

A microscopic image of a plant stem cross-section, showing a central vascular cylinder surrounded by cortical cells. The vascular bundles are arranged in a ring, and the image is overlaid with a dark, semi-transparent background. The text is centered over the image.

# The Ins and Outs of Valve Disease

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## OBJECTIVES

- Discuss the cardiac cycle in terms of valvular mechanics
- Understand the cardiac cycle where heart sounds and different murmurs fall during the cycle
- Outline an approach to a patient with valvular disease
- Discuss how valve disease can contribute to other cardiac conditions including but not limited to rhythm disturbances, CHF and angina.

# AORTIC VALVE STENOSIS

Most common cause of LV  
outflow obstruction due to  
restricted aortic valve leaflet  
motion

# Aortic Stenosis

- Acquired AS
  - Most common
  - Degeneration and calcification of the aortic valve leaflets >50 yrs
    - Inflammatory process similar to atherosclerosis:
  - Rheumatic
- Congenital AS
  - Bicuspid aortic valve
  - 30-40 yrs (cause in 50% of pts <70 yrs)
  - Associated with coarctation of the aorta

# Normal

## Open Aortic Valve

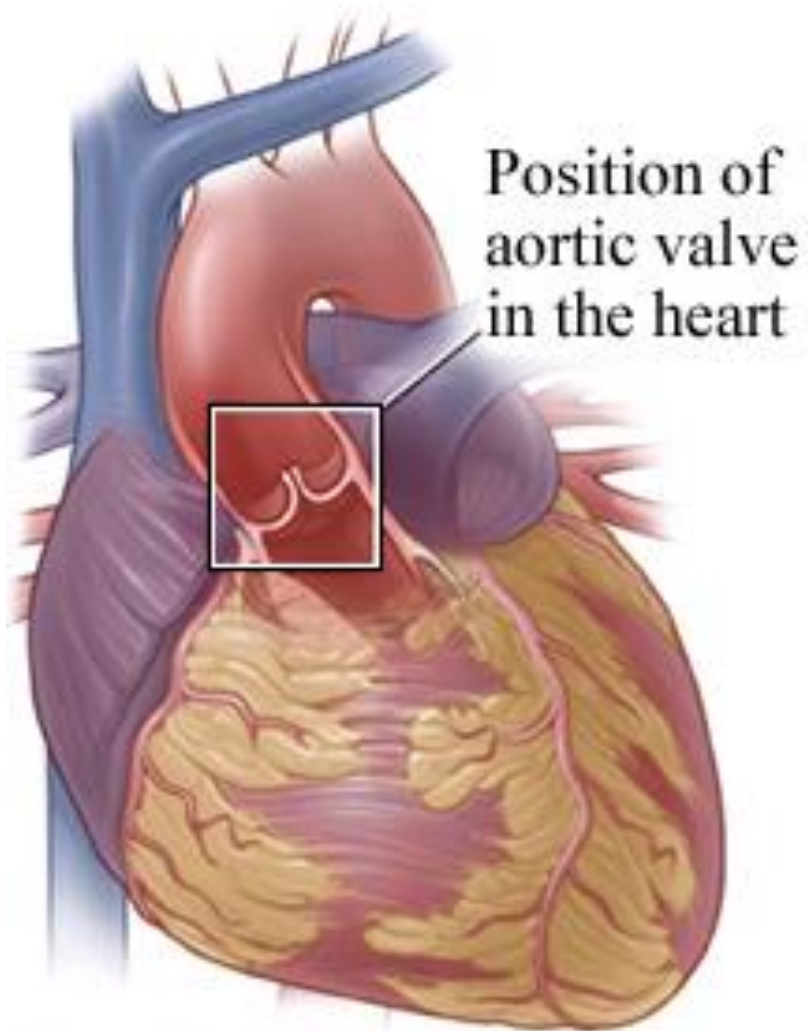


**Bicuspid Aortic Valve Stenosis**

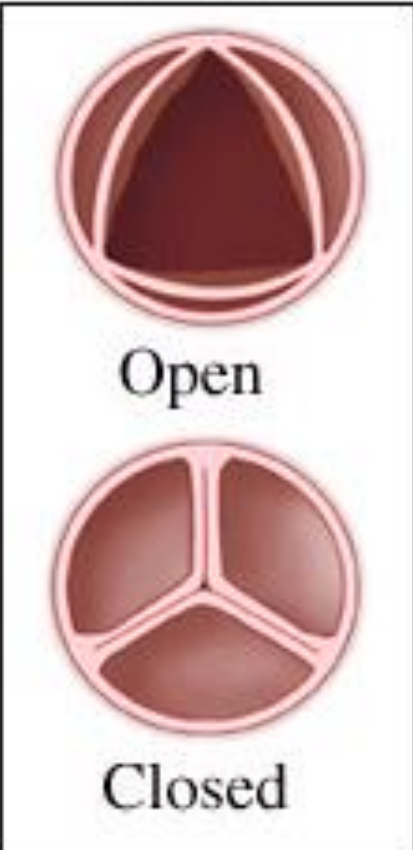


**Calcific Tricuspid Aortic Stenosis**

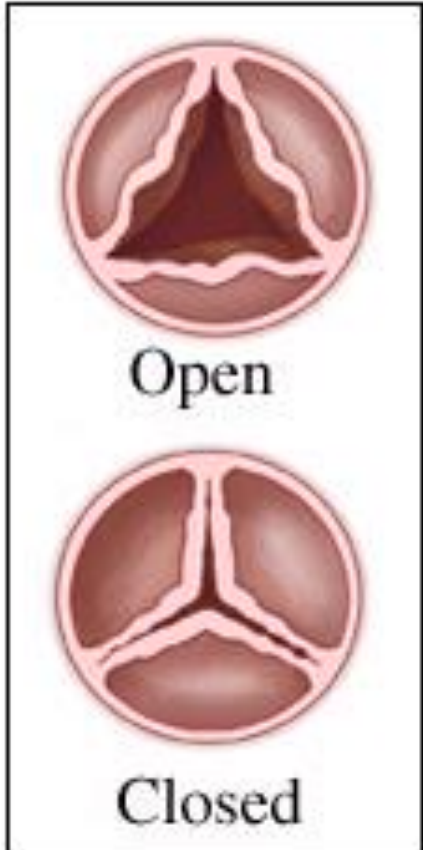




### Normal aortic valve



### Aortic valve stenosis



# EPIDEMIOLOGY

- Prevalence
  - Aortic sclerosis affects 25% of population > 65 yrs
  - Critical AS in 2-3% of population > 75 yrs
  - Bicuspid AV in 1% of population with 2:1 male to female ratio
  - > 70% of bicuspid AV pts will develop AS



Insidious progression of LV outflow obstruction

Pressure gradient develops when effective AVA  $<1/2$  baseline

Compensatory concentric LVH to maintain SV

Chronic LV pressure overload

Increase in LVEDP

Cause/exacerbate MR

Progression depends on functionally competent MV

Diastolic dysfunction and interstitial fibrosis

## PATHOPHYSIOLOGY



## Presentation

- Patients are often asymptomatic for many years
- Most common symptoms: DOE and exercise intolerance
- Progression of the stenosis results in symptoms
  - Usually occurs in 5<sup>th</sup> or 6<sup>th</sup> decade of life for acquired AS patients, about 10 years earlier for congenital AS patients

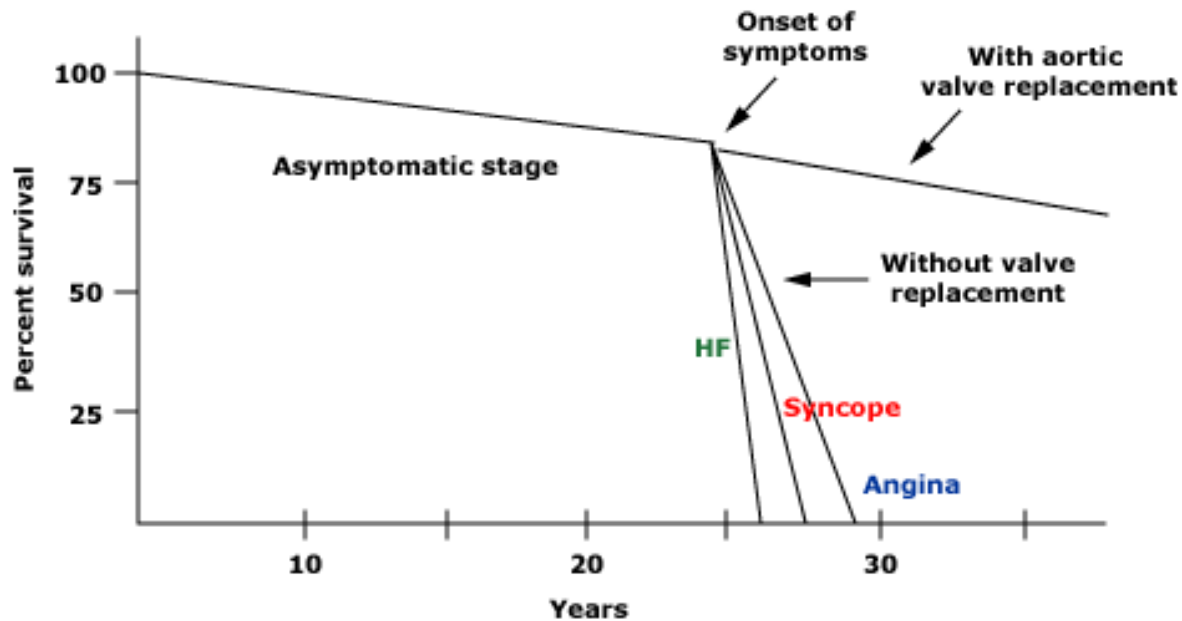
## Complications

### Remember: Aortic Stenosis Complications

- Angina
- Syncope
- Congestive heart failure

Symptoms are related to stenotic limitation to flow, increased left ventricular wall mass (therefore increased supply/demand mismatch), depending on symptoms

## Natural history of aortic stenosis



Schematic representation of the natural history of aortic stenosis and of the major impact of aortic valve replacement. Survival is excellent during the prolonged asymptomatic phase. After the development of symptoms, however, mortality exceeds 90 percent within a few years. Aortic valve replacement prevents this rapid downhill course.

# PHYSICAL EXAMINATION



- Turbulent flow across a stenotic aortic valve
- Heard best at RUSB, crescendo-decrescendo systolic murmur, late peaking, harsh, radiate to the neck, parvus et tardus\*, diminished S<sub>2</sub>\*
- Sustained apical impulse
- [AS murmur](#)

## Evaluation of AS

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EKG

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CXR

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Echo

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Cardiac catheterization

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Normal valve area = 3-4 cm<sup>2</sup>

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Severe AS < 1 cm<sup>2</sup>

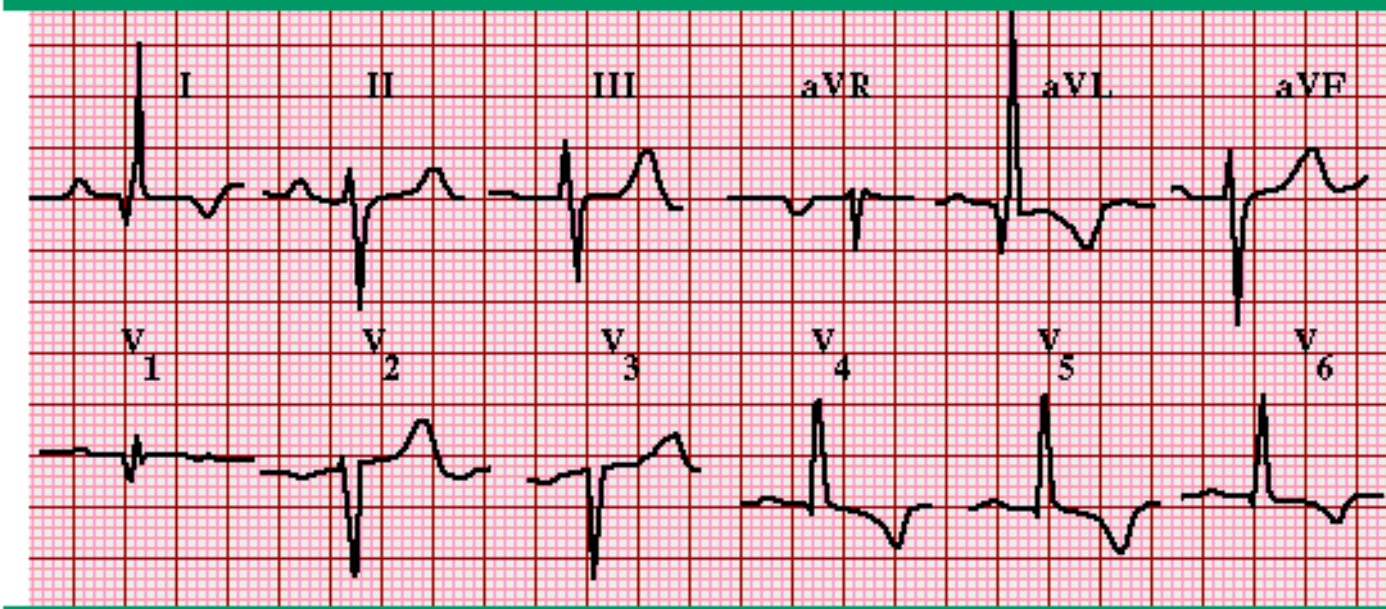
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Critical AS < 0.75 cm<sup>2</sup>

# Treatment of AS

- Aortic valve replacement is definitive
  - Balloon valvuloplasty may be used in young patients in which the patient has congenital AS
- Blood pressure control and gentle diuresis
- Statins if calcific aortic stenosis

## Left ventricular hypertrophy with strain pattern



The ST-T wave abnormalities secondary to left ventricular hypertrophy (often termed "strain") are most often seen in the anterolateral leads (eg, I, aVL, V4-V6). Typical abnormalities include a horizontal or downsloping ST segment and T wave inversions. In some cases there is concavity to the ST segment which has a final downward turn that blends into an inverted T wave.



## Calcification of the aortic root

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Lateral view of chest x-ray shows calcification at the aortic root (arrow).

*Courtesy of Jonathan Kruskal, MD.*

# ACA/AHA GUIDELINE: Indications for AVR in AS

- Class I:
  - Symptomatic severe AS
  - Severe AS in pt undergoing CABG or surgery on the aorta or other heart valve
  - Severe AS w/ LVEF <50%
- Class IIa:
  - Moderate AS in pt undergoing CABG or surgery on the aorta or other heart valve
- Class IIb:
  - Severe AS in asymptomatic pt with abnormal response to exercise
  - Severe AS in asymptomatic pt in whom surgery might be delayed at the time of symptom onset
  - Severe AS in asymptomatic pt with a high likelihood of rapid progression (age, valve calcification, CAD)
  - Mild AS in pt undergoing CABG in whom there is evidence (moderate or severe valve calcification) that progression may be rapid
  - Extremely severe AS (AVA < 0.6cm<sup>2</sup>, mean gradient >60mmHg, Jet velocity > 5.0m/sec) in asymptomatic pt in whom the expected operative mortality is <1%

# BACKGROUND



- High mortality associated with untreated severe, symptomatic AS; i.e., 50% within 2 years
- AVR reduces symptoms and improves survival
- >30% severe, symptomatic AS untreated due to advanced age or comorbidities

# Summary

- Causes of aortic stenosis

- Acquired

- Calcification vs. rheumatic

- Congenital

- Symptoms

- Angina, syncope, congestive heart failure

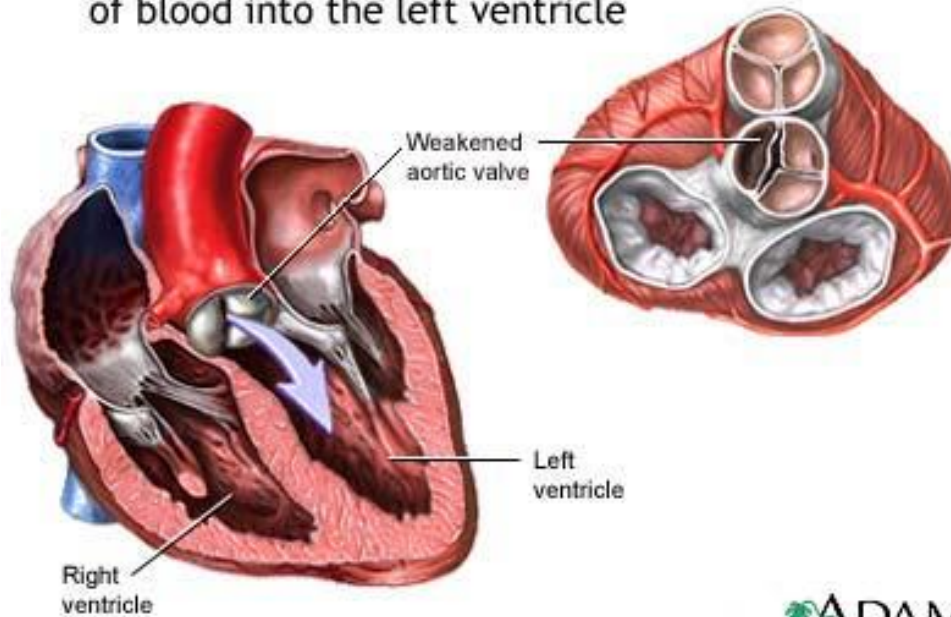
- Clinical findings

- Crescendo-decrescendo systolic murmur
- Possibly an S<sub>4</sub>
- *Parvus et tardus* (“weak” and “delayed” carotid upstrokes)

- Treatment

- Surgery

Failure of the aortic valve to close tightly causes back flow of blood into the left ventricle

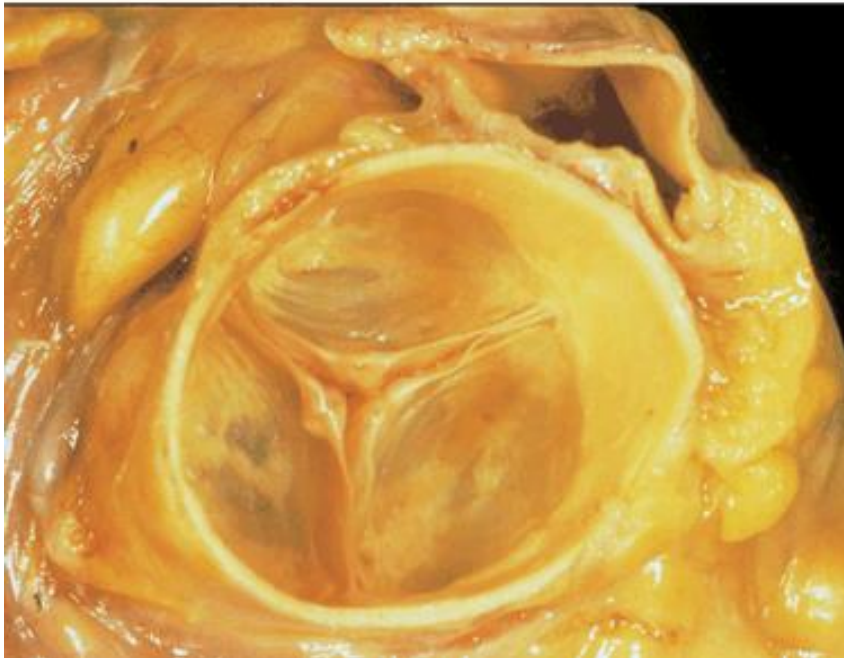


# Aortic Insufficiency

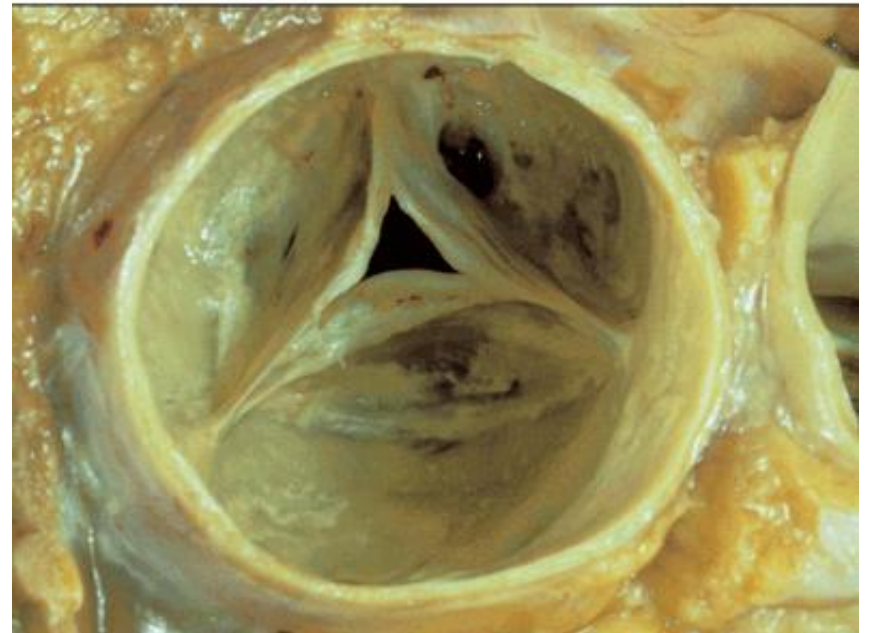
# Etiology of AI

- Causes:
  - Congenital abnormality
    - Bicuspid valve
  - Dilation of aortic root and ascending aorta
    - Aortic dissection
  - Infectious diseases
    - Rheumatic
    - Endocarditis

**Normal Closed Aortic Valve**



**Non-Inflammatory Aortic Root Dilatation**



# Causes of Aortic Insufficiency

Leaflet abnormalities	Aortic root or ascending aorta abnormalities
<b>Rheumatic fever</b> Endocarditis Trauma	<b>Systemic hypertension</b> Aortitis (eg, syphilis) Trauma
<b>Bicuspid aortic valve</b> Marfan's syndrome Fenfluramin- phentermine	Dissecting aneurysm Ehlers-Danlos syndrome



# Symptoms of AI



May be asymptomatic



Fatigue



Sense of pounding heart/pounding  
in head



Atypical or anginal-like chest pain



DOE, orthopnea, PND

# Physical Findings

Wide pulse pressure (SBP - DBP)

High systolic pressure due to large stroke volume

Low diastolic pressure due to rapid runoff

Rapid rise and fall of arterial pulses

Other findings due to hyperdynamic pulse

# Hyperdynamic Pulse Findings

- **Corrigan's pulse** — “water-hammer” pulse— rapid rise and fall
- **deMusset's sign** — head bob occurring with each heart beat.
- **Quincke's pulses** — Capillary pulsations in fingernails
- **Mueller's sign** — Systolic pulsations of the uvula.
- **Rosenbach's sign** — Systolic pulsations of the liver.
- **Gerhard's sign** — Systolic pulsations of the spleen.



# AI Murmur

- Early **diastolic** murmur at **lower left sternal border**
- Blowing
- Sustained or decrescendo
- May be best heard with patient leaning forward and holding breath after exhalation
- Austin Flint murmur – a second low-pitched diastolic murmur/“rumble” heard at the apex
- [AI murmur](#)

## Acute vs. Chronic AI

Chronic AI progresses over time so that the left ventricle has time to compensate by dilation and hypertrophy

Acute AI is a surgical emergency:

- Left ventricle has not had time to adapt
- Causes: Endocarditis, aortic root dissection, acute dysfunction of prosthetic valve, trauma
- Large regurgitant volume causes acute pulmonary edema
- Many physical exam findings are absent

# Evaluation



EKG



CXR



ECHO



CARDIAC  
CATH

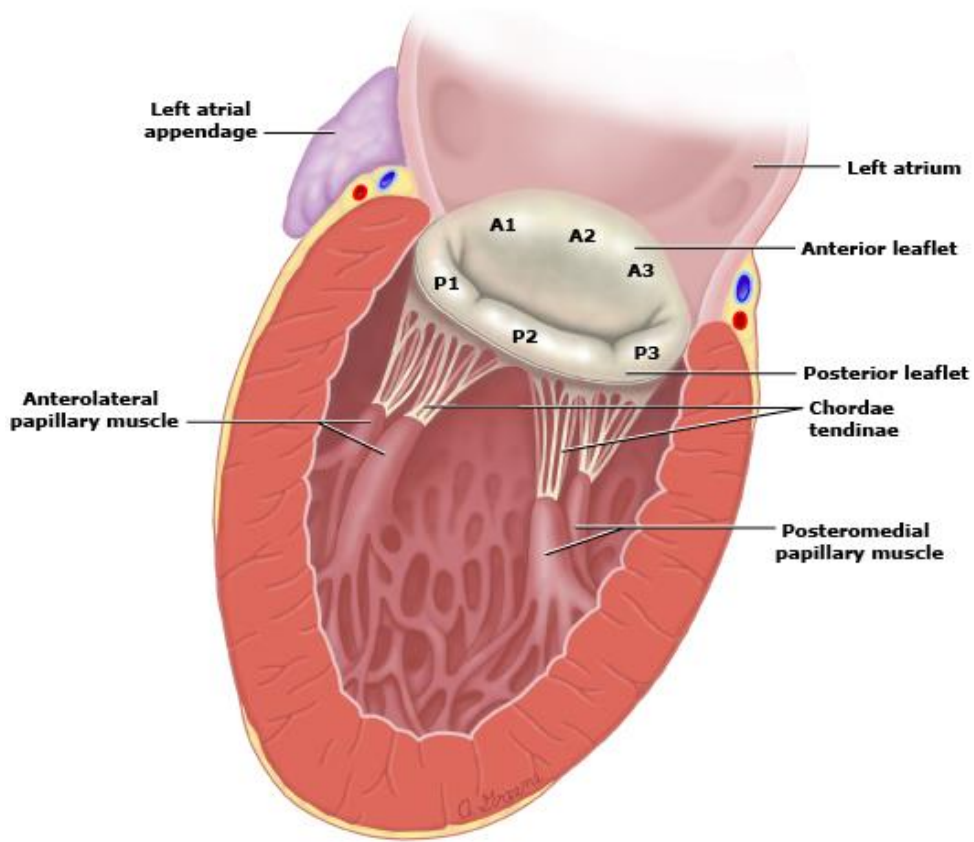
# AORTIC INSUFFICIENCY

- Medical therapy- Vasodilators: Calcium channel blockers or ACE inhibitors for afterload reduction
  - Promotes forward flow in aorta
- Serial monitoring by echo of LV function
- Surgery- valve replacement if pt is
  - Symptomatic
  - has increasing LV size
  - decreasing LV function due to AI

# Summary

- Causes of aortic insufficiency
  - Aortic root dilation, bicuspid valve, rheumatic
- Symptoms
  - “pounding” heart, atypical CP, pulmonary congestion
- Clinical findings
  - Diastolic blowing murmur at the LLSB
  - Possibly an S<sub>3</sub>
  - Hyperdynamic pulses
- Treatment
  - Meds for vasodilation, Surgery





# MITRAL VALVE

## Etiology of MS

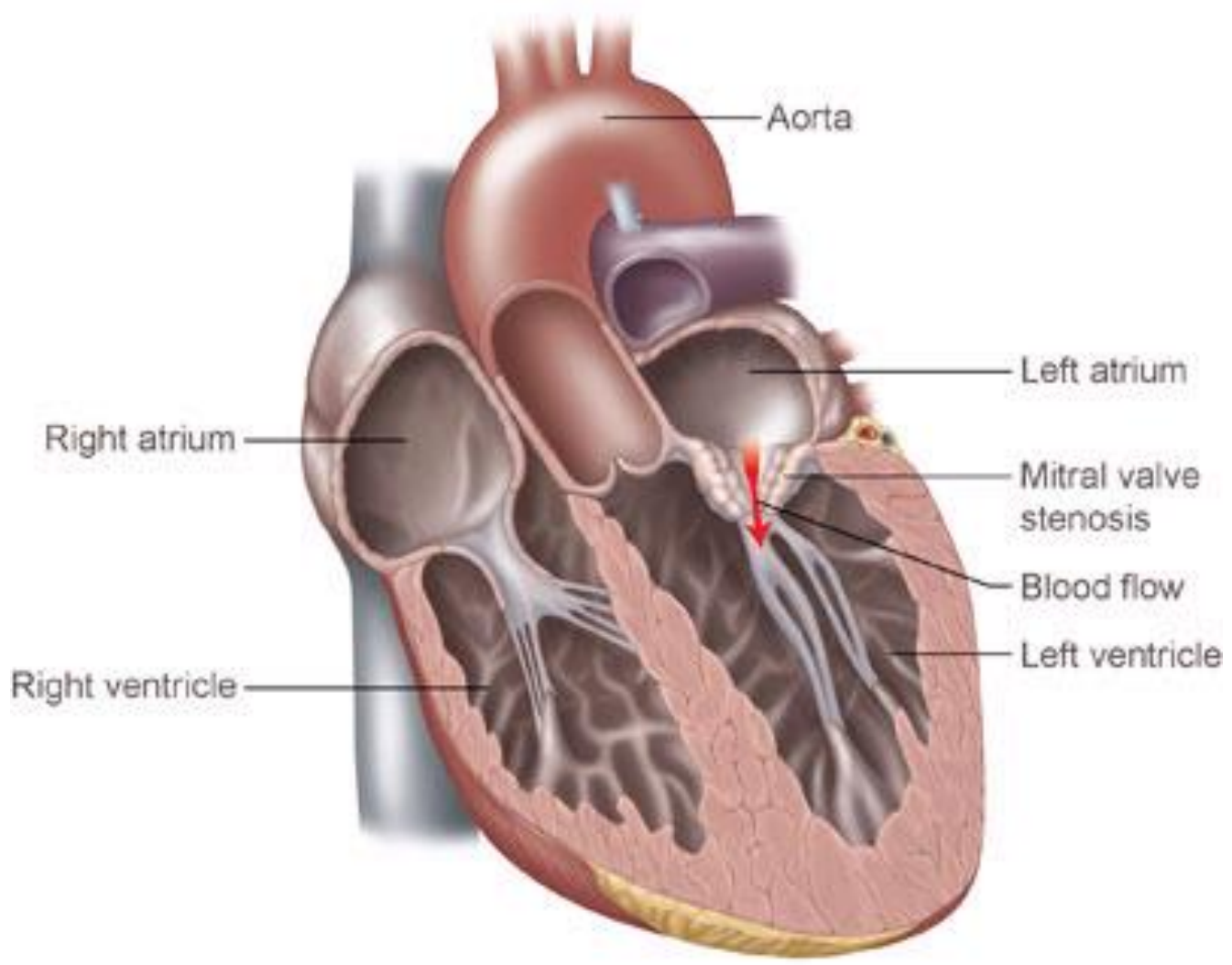
- Most have a rheumatic cause
  - Immobility and thickening of leaflets
  - Fusion of commissures
  - MS is not part of the clinical presentation of the first episode of acute rheumatic fever
- Rare cases of congenital abnormalities of MV
- Valvulitis (SLE or amyloid) or Infiltrative Dx

# Mitral Valve Stenosis

- Valvular obstruction results in increase in pressure in LA, pulm vasculature and right side of the heart

## Long Axis View of Normal Mitral Valve





# Mitral Stenosis

Looking Down on the Mitral and Tricuspid Orifice from the Atria



# Mitral Stenosis

Looking Down on a Mitral Valve  
with a Small Oval Aperture





## Presentation

- Dyspnea, orthopnea, PND
- Hemoptysis
- Chest pain
- Fatigue
- Atrial fibrillation



# Symptoms

- Interval between rheumatic fever and clinical manifestation of MS may be up to 20 yrs
- Mean interval between acute rheumatic fever and symptoms is 15-20 years
- Insidious onset of symptoms progression from mild to severe disability takes 8-9 years

## Physical Findings

- Opening snap follows S<sub>2</sub>
- Diastolic rumbling murmur heard best at the apex in left lateral decubitus position
  - Best heard with the bell
- MS murmur

# Evaluation



EKG



Echo



Exercise Stress  
Echo



Cardiac  
Catheterization



# Treatment

- Pharmacologic treatment
  - Diuretics to treat congestive symptoms
  - Maintenance of normal sinus rhythm-
    - Atrial fibrillation with RVR can be devastating and cardioversion is usually warranted

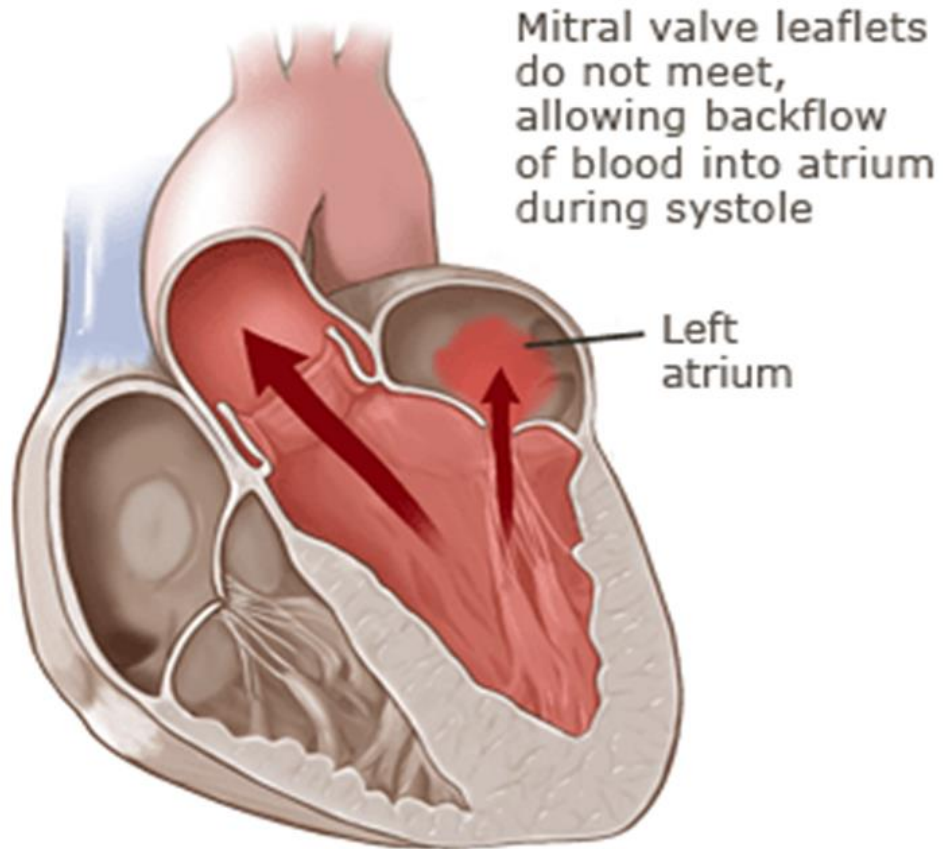
# Treatment

- Mitral valvuloplasty
  - Not a permanent fix
  - Echo criteria to determine suitability
    - Non-calcified, pliable leaflets
    - No significant mitral regurgitation
      - If present, valve replacement warranted
    - No LA thrombus
- MV replacement is the definitive treatment

# Summary

- Cause of mitral stenosis
  - Usually rheumatic fever
  - Exceedingly rare finding in western societies
- Symptoms
  - Dyspnea with slow, insidious onset
  - A-fib
- Clinical findings
  - Opening snap
  - Diastolic rumbling murmur
- Treatment
  - Surgery

## Mitral Regurgitation



Mitral valve  
regurgitation

## Causes of MR

- Mitral valve prolapse is the most common cause of isolated severe MR
- Ischemia can cause dysfunction or rupture of papillary muscle, usually the posteromedial papillary muscle as it has a single blood supply (Posterior Descending Artery)



# Etiology

## Chronic

- MVP
- LV dilation
- Posterior MI (scar)
- **Rheumatic disease**
- Endocarditis

## Acute

- Posterior wall/ papillary muscle **ischemia**
- Rupture of chordae tendinae
- Endocarditis

# Presentation

## Chronic MR

- Prolonged asymptomatic period
- Fatigue/Dyspnea on exertion
- Atrial fibrillation
- Left heart failure: DOE, Orthopnea, PND
- Can lead to pulmonary hypertension and right heart failure

## Acute MR

- Pulmonary edema
- Hypotension

## Physical Findings in MR

- Chronic:
  - **Blowing holosystolic** murmur at **apex** radiating to the axilla and possibly the back
  - S2 may be widely split
  - Laterally displaced apical impulse (PMI)
  - [MR murmur](#) (holosystolic)
  - [MR murmur](#) (with a click)
- Acute MR
  - Systolic murmur may be short, soft or absent
  - S<sub>3</sub>

# Evaluation



EKG



ECHO



CATH

# Management of Chronic MR

Often well  
tolerated

Afterload reduction-  
ACE inhibitors

Maintain sinus  
rhythm if possible

Decrease preload-  
diuretics and nitrates

# Management of Chronic MR



- Serial echocardiograms in patients with moderate to severe MR – after EF falls, outcomes are worse
- Surgery indicated for symptomatic MR and reasonable EF
- Surgery indicated for asymptomatic patients if:
  - severe MR and EF < 55-60%
  - Increase in LV end systolic dimension

## MITRAL VALVE REGURGITATION

- Severe MR in 1-2% echocardiography
- Primary
  - Intrinsic MV pathology
  - Degenerative MV disease is the most common cause
- Secondary
  - Cardiomyopathy
  - Ischemic heart disease

## Management of Acute MR

- Acute severe MR is life-threatening with hemodynamic instability and requires rapid evaluation and surgery
- Treatment:
  - IV vasodilators for afterload reduction (nitroprusside)
  - Inotropes
  - IABP



# Summary

- MVP a most common cause also rheumatic disease
- Pt. may be asymptomatic or have classic “MVP” symptoms, additionally may have DOE, A-fib, CHF
- Commonly described as holosystolic murmur heard best at apex and lower left sternal border – may radiate to axilla
- Treatment – reduce both preload and afterload (ACE and diuretics), surgery for symptomatic patients or asymptomatic patients with  $EF < 55-60\%$  or LV remodeling



THANK YOU!