NOTES
HEART VALVE DISEASE

GENERALLY, WHAT IS IT?

PATHOLOGY & CAUSES

- Wear and tear, external factors, varies by type
- Older age, smoking, hypertension, hyperlipidemia, diabetes mellitus, connective tissue disorders, endocarditis, heart attack

SIGNS & SYMPTOMS

- Normally, heart valves keep blood moving by opening for forward flow and closing to prevent backflow; symptoms evidence of flow alterations
- Murmurs, altered heart sounds
- Sometimes asymptomatic
- Advanced disease → heart failure
- Left ventricular failure symptoms
- Forward effects
  - Decreased perfusion to body tissues (e.g. decreased perfusion to brain = syncope; decreased perfusion to coronary arteries = chest pain, angina)
- Backward effects
  - Blood backs up to left atrium, into pulmonary circulation (e.g. pulmonary edema, dyspnea, fatigue, paroxysmal nocturnal dyspnea)
- Right ventricular failure symptoms
- Backup of blood to venous circulation (e.g. peripheral edema, hepatosplenomegaly)

DIAGNOSIS

- Auscultation → echocardiogram, transesophageal echocardiogram, catheterization

TREATMENT

- Lifestyle changes, pharmacotherapeutics, surgical intervention

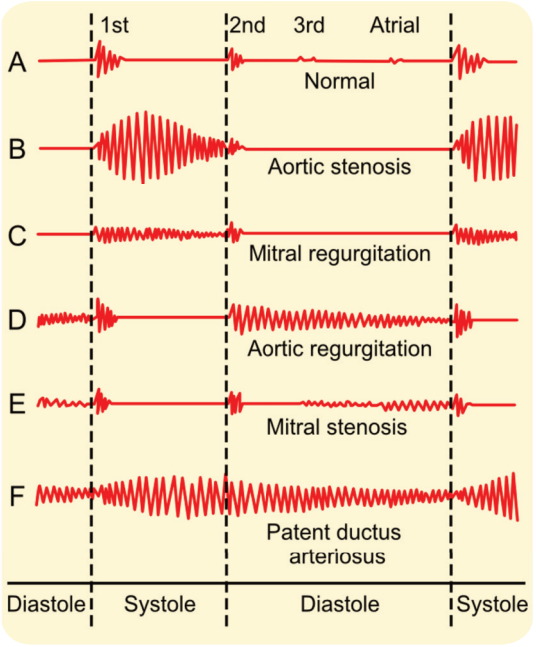

Figure 10.1 Illustration of phonocardiograms from normal and abnormal heart sounds.

AORTIC INSUFFICIENCY

osms.it/aortic-insufficiency

PATHOLOGY & CAUSES

- Widening/insufficiency of aortic valve
- Doesn't close fully, blood flows backwards during diastole
- AKA aortic regurgitation

CAUSES

Aortic root dilation

- Root dilates, pulls apart leaflets
  - Most root dilations idiopathic; some caused by aortic dissection, aneurysm, Marfan syndrome, Ehlers-Danlos syndrome, syphilis, ankylosing spondylitis, rheumatoid arthritis, systemic lupus erythematosus
  - *Valvular damage:* infective endocarditis, rheumatic fever, bicuspid aortic valve
  - Inflammation → fibrosis → valve can't seal

Acute aortic regurgitation (medical emergency)

- Infective endocarditis, trauma, aortic dissection
  - Acute aortic regurgitation presents with sudden cardiovascular collapse, pulmonary edema
  - Chronic aortic regurgitation presents less urgently, signs of heart failure

RISK FACTORS

- Hypertension, syphilis, genetic disorders (Marfan's syndrome, Ehlers-Danlos syndrome)

COMPLICATIONS

Heart failure

- High blood volume left ventricle → left ventricle compensates, adding sarcomeres in series → eccentric left ventricular hypertrophy → left ventricular dysfunction → heart failure

SIGNS & SYMPTOMS

Abnormal heart sounds

- Early decrescendo diastolic murmur, usually heard at left lower sternal border/apex
- Systolic flow murmur may develop in chronic aortic regurgitation; increased blood flow through valve during systole, regardless of stenosis

Wide pulse pressure

- Increased systolic blood pressure (SBP) and decreased diastolic blood pressure (DBP) = hyperdynamic circulation
- Calculation for pulse pressure (PP)
  - SBP - DBP = PP
- Hill's sign
  - Exaggerated difference in SBP when comparing upper, lower limbs
- Bounding pulses
  - Evidence of wide PP
  - *Corrigan pulse (water-hammer pulses):* bounding pulse, blood hammers against arterial walls

Other signs

- de Musset's sign
  - Head bobs in time with heartbeat
- Quincke's sign
  - Light compression of capillary bed leads to visible pulsations in fingers

- Traub's sign
  - Pistol shot sound head over femoral arteries
- Duroziez's sign
  - Systolic, diastolic bruit over femoral artery when partially compressed
- Landolfi's sign
  - Diastolic pupil dilation

Acute aortic regurgitation

- Severe dyspnea, chest pain, hypotension = left ventricular failure, cardiogenic shock

DIAGNOSIS

DIAGNOSTIC IMAGING

Echocardiography

- Using Doppler flow, observe regurgitation jet through aortic valve during diastole

Chest X-ray

- Nonspecific, may observe cardiomegaly

OTHER DIAGNOSTICS

Electrocardiogram

- Shows non-specific features of left ventricular hypertrophy

TREATMENT

- *Goal:* improve cardiac output, decrease regurgitant flow volume

MEDICATIONS

- Vasodilators to reduce afterload

SURGERY

- Surgical valve replacement
- Surgical replacement once ejection fraction < 55%

AORTIC STENOSIS

osms.it/aortic-stenosis

PATHOLOGY & CAUSES

- Stiffening, thickening/calcification of aortic valve (no longer opens fully during systole)
- Valve opening narrows → pressure gradient increases across valve

CAUSES

Mechanical stress

- Damaged endothelial cells over time → fibrosis and calcification → stiff valve does not open fully

Rheumatic heart disease

- Repeated inflammation, repair → fibrosis → commissural fusion

COMPLICATIONS

- Heart failure, microangiopathic hemolytic anemia (red blood cells damaged as they squeeze through small valve opening), Heyde's syndrome

SIGNS & SYMPTOMS

Asymptomatic

- Due to slow progression; abnormal heart sounds heard on auscultation
  - Ejection click
  - Harsh, systolic, crescendo-decrescendo systolic murmur at upper sternal border, radiating to carotids

Advanced state aortic stenosis

- *Classic triad:* angina, syncope, exertional dyspnea

- *Additional heart sounds:* soft, single S2/paradoxical S2 split; crescendo-decrescendo systolic murmur peaks later (the later the peak, the more severe the stenosis); S4
- *Pulsus parvus et tardus* (pulse weak, delayed)
- Narrowed pulse pressure

MNEMONIC: SAD

Characteristics of Aortic stenosis

Syncope
Angina
Dyspnea

DIAGNOSIS

DIAGNOSTIC IMAGING

Transthoracic echocardiogram (TTE)

- Observe small aortic orifice during systole, increased pressure gradient across valve, left ventricular hypertrophy, calcification of aortic valve

Cardiac catheterization

- Useful for surgical planning

OTHER DIAGNOSTICS

Electrocardiogram

- Shows non-specific features of left ventricular hypertrophy

TREATMENT

MEDICATIONS

- Venodilators, calcium channel blockers, administer beta blockers with caution

SURGERY

- Surgical valve replacement if necessary

OTHER INTERVENTIONS

- If mild, no exercise restrictions; if severe, reduced physical activity

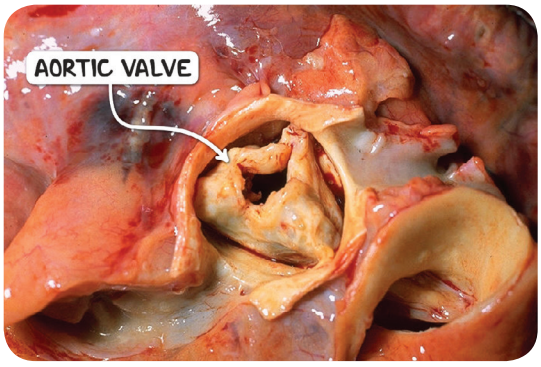

Figure 10.2 Gross pathology of severe aortic stenosis as a consequence of previous rheumatic heart disease. The valve leaflets are stiffened and fused resulting in a narrowed lumen.

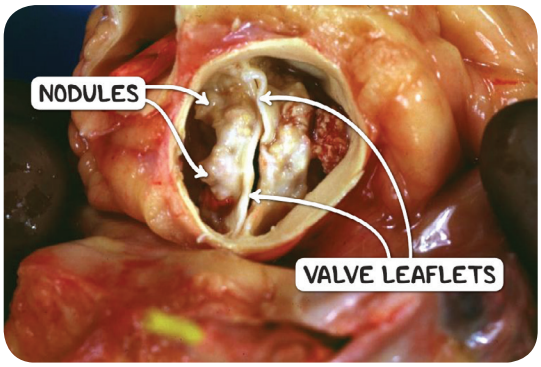

Figure 10.3 Gross pathology of a nodular bicuspid aortic valve.

CHARACTERISTICS OF AORTIC VALVE DISEASE

	AORTIC STENOSIS	AORTIC REGURGITATION
ETIOLOGY	Mechanical stress over time, rheumatic heart disease	CREAM Congenital Rheumatic damage, Endocarditis, Aortic dissection, Aortic root dilation, Marfan's
PATHOLOGY	Small opening → increased pressure	Valve improperly closes → backward flow
COMPLICATIONS	Congestive heart failure, microangiopathic hemolytic anemia, Heyde's syndrome	Congestive heart failure
RISK FACTORS	Age, bicuspid aortic valve, rheumatic fever	Hypertension, syphilis, Marfan's, Ehlers–Danlos
SIGNS & SYMPTOMS	Asymptomatic for extended period, late triad of angina, syncope, exertional dyspnea	Severe dyspnea, chest pain, hypotension
HEART SOUNDS	Ejection click, harsh systolic, crescendo-decrescendo systolic murmur, radiation to carotids	Blowing decrescendo diastolic murmur best at left lower sternal border or apex
ECG	Nonspecific changes, Left ventricular hypertrophy	Nonspecific changes, Left ventricular hypertrophy
ECHOCARDIOGRAM	Observe small orifice (during systole) Left ventricular hypertrophy	Doppler shows regurgitation during diastole
TREATMENT	Mild: watch Severe: valve replacement	Mild: watch Severe: valve replacement

MITRAL INSUFFICIENCY

osms.it/mitral-insufficieny

PATHOLOGY & CAUSES

- Mitral valve prolapses (falls back into atrium)
- Most common valvular condition
- AKA mitral regurgitation

CAUSES

Myxomatous degeneration

- Leaflets, connective tissue, surrounding tissue weakened → mitral valve prolapse
  - Associated with connective tissue disorders (e.g. Marfan syndrome, Ehlers–Danlos Syndrome)
  - Causes larger valve leaflet area, elongation of chordae tendineae → mitral valve more prone to rupture (rupture usually happens to chordae tendineae on posterior leaflet, leaflet folds up into left atrium)
  - Doesn't always cause mitral regurgitation but often does since blood will leak backwards into left atrium if leaflets don't form perfect seal

Damage to papillary muscles

- Caused by heart attacks
  - Papillary muscle dies → can't anchor chordae tendineae → mitral valve flops back → blood leaks back into left atrium

Left-sided heart failure

- Left sided heart failure → left ventricle dilates → stretches mitral valve annulus (ring) → blood leaks back into left atrium → ventricular dilation

Rheumatic fever

- Inflammatory disease affecting heart tissue, leading to chronic rheumatic heart disease
- Chronic inflammation → leaflet fibrosis → leaflets cannot form complete seal → blood leaks through

Mitral regurgitation

- Can also cause left-sided heart failure
- Regurgitant flow back into left atrium → increased preload → increased workload on left atrium, ventricle → left eccentric hypertrophy (new sarcomeres added in series to existing ones) → left sided heart failure

RISK FACTORS

- Intravenous (IV) drug use (increases likelihood of infective endocarditis)
- Congenital bicuspid aortic valve (baby born with aortic valve that has only two instead of three leaflets)
- Diabetes, high blood pressure, smoking

COMPLICATIONS

- Pulmonary congestion, edema
  - Constant elevation in blood volume, pressure in left atrium causes dilation → blood backs up into pulmonary circulation
- Pulmonary hypertension
  - Extra blood volume, pressure in left atrium backs up into lung causing higher pressure in pulmonary circulation
- Right-sided heart failure
  - Backup of blood in left atrium, lungs → pulmonary hypertension → right ventricular hypertrophy → right-sided heart failure
- Atrial fibrillation
  - Left atrium dilates → muscle walls stretch, pacemaker cells irritated
- Thrombus formation, embolism
  - Atrial fibrillation → blood stagnates, pools → increased risk of thrombus formation, blood clots → goes to systemic circulation
- Dysphagia
  - E.g. difficulty swallowing solid foods; dilated atrium compresses neighboring esophagus

SIGNS & SYMPTOMS

- Clinical manifestations of heart failure (e.g. fatigue, swelling, rapid heartbeat)
- Holosystolic murmur
  - Lasts for duration of systole

DIAGNOSIS

DIAGNOSTIC IMAGING

Transthoracic echocardiography (TTE) or transesophageal echocardiogram (TEE)

- Enlarged left atria/ventricle
- Rupture/tear/elongation of mitral valve chordae
- Regurgitation (seen as retrograde blood flow on Doppler imaging)
- Systolic bowing of mitral leaflet (>2mm beyond annular plane)
- May reveal leaflet thickening, flail leaflet, annular dilation

Chest X-ray

- May demonstrate cardiomegaly secondary to left atrial/ventricular dilation

OTHER DIAGNOSTICS

ECG

- Abnormal findings often observed in MVP
  - Early repolarization in inferior leads
  - ST depression, QTc prolongation
  - Premature ventricular contractions
- Not conclusive; result can be normal in people who have mild mitral valve disease

TREATMENT

MEDICATIONS

- Lower high blood pressure (e.g. diuretics)
- Lower cholesterol (e.g. statins)
- Prevent arrhythmias (e.g. amiodarone)
- Prevent clots with blood thinners/ anticoagulants (e.g. heparin, warfarin)
- Treat heart failure (e.g. digoxin to increase contractility)

SURGERY

Replacing/repairing valve

- Severe mitral regurgitation or stenosis = valve repair or surgical replacement of valve
  - Separate fused valve flaps
  - Reshape valve tissue to create tighter seal
  - Repair tears to increase support at base of valve
  - Replace with prosthetic valve

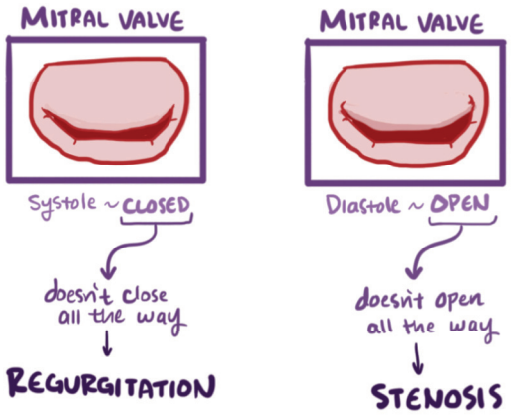

Figure 10.4 Illustration depicting differences in mitral valve shape between mitral valve insuffiency (regurgitation) and mitral stenosis.

MITRAL STENOSIS

osms.it/mitral-stenosis

PATHOLOGY & CAUSES

- Narrowing of mitral valve
- *Rheumatic fever:* inflammation → leaflets fuse together (commissural fusion) → prevents seal formation
  - Normal mitral valve opening (4–6cm^2/1.6–2.4in^2) narrows to 2cm^2/0.8in^2
  - Smaller opening → harder for blood to flow from left atrium to ventricle → blood backs up in atrium → higher pressure in left atrium

RISK FACTORS

- IV drug use
  - Increases likelihood of infective endocarditis
- Congenital bicuspid aortic valve
- Diabetes, high blood pressure, smoking

COMPLICATIONS

- Pulmonary congestion, edema
  - Constant elevation in blood volume, pressure in left atrium → left atrium dilates → blood backs up into pulmonary circulation
- Pulmonary hypertension
  - Extra blood volume, pressure in left atrium backs up into lung → higher pressure in pulmonary circulation
- Right-sided heart failure
  - Backup of blood in left atrium, lungs → pulmonary hypertension → right ventricular hypertrophy → right-sided heart failure
- Atrial fibrillation
  - Left atrium dilates → muscle walls

stretch, pacemaker cells irritated
- Thrombus formation, embolism
  - Atrial fibrillation → blood stagnates, pools → increased risk of thrombus formation, blood clots entering systemic circulation
- Dysphagia
  - Dilated atrium compresses neighboring esophagus

SIGNS & SYMPTOMS

- Clinical manifestations of heart failure
- "Snap" sound after S2 (closure of aortic, pulmonic valves)
  - Higher pressure flowing through fibrotic valve makes "snap" sound when valve opens
  - Diastolic rumble following "snap" as blood forced through smaller opening
- Dyspnea/difficulty breathing
  - Pulmonary congestion, pulmonary edema

DIAGNOSIS

DIAGNOSTIC IMAGING

Echocardiography
- Shows abnormal blood flow, narrowed/insufficient valve

Transesophageal echocardiogram (TEE)
- Enlarged left ventricle
- Enlarged left/right atria
- Possible rupture/tear of mitral valve chordae
- Possible regurgitation

Stress test (echocardiography)
- Measure blood pressure pre-, post-test
- Record how long individual able to carry out test

Chest X-ray
- Shows heart size, lung condition

OTHER DIAGNOSTICS

ECG
- Reveals abnormal electrical activity depending on severity
  - Not conclusive; result can be normal in people who have mild mitral valve disease

TREATMENT

MEDICATIONS
- Lower high blood pressure (e.g. metoprolol, lisinopril, diuretics)
- Lower cholesterol (e.g. statins)
- Prevent arrhythmias (e.g. amiodarone)
- Prevent clots with blood thinners/anticoagulants (e.g. heparin, warfarin)
- Treat heart failure (e.g. digoxin to increase contractility)

SURGERY
- *Replacing/repairing valve:* severe mitral regurgitation or stenosis = valve repair or surgical replacement of valve
  - Separate fused valve flaps
  - Reshape valve tissue to create tighter seal
  - Repair tears to increase support at base of valve
  - Replace with prosthetic valve

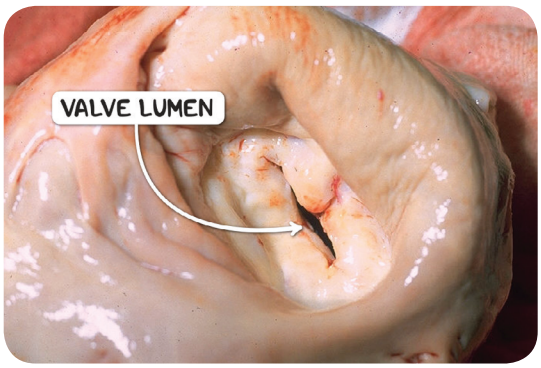

Figure 10.5 Gross pathology of a stenotic mitral valve, viewed from the left atrium.

MITRAL VALVE PROLAPSE

osms.it/mitral-valve-prolapse

PATHOLOGY & CAUSES

- Floppy mitral valve
- Cusps of valve flop into atrium during systole.
- Myxomatous degeneration from connective tissue disease (e.g. Ehler–Danlos, Marfan syndromes)
- Familial mitral valve prolapse
  - *Autosomal dominant:* variable penetrance and expression

RISK FACTORS

- Age
- Hypertension
- History of rheumatic fever
- Connective tissue disorders

COMPLICATIONS

- Heart failure, arrhythmias, systemic emboli, cardioembolic stroke, chordal rupture, sudden death

SIGNS & SYMPTOMS

- Usually asymptomatic
- *Classic heart murmur:* midsystolic click followed by systolic murmur
- *Murmur:* blood leaks backward from left ventricle into left atrium
- *Click:* leaflet folding into atrium, suddenly stopped by chordae tendineae
  - When an individual squats, click comes later, shorter murmur
  - Squatting increases venous return → fills left ventricle with more blood → left ventricle gets slightly larger → leaflets have more space → ventricle contracts, gets smaller → takes slightly longer for leaflet to be forced into atrium
  - When individual stands/performs Valsalva maneuver (forceful exhalation against closed airway), click comes sooner, longer murmur
  - Standing reduces venous return → less blood in ventricle → ventricle is slightly smaller → less room for leaflets → leaflet forced out earlier during contraction
- Individual may report palpitations

DIAGNOSIS

DIAGNOSTIC IMAGING

Chest X-ray

- May demonstrate cardiomegaly secondary to left atrial/ventricular dilation

Transthoracic echocardiography (TTE) or transesophageal echocardiogram (TEE)

- Enlarged left atria/ventricle
- Rupture/tear/elongation of mitral valve chordae
- Regurgitation (seen as retrograde blood flow on Doppler imaging)
- Systolic bowing of mitral leaflet (> 2mm beyond annular plane)
- May reveal leaflet thickening, flail leaflet, annular dilation

OTHER DIAGNOSTICS

Physical examination

- Crescendo murmur in late systole heard over apex
- Mid-systolic click (due to rapid tensing of chordae tendineae)

ECG)

- Abnormal findings often observed in MVP
  - Early repolarization in inferior leads
  - ST depression, QTc prolongation
  - Premature ventricular contractions
- Not conclusive; result can be normal in people who have mild mitral valve disease

TREATMENT

MEDICATIONS

- If palpitations present
  - Beta blockers; avoid smoking, caffeine

SURGERY

- Severe prolapse
  - Valve repair/replacement (esp. when left ventricular systolic function impaired)

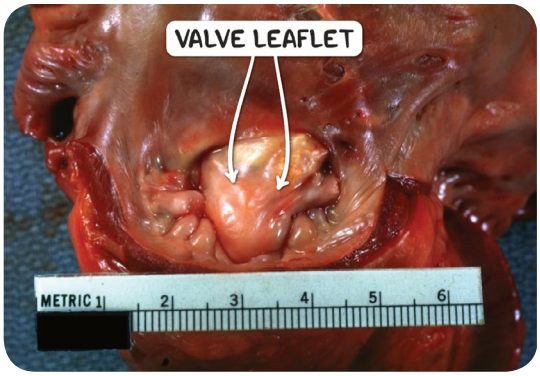

Figure 10.6 Gross pathology of a mitral valve prolapse (anterior superior leaflet) viewed from the left atrium.

PULMONARY INSUFFICIENCY

osms.it/pulmonic-insufficiency

PATHOLOGY & CAUSES

- Pulmonary valve doesn't close fully → blood leaks back into right ventricle
- AKA pulmonic regurgitation
- Blood backflow increases right ventricular blood volume → right ventricle needs to work harder during systole → eccentric ventricular hypertrophy → heart failure

CAUSES

- Congenital malformation of the leaflets common
  - Tetralogy of Fallot (TOF), Noonan's syndrome, congenital rubella
- Infective endocarditis, rheumatic heart disease, systemic disease (e.g. carcinoid disease)

COMPLICATIONS

- Right-sided heart failure
  - Ventricles cannot compensate for increased workload
- Microangiopathic hemolytic anemia
  - Shearing damage to red blood cells forced through smaller valve, leading to hemoglobinuria

SIGNS & SYMPTOMS

- Abnormal heart sounds
  - Crescendo-decrescendo murmur: blood flows through narrow pulmonary valve, causes turbulence that gets louder as more blood flows/quieter as blood flow slows, blood leaks back from pulmonary artery into right ventricle, causes murmur that starts loud, quietens
- Signs of right-sided heart failure may be present (e.g. fatigue, swelling, rapid heartbeat)

DIAGNOSIS

DIAGNOSTIC IMAGING

Echocardiogram

- Regurgitation seen on Doppler

Chest X-ray

- May show enlarged right ventricle

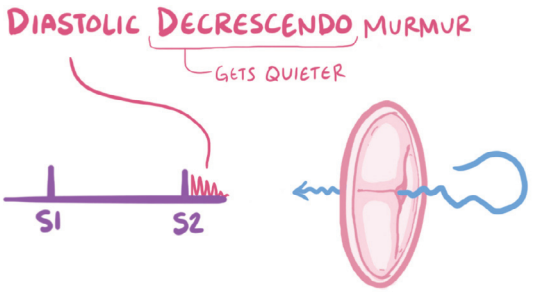

Figure 10.7 Illustration depicting decrescendo murmur as blood flows back into the right ventricle.

TREATMENT

SURGERY

- Valve replacement if symptomatic

PULMONARY STENOSIS

osms.it/pulmonic-stenosis

PATHOLOGY & CAUSES

- Pulmonary valve doesn't open fully; harder for right ventricle to pump blood to lungs
- Mechanical stress over time
  - Damages endothelial cells around valves → fibrosis, calcification → hardens valve, makes it more difficult to open fully
- Eccentric right ventricular hypertrophy: right ventricle must compensate for larger amount of blood volume due to backflow of blood

CAUSES

- Congenital malformation of leaflets
  - Associated with tetralogy of Fallot, Noonan's syndrome, congenital rubella
- Systemic disease (e.g. carcinoid disease)

RISK FACTORS

- History of rheumatic heart disease, heart surgery, or infective endocarditis

COMPLICATIONS

- Right-sided heart failure
  - Right ventricle cannot compensate for increased force required to push blood through valve

SIGNS & SYMPTOMS

- Initially asymptomatic
- Diastolic crescendo-decrescendo murmur: abnormal heart sound caused by turbulent blood flow through pulmonary valve that does not close properly; starts loud, quietens
- Ejection click: valve resists, then finally snaps open
- Appears often as right-sided heart failure

DIAGNOSIS

DIAGNOSTIC IMAGING

Echocardiogram

- Thickened leaflets, hard to see location of stenosis

TREATMENT

- Balloon valvuloplasty
- Valve replacement if symptomatic right-sided heart failure

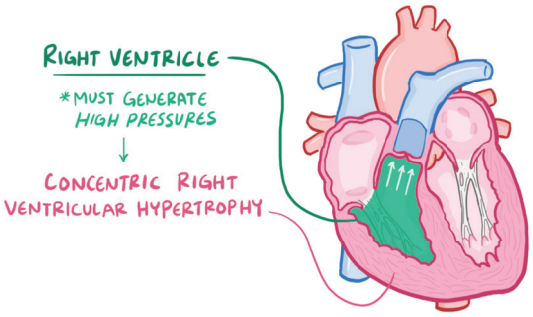

Figure 10.8 Illustration depicting hypertrophy of right ventricle due to increased blood pressure in the right ventricle.

TRICUSPID INSUFFICIENCY

osms.it/tricuspid-insufficiency

PATHOLOGY & CAUSES

- Cusps of valve prolapse during systole → blood backs up into right atrium.
- AKA tricuspid regurgitation

CAUSES

- Rheumatic heart disease
  - Most common cause
  - Autoimmune reaction involving valve leaflets → chronic inflammation → leaflet fibrosis → valve unable to form seal
- Myocardial infarction
  - Papillary muscles malfunction → destroyed papillary muscles can't anchor chordae tendineae → blood flows from right ventricle to right atrium
- Pulmonary hypertension
  - Increase in right ventricular pressure → dilates tricuspid valve → blood flows backward
- Congenital causes
  - Leaflets are displaced → difficult to form seal (e.g. Ebstein anomaly)
- Carcinoid syndrome
  - Fibrous tissue deposited on valves
- Myxomatous valve degeneration
- Infective endocarditis
- Trauma
  - Catheter insertion
  - Endocardial pacemaker insertion
  - Blunt chest trauma

RISK FACTORS

- Disease processes may cause pulmonary hypertension
- IV drug abuse

COMPLICATIONS

- Heart failure
  - Increased ventricular preload → eccentric ventricular hypertrophy → right ventricular failure
- Ventricular hypertrophy
  - Structural change in heart → annulus stretches → more blood leakage → worsens regurgitation

SIGNS & SYMPTOMS

- Holosystolic murmur
  - Movement of blood heard throughout systole
- Carvallo's sign
  - Murmur gets louder with inspiration due to negative pressure in chest, more blood backs up into heart
- S3, S4
- Signs of right-sided heart failure

DIAGNOSIS

DIAGNOSTIC IMAGING

Echocardiogram with Doppler

- Shows backflow

X-ray

- Shows right ventricular enlargement

TREATMENT

SURGERY

- Surgical repair/replacement if symptomatic

TRICUSPID STENOSIS

osms.it/tricuspid-stenosis

PATHOLOGY & CAUSES

- Valve unable to open completely during diastole.
- Valve leaflets fuse (commissural fusion) → narrowing of tricuspid valve → impaired blood flow from right atrium to right ventricle

CAUSES

- Rheumatic heart disease
  - Most common cause
  - Can occur with mitral regurgitation, aortic valve disease
- Congenital atresia, stenosis
- Pacemaker-induced fibrosis
- Cardiac tumors
- Infective endocarditis

COMPLICATIONS

- Increased right atrial volume, pressure → atrial dilation → blood backs up into venous circulation
- Dilation of right atrium → muscle walls stretch → pacemaker cells become irritable → increases risk of atrial flutter, fibrillation

SIGNS & SYMPTOMS

- Ejection click
  - Fibrotic valve makes distinctive snap
- Diastolic rumble
  - As blood is forced through small valve opening
- Increased ventricular preload → right ventricular failure → signs of congestion in venous system
  - Jugular venous distention (JVD) may cause some individuals to feel uncomfortable fluttering in neck

DIAGNOSIS

DIAGNOSTIC IMAGING

Echocardiography

- Assess degree of leaflet damage, flow across valve

OTHER DIAGNOSTICS

Cardiac catheterization

- Measure pressure in right side of heart

TREATMENT

SURGERY

- Balloon valvuloplasty, valve repair/ replacement

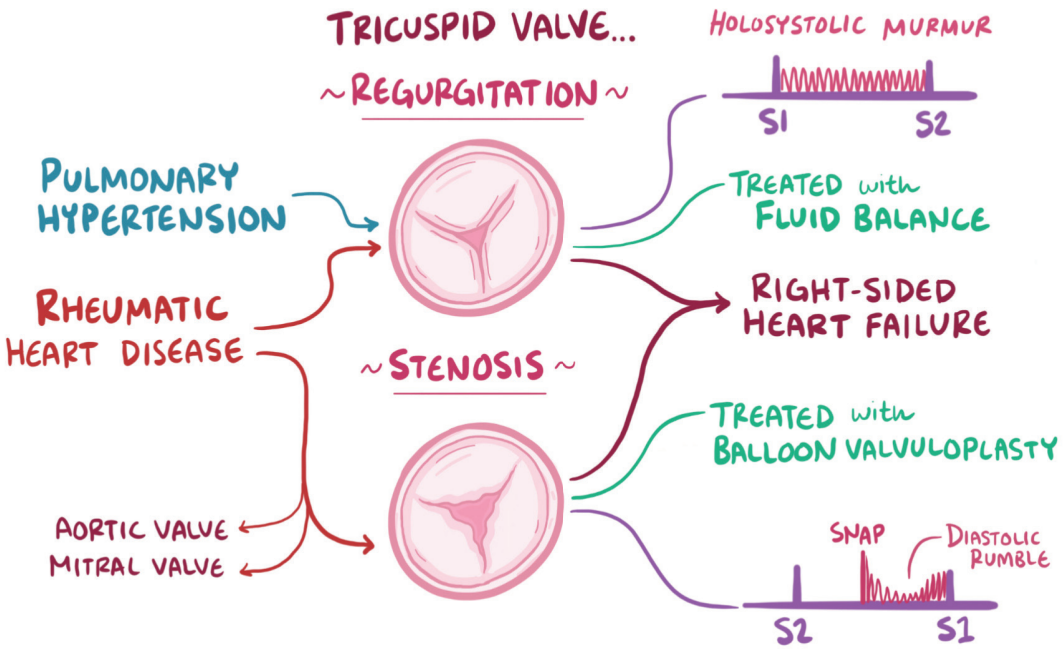

Figure 10.9 Illustration depicting differences between tricuspid valve regurgitation and tricuspid valve stenosis.

CHARACTERISTICS OF VALVULAR MURMURS

	MURMUR	LOCATION & RADIATION	OTHER FINDINGS
AORTIC STENOSIS	Harsh systolic crescendo-decresendo with ejection click	Upper sternal border → radiates to carotids	Paradoxical S2 split, S4, narrow pulse pressure
AORTIC INSUFFICIENCY	Early decrescendo diastolic	Left lower sternal border	de Musset's Sign, Quincke's sign
MITRAL INSUFFICIENCY	Holosystolic murmur	Apex; radiates to the back or clavicular area	Diminished S1, wide S2, S3 gallop
MITRAL STENOSIS	S2 with opening snap then low-pitched diastolic rumble	Left lateral decubitus position with bell	High left atrium pressure
MITRAL VALVE PROLAPSE	Midsystolic click → systolic murmur	Apex	Standing increases murmur, squatting decreases
PULMONIC INSUFFICIENCY	Crescendo-decrescendo	Left upper sternal border	N/A
PULMONIC STENOSIS	Diastolic crescendo-decrescendo	Right upper sternal border	Ejection click
TRICUSPID INSUFFICIENCY	Blowing holosystolic murmur	Left lower sternal border	Carvallo's sign, S3, S4
TRICUSPID STENOSIS	Diastolic rumble	Left lower sternal border	Ejection click