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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: 4-5cm$^2$
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: Pathophysioloogy

• 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: 1.0-1.4 cm$^2$
  – Mild: 1.5-4.0 cm$^2$

• Symptoms unusual until area $\leq 1.5 \text{ cm}$ but... during unusual flows (eg. exercise) or ... tachycardia which 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 P₀, 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

Mitral Stenosis
Echocardiography: Short Axis

Normal

Mitral Stenosis
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 \( \rightarrow \) 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

- ECG
- LV
- LA
- Time
- Heart sounds
- S1
- S2
- Tall v wave
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

- **NORMAL (SYSTOLE)**
- **ACUTE MITRAL REGURGITATION**
- **CHRONIC MITRAL REGURGITATION**
Mitral Regurgitation: Clinical Features

- Mild MR ➔ no sx
- When sx occur
  - Fatigue
  - Dyspnea
- Physical Exam:
  - Lateral; dynamic LV apex beat
  - Often diminished S₁ (leaflet don’t coapt); S₃ often present
  - Apical systolic murmur
  - Holosystolic murmur to axilla
Mitral Regurgitation: Auscultation

(a) Slight

Late systolic murmur—
a preceding click indicates prolapse.

(b) Moderate

Loud pansystolic murmur
with late systolic crescendo.

Loud pansystolic murmur
continuing past A2
Soft opening snap
Loud third sound
Short mid-diastolic murmur

A2 softly causing wide
splitting of second sound.
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+)
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
  - redundant
  - thickened
  - 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

Schematic representation of heart beat stages removed.

NORMAL

POSTERIOR

VENTRICULAR

DIASTOLE

VENTRICULAR

SYSTOLE

CALCIFICATION

Source Undetermined
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

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
- Etiology
- Pathophysiology
- Clinical Features
- Diagnostic Testing
- Differential Diagnosis
- Management

Aortic Regurgitation
Aortic Stenosis: Pathology

**Normal**

**Congenital**

**Acquired**

Sources Undetermined
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
- Angina pectoris
- Syncope
Aortic Stenosis: Clinical Findings

- Dyspnea
- Angina pectoris
- Syncope
Carotid Pulse

Normal

Parvus et tardus pulse
Aortic Stenosis

Laboratory Evaluation

- Chest radiology
- Electrocardiography
- Echocardiography
- Stress testing
- Catheterization
Aortic Stenosis: Chest radiology

Sources Undetermined
The Electrocardiogram
Echocardiography: Parasternal

Normal

Aortic Stenosis
Echocardiography: Short Axis

Normal:

Aortic Stenosis
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

- Latent period (increasing obstruction, myocardial overload)
- Onset severe symptoms

% Survival vs. Age (years)

Average death
Age (♂)

Braunwald, Circulation, 1968
Schematic representation of pulmonary autograph removed
Aortic Stenosis: Management

• Young patient
  – Balloon valvotomy
  – Ross procedure

• Adults
  – Valve replacement
Cribier-Edwards Percutaneous Valve
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: ↓Cusp area → central defect
- Endocarditis: Destroys cusp by tears
- Aortic root: Dilation → 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

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<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
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<tbody>
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<td>Blood Pressure (mm/Hg)</td>
<td>132/76</td>
<td>144/67</td>
<td>152/58</td>
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M. Shea
Carotid Pulse

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

[Diagram of electrocardiogram tracings from different leads: I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6]
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
Medical Therapy

- Noninvasive follow-up
Severe Aortic Regurgitation: The Asymptomatic Patient

Asymptomatic patients with normal LV function, %

- Sudden death
- Onset of symptoms
- Onset of asymptomatic left ventricular dysfunction

Time, y
Aortic Regurgitation: Management

Surgical Therapy

- Repair
  - Aortic valve
  - Replacement
- Aortic root replacement
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