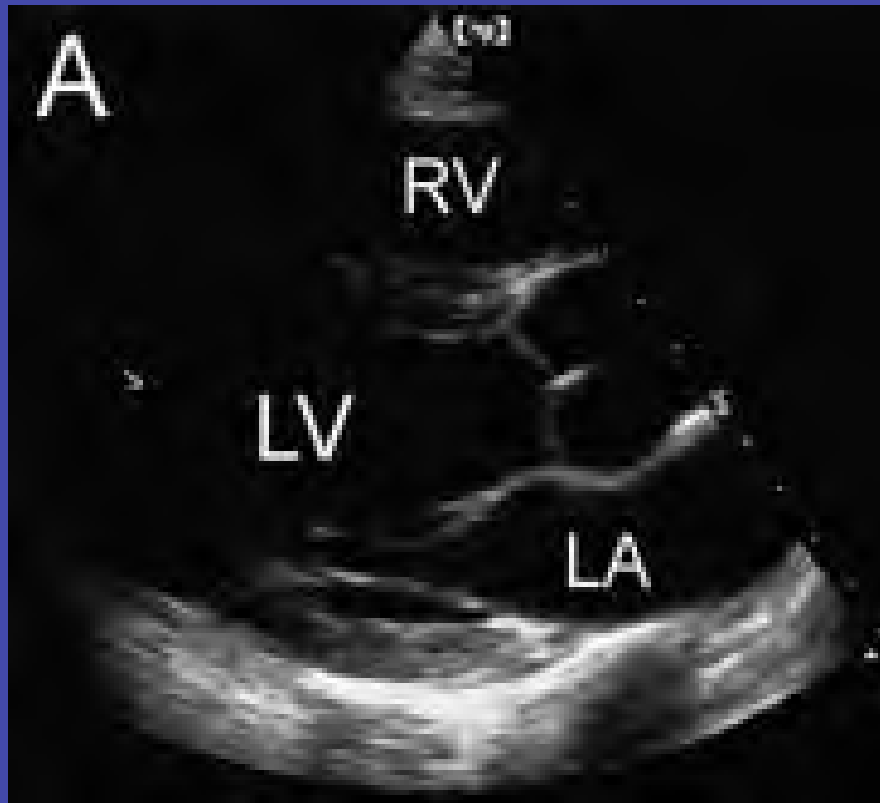
V₄



V₅

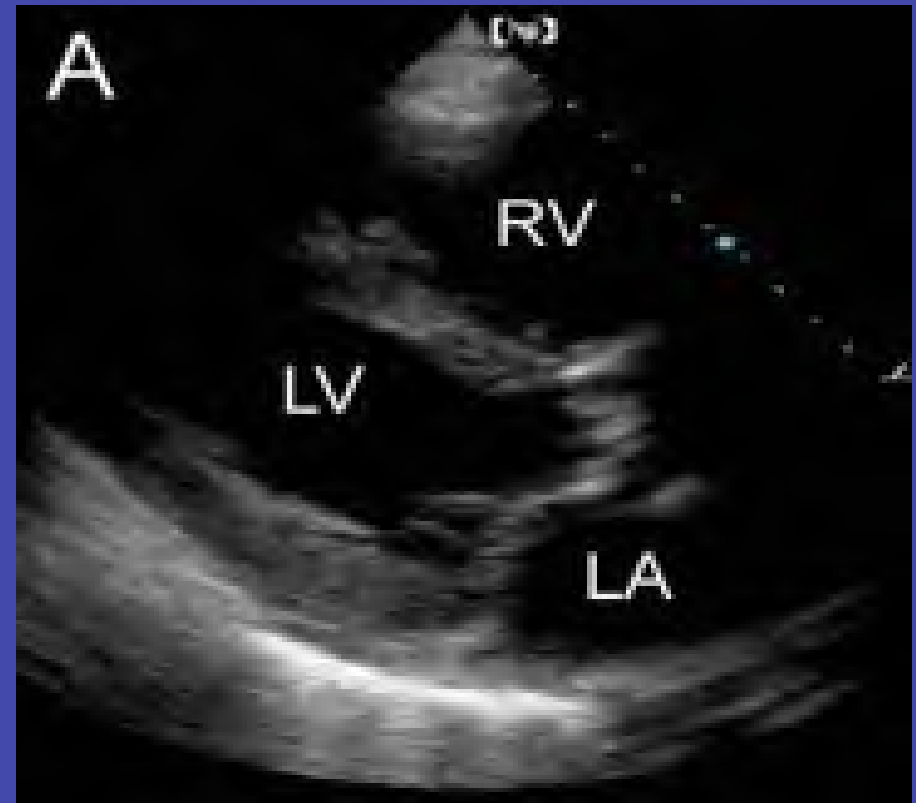
Echocardiography: Parasternal

Normal



PD-INEL Source Undetermined

Aortic Stenosis



PD-INEL Source Undetermined

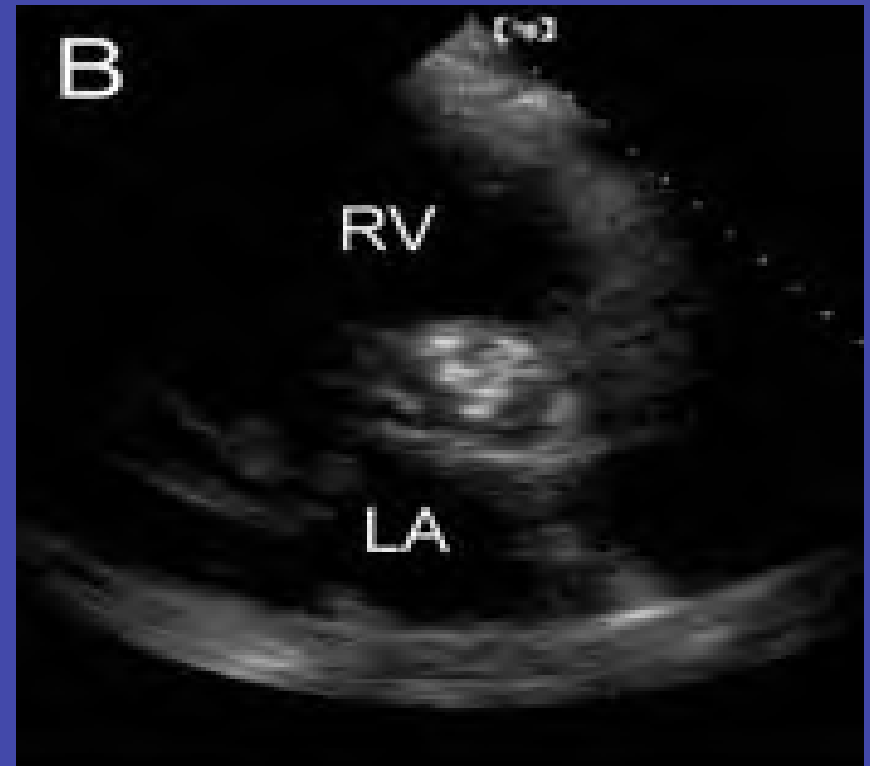
Echocardiography: Short Axis

Normal:



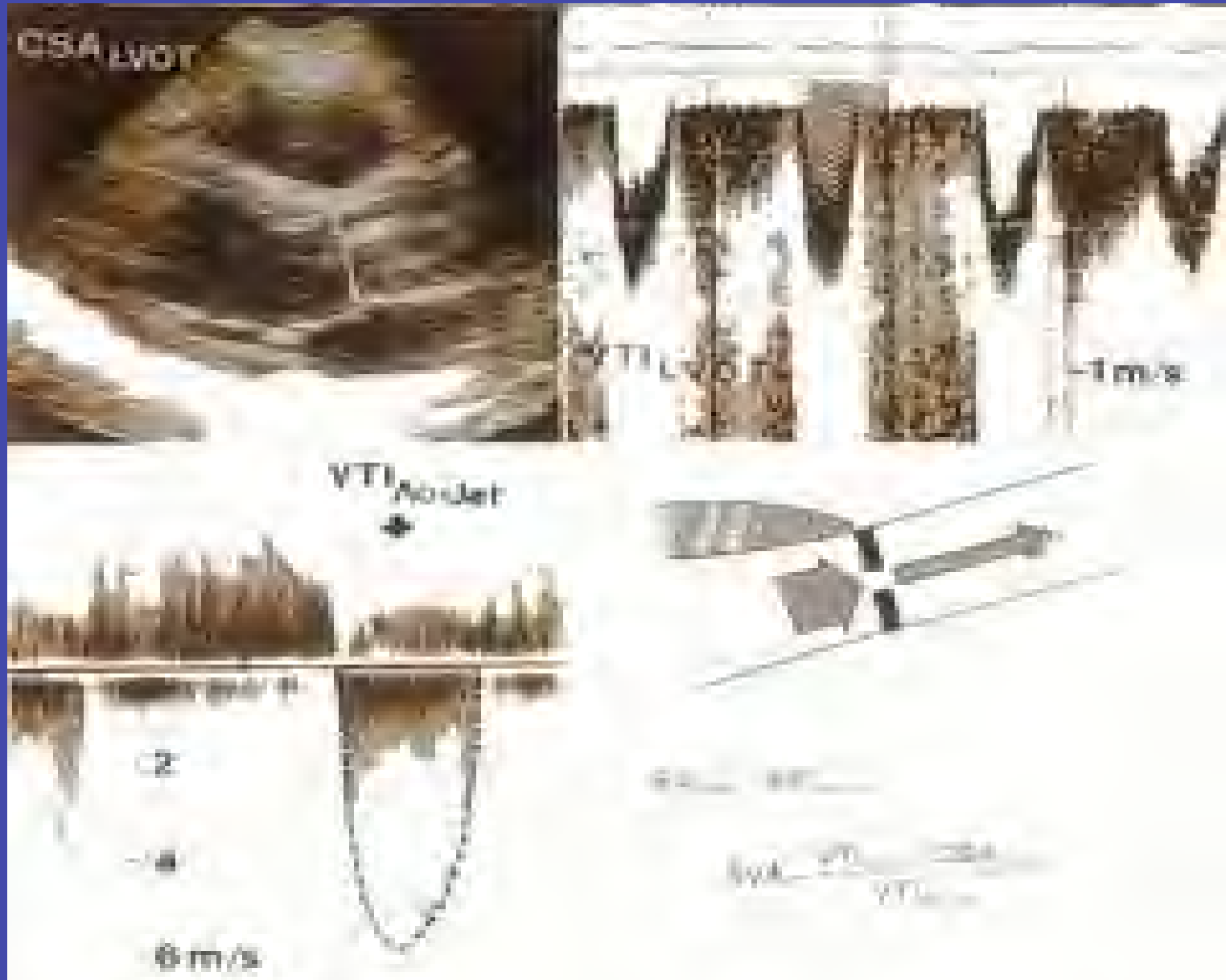
PD-INEL Source Undetermined

Aortic Stenosis



PD-INEL Source Undetermined

Aortic Stenosis: Continuity Equation



Aortic Valve Stenosis: Echo Findings

Leaflet changes:

- ↑ Thickening
- ↑ Calcification
- ↓ Mobility

Ventricular changes:

- Left ventricular hypertrophy

Doppler changes:

- ↑ valve gradient / ↓ valve area

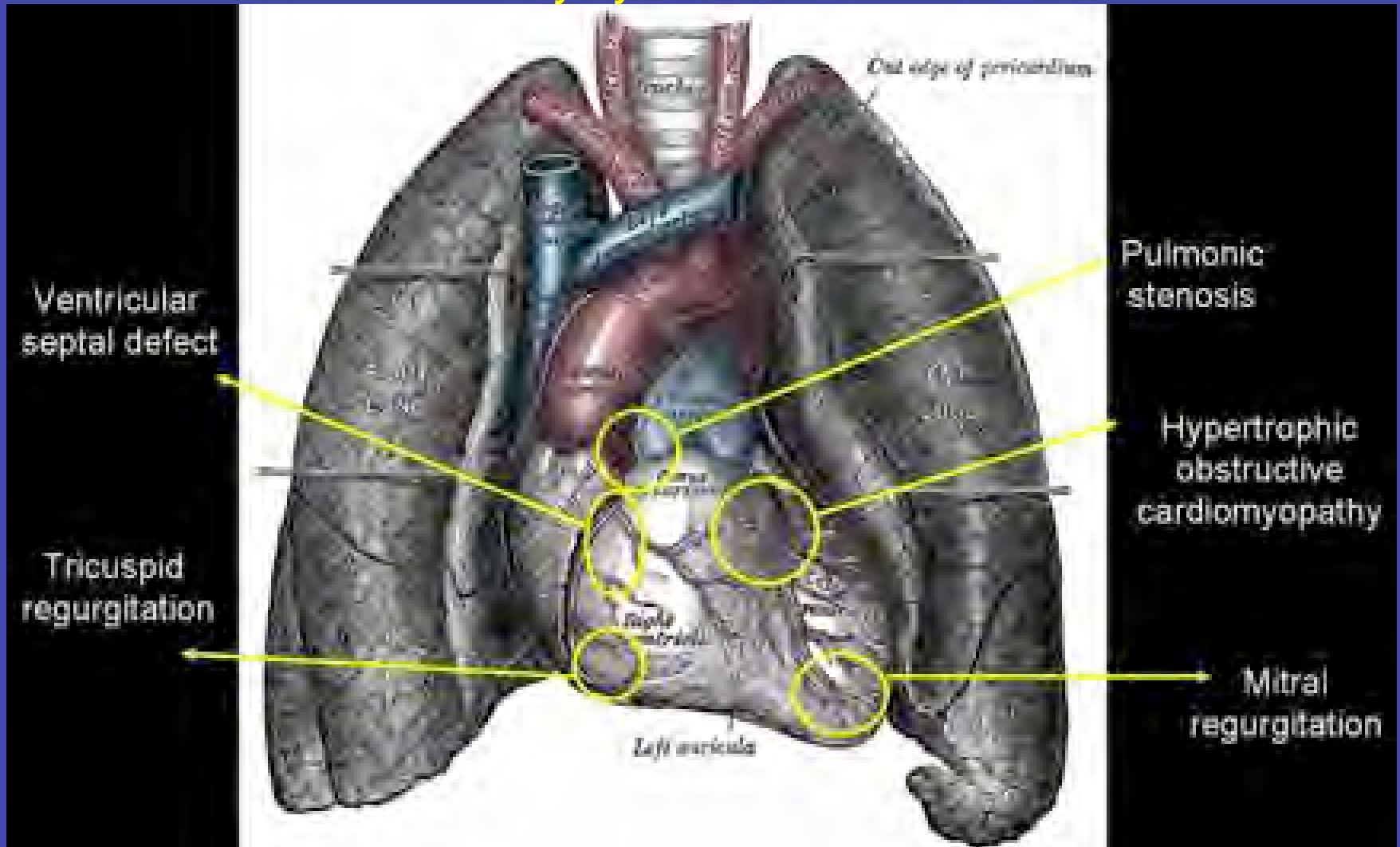
Aortic Stenosis

Laboratory Evaluation

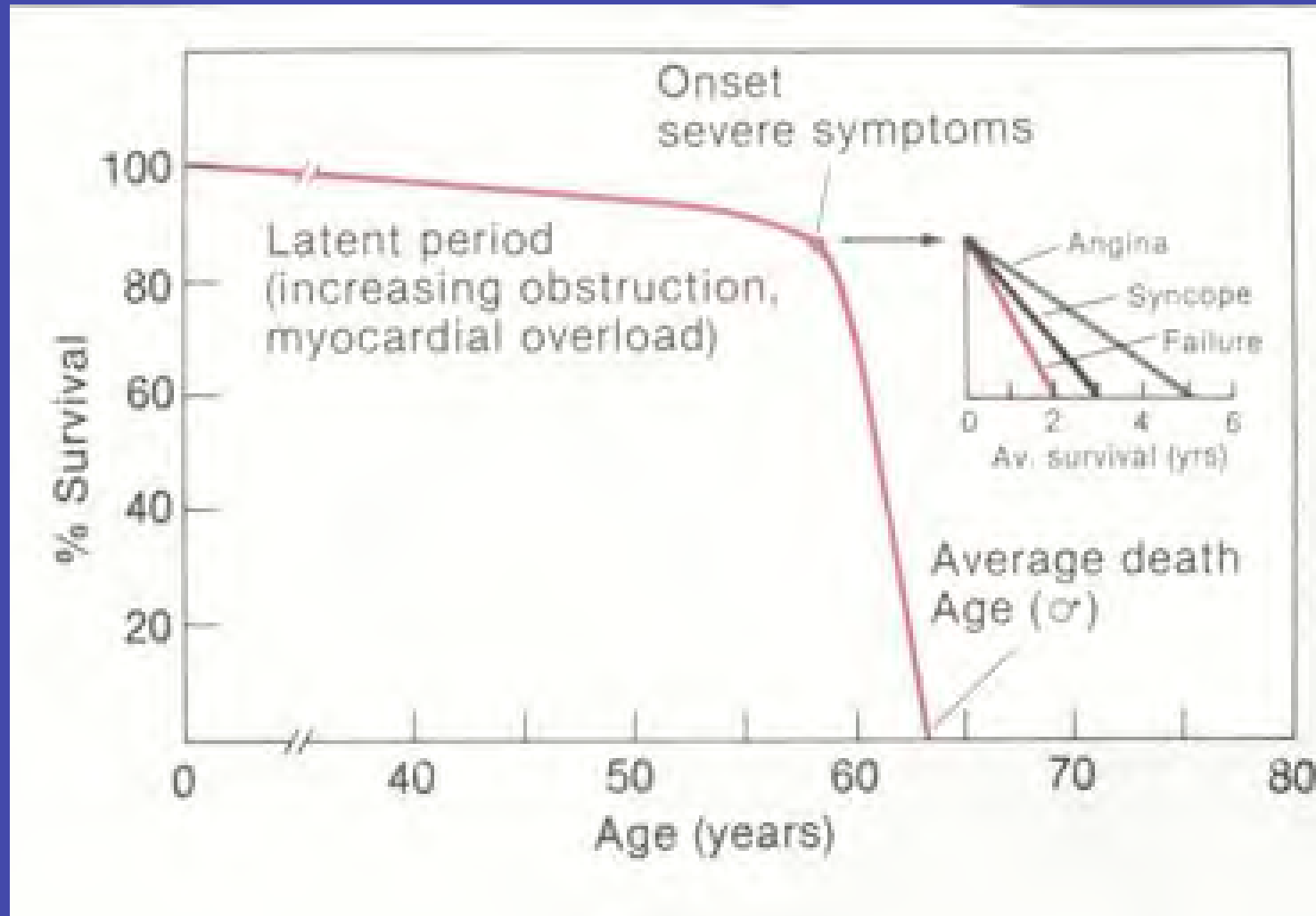
- ❖ Chest radiology
- ❖ Electrocardiography
- ❖ Echocardiography
- ❖ Stress testing
- ❖ Catheterization

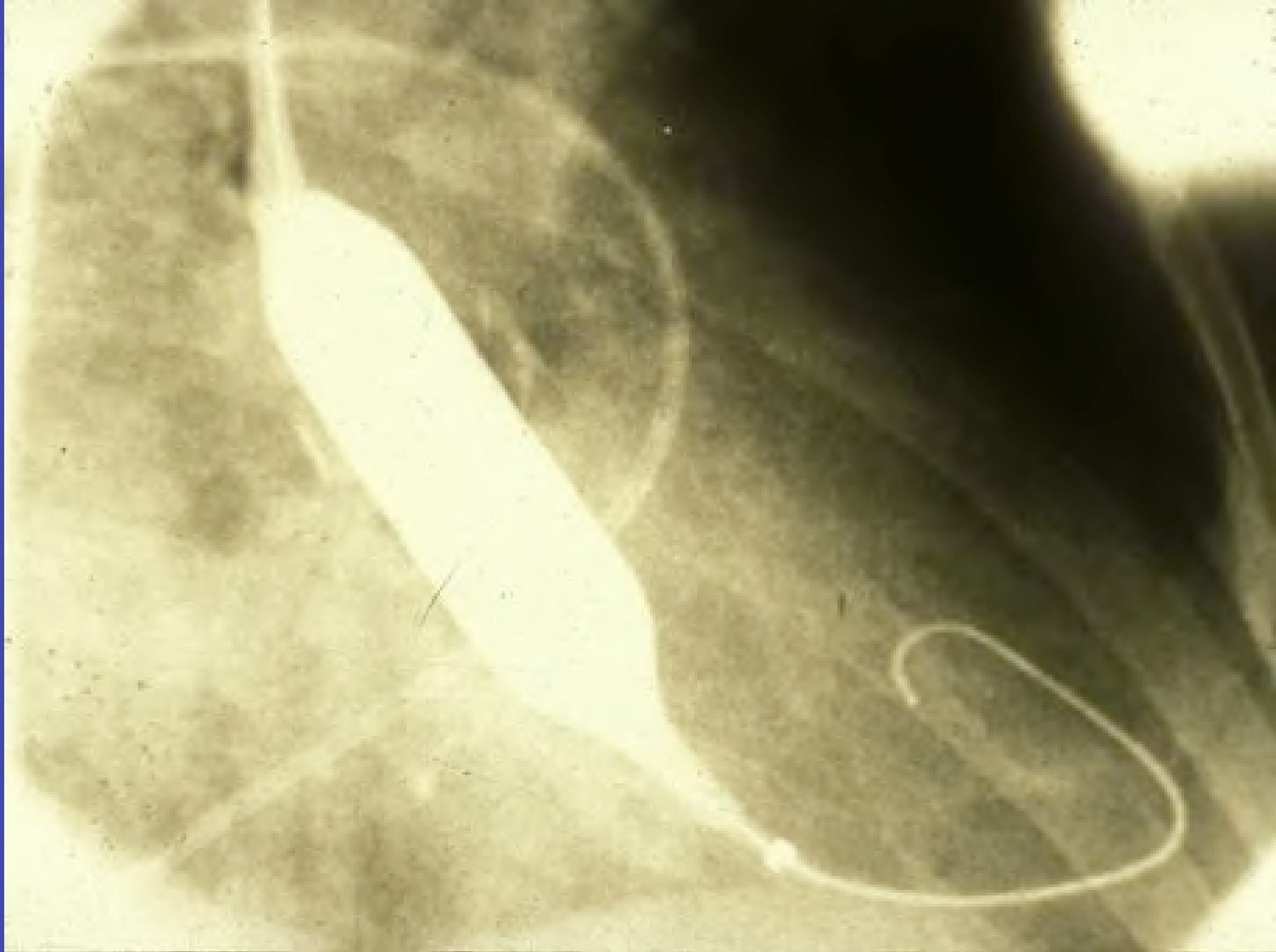
Aortic Stenosis: Differential Diagnosis

Any systolic murmur



Natural History of Aortic Stenosis





Schematic
representation of
pulmonary
autograph
removed

Aortic Stenosis: Management

- Young patient
 - Balloon valvotomy
 - Ross procedure
- Adults
 - Valve replacement

Cribier-Edwards Percutaneous Valve



PD-INEL Source Undetermined



PD-INEL [medGadget](#)



PD-INEL Source Undetermined

Aortic Regurgitation

Aortic Regurgitation: Etiology

Abnormalities of valve leaflets

- Rheumatic
- Endocarditis
- Bicuspid valve

Dilatation of aortic root

- Aortic aneurysm/dissection
- Annulo-aortic ectasia
- Marfan syndrome
- Syphilis

Aortic Valve Regurgitation: Pathophysiology

Normal Valve Function:

- Total cusp area $>$ aortic root area by 1.8 x
- Allows leaflets to overlap/abut
- Helps prevent prolapse in diastole

Impact of Diseases:

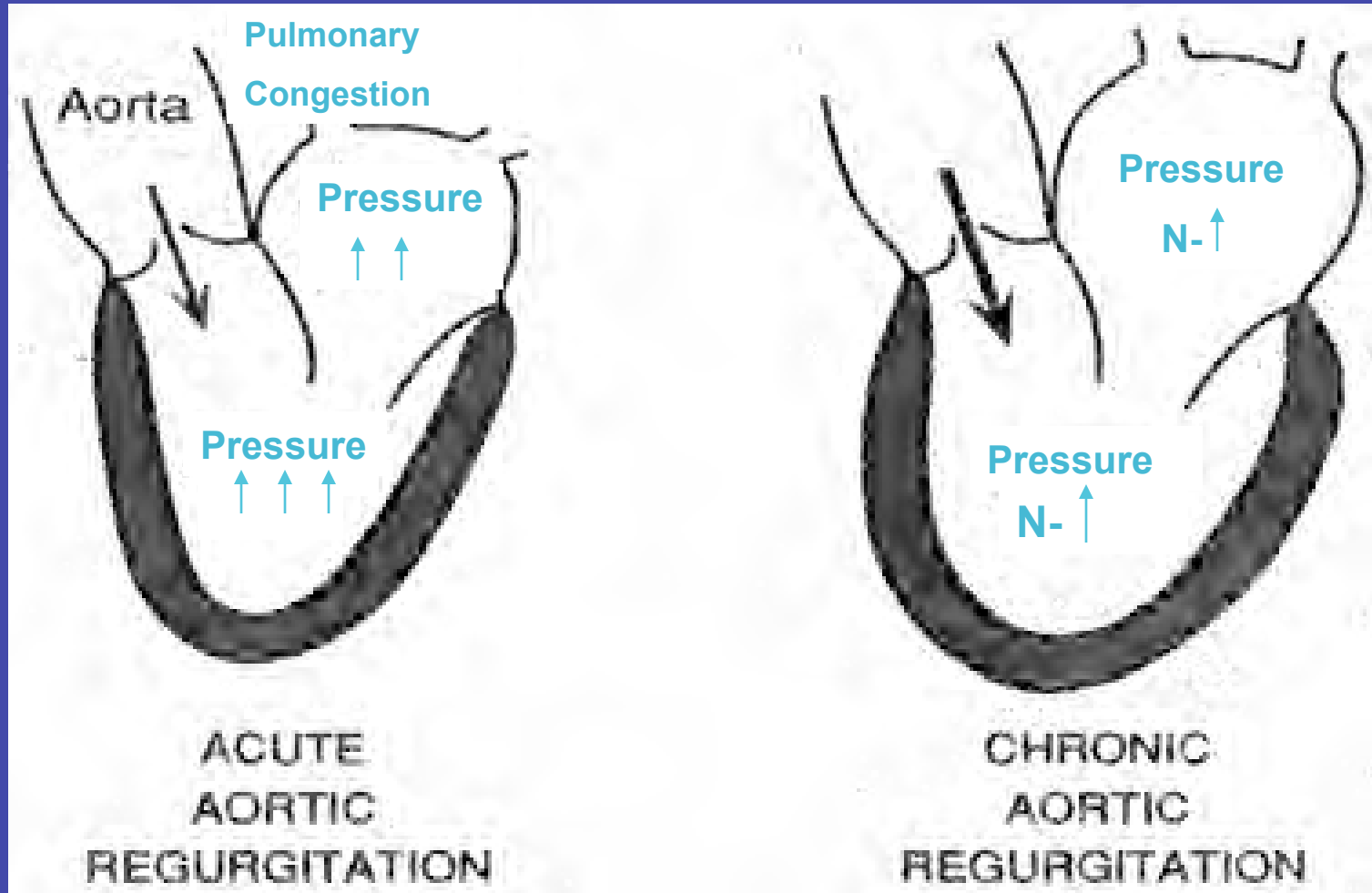
- Rheumatic: \downarrow Cusp area \rightarrow central defect
- Endocarditis: Destroys cusp by tears
- Aortic root: Dilation \rightarrow central defect

Aortic Valve Regurgitation: Pathophysiology

Dominant Hemodynamics: LV volume overload

- Critical determinant of severity - area of regurgitant orifice area
- End diastolic volume increases & stroke volume increases
- Dilation and hypertrophy of LV
- Diastolic burden reaches critical point → leading to heart failure
- Low diastolic blood pressure: incomp. valve and vasodilation

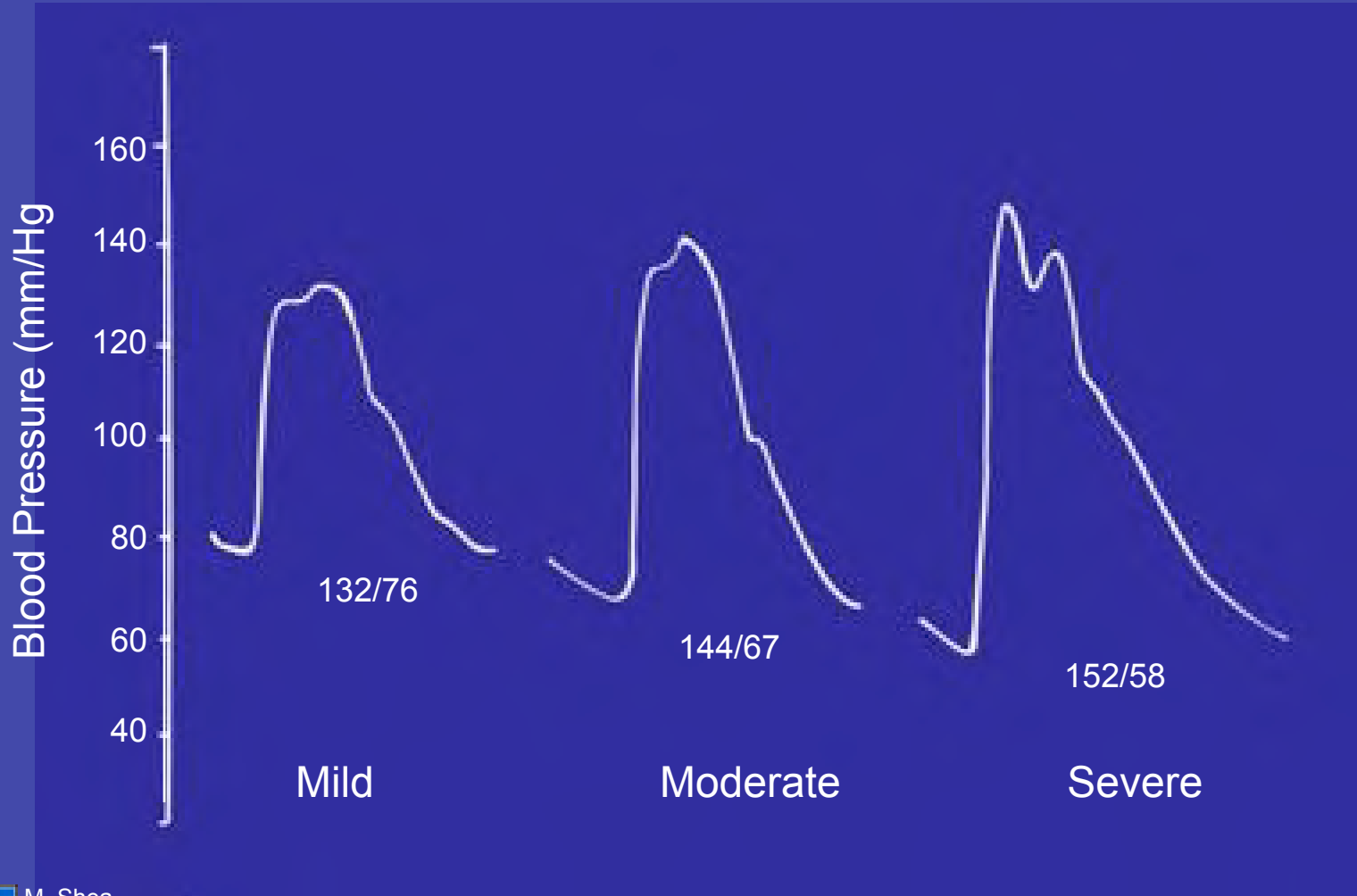
Aortic Valve Regurgitation: Pathophysiology - Acute vs. Chronic



Aortic Regurgitation: Clinical Features

- Long course
- Palpitations
- Dyspnea
- Fatigue
- Angina pectoris

The Arterial Pulse and Blood Pressures in Aortic Regurgitation



Carotid Pulse



PD-INEL Source Undetermined

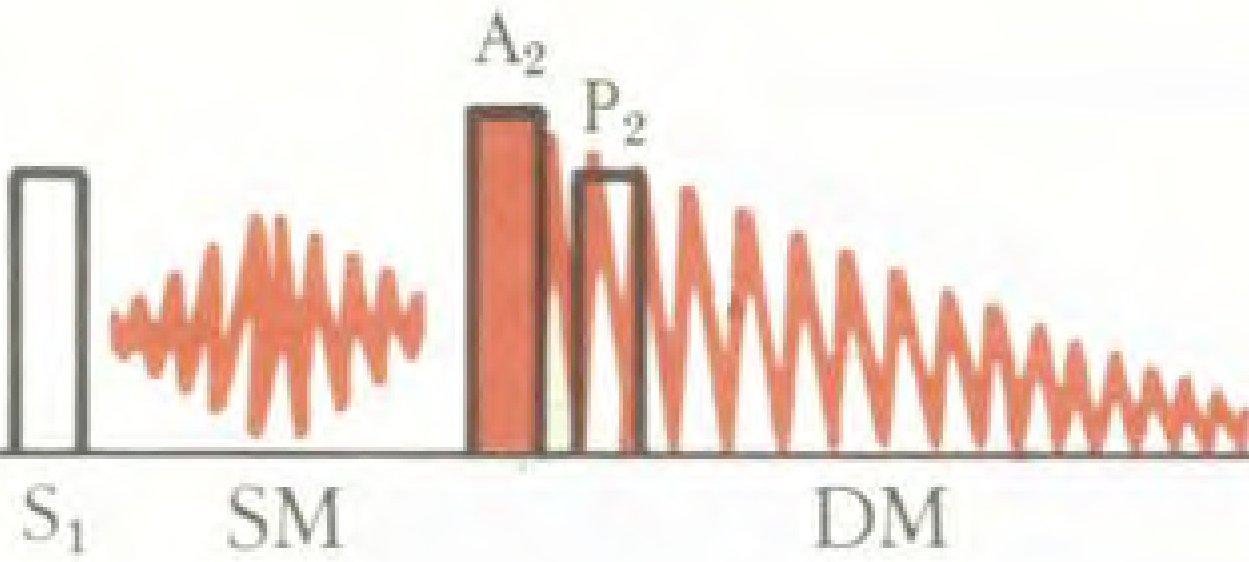


PD-INEL Source Undetermined

Hyperkinetic pulse

Aortic Valve Regurgitation: Physical Examination

- LV apex impulse: displaced laterally, downward, dynamic, enlarged
- Systolic murmur: may or may not imply valve stenosis...rapid ejection of stroke volume across aortic valve
- Diastolic murmur: decrescendo murmur; valvular AR - louder LUSB. Aortic root disease - louder RUSB



Aortic Regurgitation

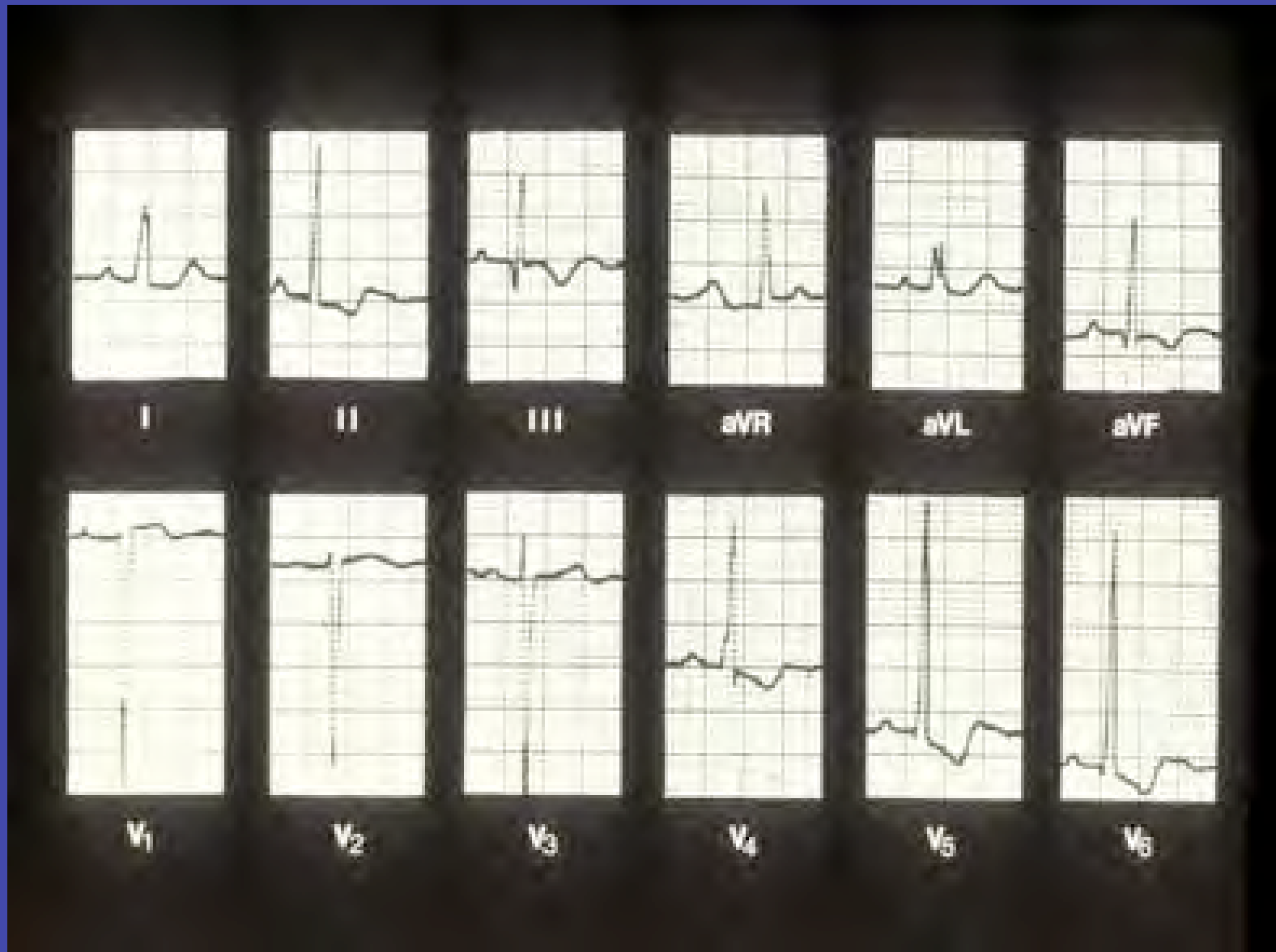
Laboratory Evaluation

- Chest radiology
- Electrocardiography
- Echocardiography
- Exercise testing
- Cardiac catheterization

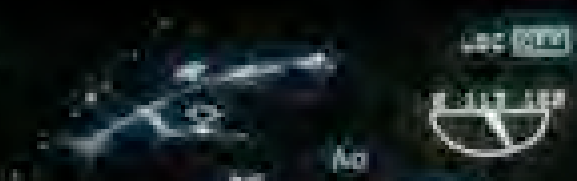
Aortic Regurgitation: Chest X-ray



The Electrocardiogram



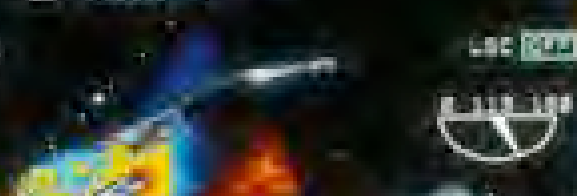
04:58
5:43
3/20/08
08:17:07
100%
LAC



04:59:12
5:43
3/20/08
08:17:07
100%
LAC



04:59:58
5:43
3/20/08
08:17:07
100%
LAC



05:00:27
5:43
3/20/08
08:17:07
100%
LAC



05:01:00
5:43
3/20/08
08:17:07
100%
LAC



05:01:28
5:43
3/20/08
08:17:07
100%
LAC



Aortic Regurgitation

Laboratory Evaluation

- Chest radiology
- Electrocardiography
- Echocardiography
- Exercise testing
- Cardiac catheterization

Aortic Regurgitation: Differential Diagnosis

- Mitral stenosis
- Pulmonic regurgitation
- Patent ductus arteriosus

Aortic Regurgitation

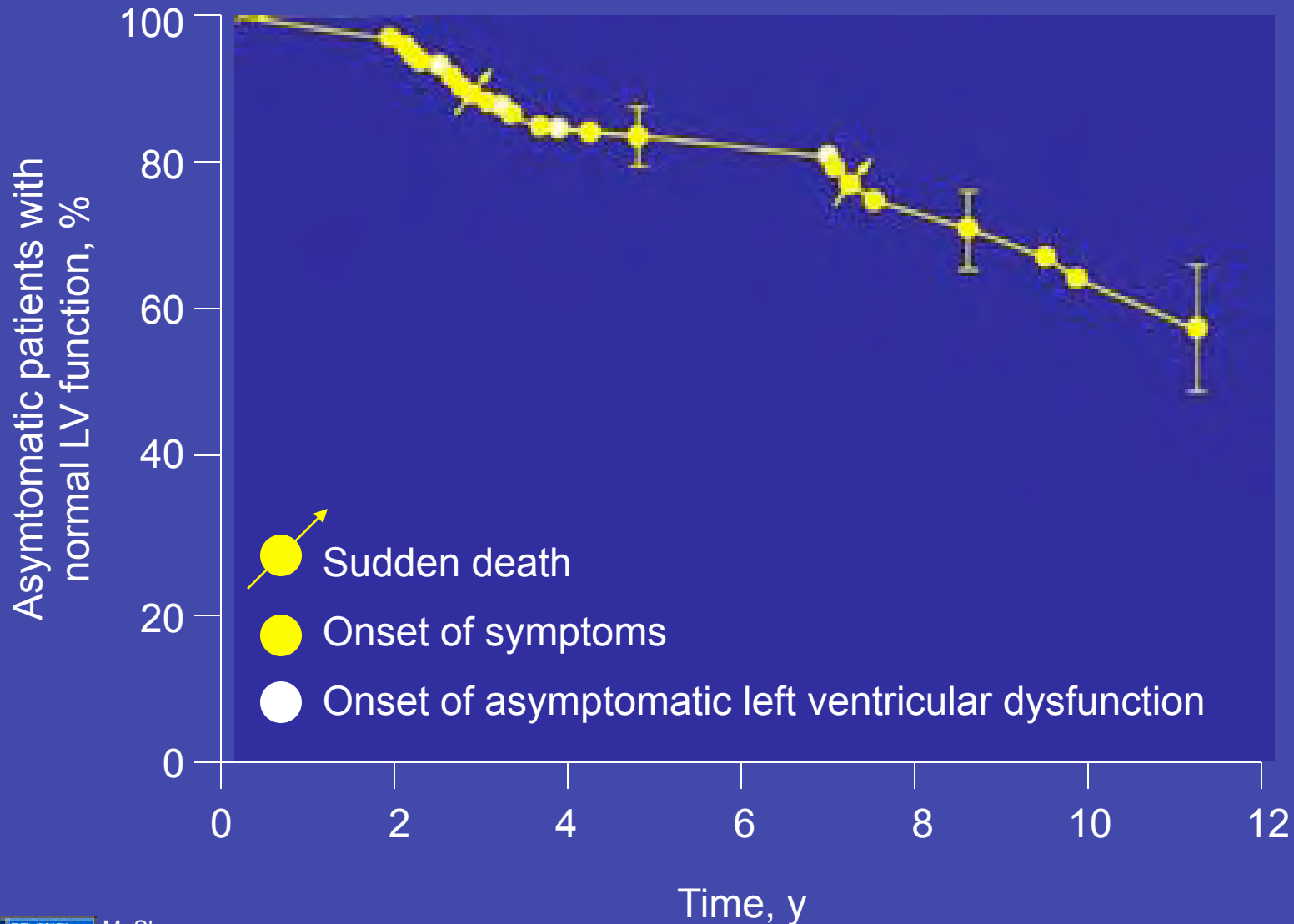
Management

Aortic Regurgitation: Management

Medical Therapy

- Noninvasive follow-up

Severe Aortic Regurgitation: The Asymptomatic Patient



Aortic Regurgitation: Management

Surgical Therapy

- Aortic valve
 - Repair
 - Replacement
- Aortic root replacement

Additional Source Information

for more information see: <http://open.umich.edu/wiki/CitationPolicy>

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Slide 32: Brown University, http://www.brown.edu/Courses/Bio_281-cardio/cardio/handout2.html

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Slide 74: Adapted by University of Michigan, Gray's Anatomy, Wikimedia Commons, <http://commons.wikimedia.org/wiki/File:Heart-and-lungs.jpg>

Slide 75: Braunwald, Circulation, 1968

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Slide 79: Sources Undetermined; medGadget, http://medgadget.com/archives/2005/06/edwards_lifesci.html

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