Lecture 4: VHD (Valvular Heart Disease)

🔷 ***Intro Section***

"Extra General Info" These are key foundational points about murmurs and types of cardiac overload.

1. **"Volume problem (eccentric hypertrophy)" → causes Systolic Heart Failure- s3 sound - regurge**
- *Volume overload* leads to **eccentric hypertrophy**, where the **ventricle dilates** (walls become thin and stretched).
- Because the heart can't **eject the extra volume**, this causes **systolic failure** (↓ EF, weak pump).

2. **"Pressure problem (concentric hypertrophy)" → causes Diastolic Heart Failure- s4 sound - stenosis**
- In **pressure overload**, the ventricle **thickens** (concentric hypertrophy), which makes it **stiff** and unable to relax.
- This causes **diastolic failure**: preserved EF but impaired filling.

3. **"Systolic murmurs can be physiological but diastolic murmurs are always pathological"**
- 💡 *Key clinical pearl*:
- Systolic murmurs may be **innocent** (e.g., in athletes, pregnancy).
- Diastolic murmurs are **always abnormal** and suggest structural valve disease.

🔴 ***Mitral Regurgitation (MR)***

"Regurgitating diseases" → MR (Mitral valve incompetence)

1. **Acute vs. Chronic MR**
- **Acute**: more severe, often due to **sudden valve rupture or ischemia**, and may **not have murmurs**.
- **Chronic**: allows time for LA adaptation, often **has murmurs**. (loud)

🔶 **Primary MR:**

- **"The problem is in the valve itself"**
- **Due to:**

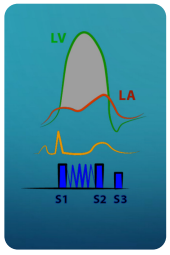
1. *Mitral Valve Prolapse* → most common cause.
2. *Rheumatic Fever* → damages chordae/papillary muscles.
3. ⚠️ **Extra note**: caused by *Streptococcus pharyngitis, Group A*.

🔷 **Secondary MR:**

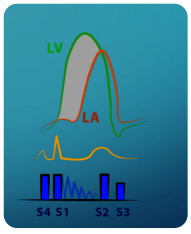
- Valve is structurally normal, but **dilated ventricles** (from heart failure or ischemia) pull valve leaflets apart.

1. *Dilated ventricles* (Functional MR)
2. *Ischemic post-MI MR* — papillary muscle dysfunction.

Chronic



Acute



🔷 **Hemodynamics of MR**

Two diagrams are shown for chronic vs acute MR:

- On the left: **Chronic MR**
- On the right: **Acute MR**

🟢 **Chronic MR:**

- LA **volume is large**, so pressure doesn't rise quickly → murmur is **long and loud**.
- Quote: "**Pressure gradient is high → Loud murmur**"

🔴 **Acute MR:**

- LA **has no time to adapt**, so pressure rises fast → **absent or soft murmur**
- Quote: the body is surprised by the amount of blood so pressure rises quickly , so the gradient difference is small which means absent or soft murmur

Clinical Features & Physical Signs

🔷 **Clinical Features**

🔹 **"Symptoms → mainly due to pulmonary congestion (dyspnea, orthopnea, PND, fatigue)"**

- These symptoms reflect **left-sided heart failure** because of blood backing up into the lungs.
- 💬 Let's break it down:
- **Dyspnea** = shortness of breath (first on exertion, then at rest).
- **Orthopnea** = difficulty breathing when lying flat (needs multiple pillows).
- **PND (Paroxysmal Nocturnal Dyspnea)** = sudden breathlessness at night that wakes the patient up.
- **Fatigue** = from reduced cardiac output.

🧠 All of this comes from elevated **left atrial pressure** → leads to **pulmonary venous hypertension**.

🔷 **Signs**

🔹 **"Apical displaced apex"**

- In chronic MR, the left ventricle enlarges → this pushes the **apex beat downward and laterally**.
- **Palpable on physical exam.**

🔹 **"S3 gallop"**

- Caused by **volume overload** → rapid ventricular filling during early diastole.
- Very characteristic of **MR or HF**.

🔹 **"Pansystolic murmur loudest at apex, radiates to axilla"**

- "Pansystolic" = murmur is heard **throughout systole**, from **S1 to S2**.
- **Location:** Loudest at **apex**.
- **Radiation:** Spreads to **left axilla** → classic clue for MR.

⊕ A-fib is common
⊕ unclear S2
⊕ unclear JVP.

🗂️ **Let's Organize These Signs in a Quick Table**

Feature	Description
Apical Displacement	Due to LV dilation from volume overload
S3 Gallop	Early diastolic sound, indicates increased volume
Pansystolic Murmur	Begins at S1, ends at S2; classic of MR
Murmur Radiation	Radiates to axilla due to direction of regurgitant jet

Investigations for MR

🔹 **CXR (Chest X-ray)**

"Shows pulmonary congestion, LA enlargement"

- **Pulmonary congestion** = hazy lung fields, Kerley B lines → due to backflow of blood into lungs.
- **LA enlargement** = might appear as a straightening of the left heart border or double right heart border.

🔹 **ECG**

"May show LA enlargement ± AF"

- **Chronic MR → LA enlargement → stretching of conduction fibers → Atrial Fibrillation (AF)**
- ECG signs of LA enlargement:
- Biphasic P wave in V1
- Wide, notched P waves in lead II ("P mitrale")

🔹 **ECHO (TTE → then TEE if unclear)**

"ECHO confirms diagnosis and severity"

- **TTE (Transthoracic Echo)** = First-line, non-invasive.
- **TEE (Transesophageal Echo)** = If TTE is unclear or for surgical planning.
- It evaluates:
- Size and function of LV and LA
- Valve leaflet motion
- Regurgitant volume
- Pulmonary pressure

🧠 **ECHO = gold standard** for evaluating valve pathology and severity.

💊 **Management of MR**

Now for treatment. This part is split into **Medical** and **Surgical**:

🔹 **Medical Treatment (when mild/moderate or not surgical candidate):**

"Control symptoms: diuretics, vasodilators, treat AF if present"

- **Diuretics** → relieve pulmonary congestion.
- **Vasodilators** → reduce afterload, reduce regurgitant volume (e.g. ACE inhibitors).
- **Rate/rhythm control** if **AF is present** → e.g., β-blockers, digoxin, anticoagulation if AF.

} → Symptomatic patients, if asymptomatic and preserved LV and absence of systemic HTN = no vasodilators.

IABP → Bridge for surgery

🔹 **Surgical Treatment:**

"Valve repair or replacement if symptomatic or LV EF ↓ or LV dilated"

🔸 **Indications for surgery:**

- **Symptomatic severe MR**
- **Asymptomatic with EF ≤60%**
- **Asymptomatic with LV dilation (LVESD ≥ 40 mm)**
- **New-onset AF or pulmonary hypertension**

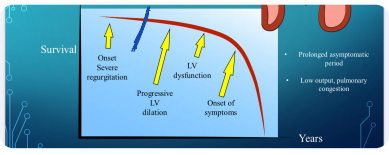
🧠 **Valve repair** is preferred over replacement if feasible — better survival, no need for lifelong anticoagulation.

Note: ClIP is prefered over surgery (for HF patients)

✅ **Summary Table: MR Investigation & Management**

Investigation	Purpose
CXR	Pulmonary congestion, LA size
ECG	LA enlargement, AF
ECHO (TTE/TEE)	Confirm MR, assess severity
Treatment	**Indications**
Medical	Symptom control (diuretics, ACEI, AF mgmt)
Surgical Repair	Severe MR, symptoms, LV dysfunction/dilation

* Best time to do surgery? as soon as the patient is diagnosed :



🟡 Aortic Regurgitation (AR)

🩸 Pathophysiology

Let's decode this line by line.

"Blood leaks back from aorta → LV during diastole"

- Normally, the aortic valve **closes during diastole** to prevent blood from returning to the LV.
- In AR, the valve is **incompetent**, so blood **leaks backward** → from **aorta → LV** → during **diastole**.

"Causes volume overload → eccentric hypertrophy → systolic HF"

- The LV now receives:
- Blood from **left atrium**
- **+ Regurgitant blood from the aorta**
- So total volume in LV = **↑↑**
- Result: LV **dilates** → **eccentric hypertrophy** → **↓ ejection efficiency** → **systolic heart failure**

🧠 *Same as MR — it's a volume overload lesion.*

🔍 Etiologies of AR

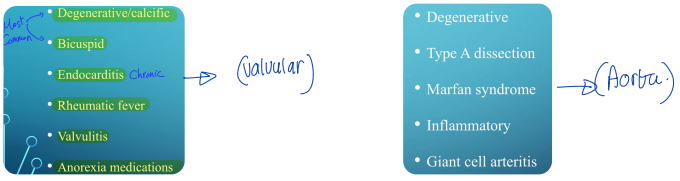
Let's break your handwritten list into **primary valve causes vs aortic root causes**:

1. Valve pathology:

- **Rheumatic fever**
- **Infective endocarditis**
- **Congenital bicuspid valve**

2. Aortic root pathology:

- **Marfan syndrome**
- **Aortic dissection**
- **Syphilitic aortitis** (rare but classic)



🧠 Aortic dissection causes **sudden severe AR**, especially type A.

🧠 **Let's build a quick classification table:**

Category	Examples
Valve causes	Rheumatic fever, endocarditis, bicuspid valve
Aortic root causes	Marfan syndrome, aortic dissection, syphilis

📈 Hemodynamics

"Increased LVEDV, ↑ SBP, ↓ DBP → widened pulse pressure"

Let's explain:

- **LVEDV (LV end-diastolic volume)** ↑ due to regurgitation
- **Systolic BP (SBP)** ↑ → strong contraction with high volume
- **Diastolic BP (DBP)** ↓ → blood leaks back to LV → pressure drops quickly
- Result = **Widened pulse pressure**
- Example: 160/50

🩺 This gives **bounding pulses**, which you'll see in signs below.

🔊 Clinical Features & Physical Signs of Aortic Regurgitation (AR)

🔹 "Symptoms: mostly due to LV failure"

- AR causes **volume overload → LV dilation → systolic failure**
- Symptoms = same as **left-sided heart failure**:
- Fatigue
- Dyspnea on exertion
- Orthopnea
- Paroxysmal nocturnal dyspnea (PND)
- Palpitations (from large stroke volume)

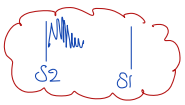
🔹 "Signs" – this is the GOLD section

Let's go one by one:

✅ **1. Early Diastolic Murmur (EDM)** (Decrescendo murmur) (the shorter the murmur = more severe)

"High-pitched, blowing, best heard at LSB, leaning forward, end expiration"

- **"Early diastolic"** = after A2 (aortic valve closure)
- **"Blowing"** = due to blood flowing backward into LV
- **Best heard at**: Left sternal border (3rd–4th ICS)
- **Leaning forward, full expiration** = brings aorta closer to chest wall → improves sound



🧠 This is the **hallmark murmur of AR**

✅ **2. Widened Pulse Pressure**

- Example: 160/50 mmHg
- High SBP (↑ stroke volume) + Low DBP (aortic leak)
- Causes **bounding pulses**

✅ **3. Corrigan's Pulse**
"Water-hammer pulse"
- Rapid upstroke, then quick collapse
- Can be seen in **radial or carotid pulse**

✅ **4. Quincke's Sign**
"Capillary pulsation in nails"
- Blanching and flushing when light pressure applied to fingernail

✅ **5. Musset's Sign**
"Head bobbing with each heartbeat"
- Seen in severe AR → transmitted bounding pulse to neck muscles

✅ **6. Duroziez's Sign**
"Systolic & diastolic bruit over femoral artery when compressed"
- Place stethoscope over femoral artery while applying pressure
- You'll hear both systolic & diastolic flow sounds

🧠 **Why all these weird signs?**
They all come from one thing: **a huge stroke volume + rapid diastolic runoff** = **hyperdynamic circulation**

🗂️ **Summary Table: Classic AR Physical Findings**

Sign	Description
EDM	High-pitched diastolic murmur at LSB
Widened PP	↑ SBP, ↓ DBP (e.g., 160/50)
Corrigan's pulse	Water-hammer pulse
Quincke's sign	Nailbed capillary pulsation
Musset's sign	Head bobbing
Duroziez's sign	Dual femoral artery murmur with compression

🔍 **Investigations and Treatment of Aortic Regurgitation (AR)**

🔬 **Investigations**

🔷 **Chest X-ray (CXR)**
"Shows LV enlargement ± aortic root dilation"
- In chronic AR, the **left ventricle dilates** due to volume overload.
- You may also see:
- Enlarged cardiac silhouette
- Prominent ascending aorta (if root is involved)

🔷 **ECG**
"Shows LVH"
- In **chronic AR**, the **LV muscle thickens** as it adapts.
- ECG signs of **LVH** include:
- Tall R waves in V5–V6
- Deep S waves in V1–V2
- LV strain pattern (ST-T changes)

🔷 **Echo (TTE, TEE if needed)** GS
"Confirm severity, LV size/function"
- **TTE** is the first-line test.
- It shows:
- Valve morphology
- Regurgitant jet (via Doppler)
- LV size and function
- Aortic root dimensions
- **TEE** is used:
- If TTE image quality is poor
- Or if endocarditis, aortic dissection, or pre-op assessment is needed

💊 **Medical Treatment**
"Control symptoms: Diuretics, vasodilators, ACEI"

Used in:

- **Chronic mild/moderate AR**
- **Inoperable patients**
- **Bridge to surgery**
- **Diuretics**: ↓ pulmonary congestion
- **Vasodilators (e.g. ACEI, nifedipine)**: ↓ afterload → ↓ regurgitation
- **Beta blockers**: *Avoid* in AR — they prolong diastole → more regurg!

So if : 1- asymptomatic, no LV dysfunction, no systemic HTN = no tx
2- asymptomatic , severe AR and LV dysfunction = vasodilators to relieve afterload
3- if symptomatic, severe AR = surgery
4- indications for surgery = surgery

🛠️ **Surgical Treatment**

"Valve replacement if symptomatic or LV EF <55%, or LVESD >50mm"

🧠 Indications for surgery:

- **Symptomatic severe AR**
- **Asymptomatic with ↓ LV EF (<55%)**
- **Asymptomatic with ↑ LV end-systolic dimension (LVESD >50 mm)**
- **Significant aortic root dilation (>50 mm)**

Surgical options:

- **Aortic valve replacement (AVR)**
- May be combined with **root replacement** (e.g. Bentall procedure) if needed

🧠 **Summary Table – AR: Investigations & Management**

Investigation	What it shows
CXR	LV enlargement, aortic root changes
ECG	LVH due to volume overload
ECHO	Regurgitant flow, valve anatomy, LV size
Treatment	**When to use**
Medical therapy	Mild cases, symptom control
Surgery (AVR)	EF <55%, LVESD >50mm, symptoms

💙 **Mitral Stenosis (MS)**

As always, I'll explain every line of your handwritten notes clearly, with logic and extra tools to help you truly master it.

🔷 **Pathophysiology**

"Mitral valve narrowing → obstructs LV filling → ↑ LA pressure → pulmonary HTN → RHF"

Let's break this sequence down step by step:

1. **Mitral valve becomes stenotic** → The opening between LA and LV is narrowed.
2. **LV can't fill easily during diastole** → Blood backs up in the LA.
3. **LA pressure increases** → Left atrium dilates and pressure pushes backward.
4. **Pulmonary venous congestion** → Leads to **pulmonary hypertension**.
5. **Chronic pressure in lungs** → right heart overload → Eventually causes **right heart failure (RHF)**

🧠 The **LV is usually normal size** and function in MS — the problem is **before it**.

🔷 **Causes**

"Rheumatic fever is #1 (esp in developing countries)"

- Rheumatic fever → **fibrosis + fusion of mitral valve leaflets**
- This is the most common cause worldwide.
- Others are rare (congenital MS, radiation, etc.)

📈 **Hemodynamics of MS**

"↑ LA pressure → pulmonary HTN → RVH, TR"

Let's chart this sequence:

Valve Event	Effect on Chambers
Mitral stenosis	↑ LA pressure
	→ Pulmonary congestion
	→ Pulmonary HTN
	→ Right ventricular hypertrophy (RVH)
	→ Functional tricuspid regurg (TR)

💡 **Bonus Concept:**

- **MS = pressure overload of LA → LA dilation**
- **If untreated → pulmonary vasculature remodeling → RV failure**

🔍 **Explanation:**

- **Mitral valve narrowing** = less space for blood to flow from LA to LV.
- This slows filling of LV in diastole, so **LA pressure increases** (↑ LAP).
- The LA backs up into **pulmonary veins → pulmonary hypertension (PHTN)**.
- Chronic PHTN stresses the **right side of the heart**, eventually causing **right heart failure (RHF)**.

🧠 *LV is usually unaffected in MS — it's a pre-LV problem!*

📝 **Your Note:**

"Cause: RF >> fibrosis of mitral valve"

🔍 **Explanation:**

- **RF = Rheumatic fever**, the most common cause worldwide.
- It leads to **thickening and fusion of leaflets**, especially at the **commissures**.
- Over time → **fixed, narrow valve opening**

📝 **Your Note:**

"↑ LAP → ↑ pulm v. pressure → pulm HTN → RVH + TR"

🔍 **Explanation:**

- Blood backs up from LA → pulmonary veins → pulmonary arteries → right ventricle.
- RV faces more pressure → **hypertrophies (RVH)**.
- RV dilation may stretch the tricuspid valve → **functional tricuspid regurgitation (TR)**.

🔁 **Let's Summarize This Cascade in a Flow Table:**

Pathological Step	Result
Mitral valve narrowing (MS)	↓ LV filling (diastolic flow obstruction)
↑ LA pressure	LA dilation
↑ Pulmonary venous pressure	Pulmonary congestion
↑ Pulmonary artery pressure	Pulmonary hypertension
↑ RV pressure load	RV hypertrophy → Tricuspid Regurgitation

Mitral Stenosis – Symptoms & Signs

* it will cause HF even though LV function is preserved.

📝 **Your Note:**

"Symptoms due to pulmonary congestion + ↓ CO"

🧠 **Explanation:**

- Blood can't flow easily from LA to LV → **LA pressure rises** → lungs get congested → You get:
- **Dyspnea** (most common)
- **Orthopnea**
- **PND**
- ↓ LV filling → **↓ cardiac output (CO)** → Leads to:
- **Fatigue**
- **Cold extremities**
- **Exercise intolerance**

(+) hemoptysis.

📝 **Your Note:**

"Signs → Malar flush, loud S1, opening snap, diastolic rumble"
Let's go one by one and explain them like a master:

🔹 **Malar Flush**

- Reddish-purple cheeks
- Due to **low cardiac output → vasodilation + CO_2 buildup**
- Classic in **young females** with chronic MS

🔹 **Loud S1**

- Mitral valve **slams shut** forcefully (because it's stiff but still mobile)
- **Earlier in disease** when valve is still pliable
- As disease progresses → S1 becomes **soft**

🔹 **Opening Snap (OS)**

- High-frequency sound after S2
- Comes from **forced opening of stiff mitral valve** during diastole
- **More severe MS = earlier OS**

🔹 **Mid-diastolic murmur (rumble)**

- **Low-pitched**, best heard at **apex**, with **bell of stethoscope**
- Occurs when blood tries to flow from LA → LV through narrow valve
- **↑ with exercise or lying left lateral**

🎧 **Quick Table of Auscultation in MS:**

Sound	What it means
Loud S1	Stiff valve slamming shut (early MS)
Opening Snap	Valve forced open (after S2)
Diastolic Rumble	Turbulent flow during diastole
Malar Flush	Vasodilation from low output (facial sign)

📋 **Mitral Stenosis – Investigations**

📝 **Your Note:**

"ECG → LAE ± AF"

🧠 **Explanation:**

- Chronic MS causes **left atrial enlargement (LAE)**:
- Because of constant pressure overload
- This stretched atrium may lead to:
- **Atrial fibrillation (AF)** — very common in MS
- On ECG:
- **LAE** → "P mitrale" (broad, notched P waves in lead II)
- **AF** → no clear P waves, irregularly irregular rhythm

📝 **Your Note:**

"CXR → LAE, pulm congestion, straight left heart border"

🧠 **Explanation:**

- **LAE** → causes visible bulge in left atrial appendage = **straightening** of left heart border
- **Pulmonary congestion**:
- Hazy vascular markings
- Kerley B lines
- Upper lobe diversion ("cephalization")

🧠 Classic exam image = straight left border + pulmonary edema

📝 **Your Note:**

"Echo → confirm diagnosis and assess severity"

🧠 **Explanation:**

- Echo is the **gold standard** for diagnosing and grading MS.
- What we see:
- Mitral valve thickening, calcification, fused commissures
- Valve area calculation (normal = 4–6 cm^2)
- **Severe MS = <1.5 cm^2**
- Pressure gradient between LA and LV

🧠 Echo can also assess:

- LA size
- Pulmonary pressures
- RV function
- Presence of thrombus (via TEE)

💊 **Mitral Stenosis – Treatment**

📝 **Your Note:**

"Treat AF: rate control, anticoagulation"

🧠 **Explanation:**

- AF is common in MS → may cause palpitations, syncope, emboli
- **Rate control**:
- β-blockers or digoxin (esp if heart failure)
- **Anticoagulation**:
- Needed if AF present to prevent **stroke**

- Always use **warfarin** (DOACs not reliable in MS with AF)

📝 **Your Note:**

"Symptom control → diuretics"

🧠 **Explanation:**

- **Diuretics** like furosemide help reduce:
- Pulmonary congestion
- Dyspnea
- They **do not treat the valve** — just manage volume overload

* Surgery:
1. Severe symptoms at rest or exercise
2. if Mild symptoms → consider a balloon although it's not curative.

📝 **Your Note:**

"Definitive → balloon valvotomy or valve replacement"

🧠 **Explanation:**

- **Percutaneous balloon mitral valvotomy (PBMV)**:
- Best for **young patients**, non-calcified valves
- Opens valve by stretching fused leaflets
- **Valve replacement**:
- If PBMV is contraindicated (calcified, thrombus, MR present)
- Requires lifelong anticoagulation (if mechanical valve)

🟢 **Summary Table – MS Investigation & Management**

Tool	Finding
ECG	LAE, ± AF
CXR	LA enlargement, straight LHB, pulmonary edema
Echo	Valve area <1.5 cm², LA pressure gradient
Treatment	**When to Use**
Diuretics	Symptom relief only
Rate control + warfarin	If AF present
Balloon valvotomy (PBMV)	Young, non-calcified valves
Valve replacement	Severe, calcified, or thrombus

🔴 **1. Aortic Stenosis (AS): General Overview**

It has 3 locations: 1️⃣Supravalvular 2️⃣Subvalvular 3️⃣Valvular (Most Common)

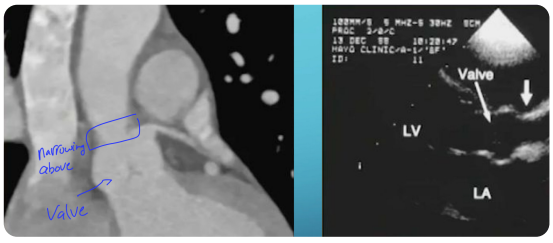
Location	Description
Supravalvular	Above the valve (in the ascending aorta) 🚗
Subvalvular	Below the valve (in the outflow tract) 🚽
Valvular	At the level of the valve itself (most common) 🩺

🅰️ **Supravalvular Aortic Stenosis**

Definition: Stenosis at the **level of the aorta** (not the valve!) 🎯 It is a **single discrete narrowing** with **long tubular hyperplasia** of the ascending aorta.

🔍 **Clinical Examination:**

- **On physical exam (PF):**
- **Thrills** felt at:
- **Suprasternal notch** 🦴
- Or **Right carotid artery** 🫀
- **Auscultation findings:**
- **Loud S2** 🔊
- **Systolic murmur** best heard over **right 2nd intercostal space (ICS)** 🎧
- **Special feature:** ✨
- **Ejection click** early in systole (🔊) → due to **sudden valve opening**



🛠️ **Management:**

- **Surgical**, and may need a **conduit** (prosthetic graft tube) if severe 🛠️

🅱️ **Subvalvular Aortic Stenosis**

Seen in ~10% of AS cases

📌 **Etiology:**

- A **discrete ridge** or **tunnel-like stenosis** below the aortic valve.
- Often associated with **Aortic Regurgitation (AR)** due to jet impact on valve.

🧪 **Diagnosis:**

- **Echocardiography (ECHO)**:
- **TTE** (Transthoracic) 🫀 first-line

- If unclear, use **TEE** (Transesophageal) 🔪

🛠️ **Treatment:**

- **Surgical resection**, especially if:
- **Severe**
- Or **AR is progressing** 🛠️

⚫ **Valvular Aortic Stenosis (Most Common Type)**

🧬 **Etiologies (Causes):**

Type	Notes
1️⃣ Degenerative	Due to aging (senile calcific AS) ⏳
2️⃣ Rheumatic	Seen in 40–60% of cases 🩸
3️⃣ Calcified bicuspid	~40–60% – congenital anomaly 🧬
4️⃣ Congenital	<30%, either **bicuspid** or **unicuspid** 👶👴

🟦 **Note:** Always **screen 1st degree relatives** for bicuspid valve 📸 You **must scan the whole aorta** if bicuspid valve is present!

🧪 **Hemodynamics:**

🧠 Wall tension = (Radius × Pressure) / (2 × wall thickness) 🫀 At early stages: LV **hypertrophies** → normalizes tension ⏳ Late stage: ↓ LVEF (left ventricular ejection fraction)

⚠️ **Clinical Features:**

Feature	Description
1	Pulmonary edema (due to ↑ LV pressure) 💧
2	Shortness of breath (SOB) 😮‍💨
3	**Angina** due to **↑ oxygen demand** to normalize LV pressure 💔➡️🫀
4	Syncope (especially during exertion) 😵

🎧 **Auscultation Signs:**

Sign	Meaning
1️⃣ Single or soft **S2**	**Softer = more severe** AS (valve can't close well) 🔇
2️⃣ Crescendo-decrescendo murmur	Classic systolic murmur 📈📉 radiating to carotid arteries
3️⃣ s4 gallop	Stiff LV, late diastolic sound 🔈
4️⃣ Pulsus parvus et tardus	Weak + delayed pulse ✋🕒

🧪 **Investigations:**

- **Echocardiography (ECHO)**: First-line for diagnosis
- **CT Scan**: To assess valve **calcium load** or **anatomy** for surgery

🛠️ **Treatment:**

Condition	Management
Asymptomatic + normal LV	No treatment required ❌
Symptomatic	**Surgical aortic valve replacement** (SAVR) 🛠️ or **TAVR** (Transcatheter Aortic Valve Replacement) for elderly

⚠️ In **young** patients: use **mechanical valves** 👴 In **elderly**: use **bioprosthetic valve (TAVR)**

🧠 **Signs of Severe Aortic Stenosis:**

Clinical Sign	Meaning
1️⃣ Late systolic murmur	Indicates higher severity 🔴
2️⃣ Single S2 sound	Suggests poor valve closure ➡️ soft sound 🔕

🟫 **Tricuspid Regurgitation (TR)**

🔄 **Definition:**

TR = Backward leakage of blood from the right ventricle (RV) into the right atrium (RA) during **systole**.
Why? Because the **tricuspid valve** doesn't close properly — so blood regurgitates (leaks) back when the RV contracts.

🧪 **Etiologies (Causes)**

Type	Cause/Example
🟥 **Functional TR**	Due to **RV dilation**, the valve annulus stretches.
No structural defect in the valve leaflets themselves.	
Often seen with:	

- Pulmonary hypertension
- Left heart failure

- RV infarction
- COPD | | 🟧 **Primary (organic) TR** | Structural problem in the valve leaflets. Examples:
- **Rheumatic heart disease**
- **Endocarditis** (especially in IV drug users)
- **Ebstein anomaly** (congenital)
- **Carcinoid syndrome** (serotonin damages right heart valves) |

🧠 **How TR Develops Mechanically:**

1. **Annular dilation** → valve can't close
2. Blood flows **back into RA during systole**
3. → RA dilates
4. → Leads to **right-sided heart failure**

📋 **Signs and Symptoms**

System Affected	Clinical Features
❤️ **Cardiac**	Fatigue, palpitations
🫁 **Pulmonary**	May be clear or mild congestion (not dominant)
🦵 **Systemic**	**JVD**, hepatomegaly, peripheral edema, ascites
👂 **Murmur**	**Holosystolic murmur** best heard at **left lower sternal border**, ↑ with inspiration (**Carvallo's sign**)

🎧 **Carvallo's Sign =** 🔊

- TR murmur gets **louder with inspiration**
- This helps distinguish it from **mitral regurgitation**, which does not increase with inspiration.

🧪 **Investigations:**

- **Echocardiography**: Main tool to evaluate valve structure and RV function
- **ECG**: May show signs of RA enlargement or RV strain
- **CXR**: Cardiomegaly, prominent RA/RV

🛠️ **Management:**

Case	Management
Mild/Moderate Functional TR	Treat the **underlying cause** (e.g., PH, LHF)
Severe or Primary TR	**Surgery** if symptomatic or progressive
Valve repair vs replacement	Depends on anatomy & severity

	MR	AR	AS	MS	TR	
Valve	Mitral	Aortic	Aortic	Mitral	Tricuspid	
Phase affected	Systole	Diastole	Systole	Diastole	Systole	
Mechanism	Blood leaks LV → LA	Blood leaks Aorta → LV	Obstruction LV → Aorta	Obstruction LA → LV	Blood leaks RV → RA	
Overload type	Volume	Volume	Pressure	Pressure	Volume	
Hypertrophy	Eccentric	Eccentric	Concentric	Concentric	Eccentric (secondary)	
Heart Failure	Systolic	Systolic	Diastolic	Diastolic	Right-sided	
Most common cause	MVP, Rheumatic	Bicuspid, Endocarditis, Marfan	Degeneration (aging), Bicuspid	Rheumatic Fever	Pulm. HTN, RV dilation	
Key symptoms	SOB, PND, palpitations	SOB, fatigue, palpitations	Angina, Syncope, Dyspnea	SOB, Hemoptysis, Palpitations	Fatigue, edema, hepatomegaly	
Key signs	S3, AFib	Corrigan, Quincke, wide PP, S3	Parvus et Tardus, S4	Loud S1, Opening Snap	JVP v-wave, Carvallo's sign	
Murmur type	Pansystolic	Early diastolic decrescendo	Crescendo–decrescendo	Mid-diastolic	Pansystolic	
Murmur heard at	Apex → axilla	LSB (best at 2nd–4th ICS)	2nd RICS → carotids	Apex	LLSB (↑ with inspiration)	
ECG findings	LAE, AFib	LVH	LVH	LAE, AFib	RA dilation	
Echo role	Severity + repair plan	Severity + aortic root	Valve area + gradient	Valve area + gradient	Valve structure + severity	
Best test (Dx)	TTE + Doppler	Echo	Echo ± CT	Echo	Echo	
Medical Tx	Vasodilators (if symptomatic)	Vasodilators (if ↓ EF)	None if asymptomatic	Balloon if mild, anticoag if AF	Diuretics, treat underlying cause	
Surgical indications	Severe + EF <60% or symptoms	Severe + EF <50% or symptoms	Symptomatic or severe	Severe MS, symptoms	Severe symptoms, failed diuretics	
Surgical options	Repair > Replacement	AVR	AVR or TAVR	Surgery or balloon	Repair / Replace if left-side op	

Percutaneous option	Mitral clip	TAVR (elderly/high-risk)	TAVR	Balloon commissurotomy	No device (remove lead if cause)
EF cutoff for surgery	<60%	<50%	Not fixed (symptoms-based)	Not EF-based	Not EF-based