AUSCULTATORY FINDINGS IN PROSTHETIC HEART VALVES

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I MECHANICAL VALVES (THE "CLICKS")

- **Core Acoustic Principle:** Mechanical prosthetic valves (bileaflet such as St. Jude Medical/On-X, tilting-disc such as Medtronic-Hall/TTK Chitra, and historical caged-ball such as Starr-Edwards) generate sharp, high-frequency, metallic opening and closing clicks produced by the occluder impacting the valve housing or struts.

A Mitral Position (MVR)

- **Closing Click (CC):** Coincides with the first heart sound (S1); it is sharp, metallic, and substantially louder than a native S1, often palpable at the apex.
- **Opening Click (OC):** Occurs in early diastole (0.07 to 0.11 seconds after A2, analogous to the timing of a mitral Opening Snap). In modern bileaflet valves, the closing click is louder than the opening click.
- **Murmurs:**
  - **Normal:** A soft, short Grade 1 to 2/6 mid-diastolic rumble/flow murmur at the apex (best heard in the left lateral decubitus position) is physiological due to the inherent transvalvular gradient across the prosthetic sewing ring, and a soft early-to-mid systolic aortic outflow murmur may also be heard.
  - **Abnormal:** A holosystolic (pansystolic) apical murmur in a mechanical mitral valve is pathological and indicates significant Paravalvular Leak (PVL) or transvalvular regurgitation from incomplete disc closure (thrombus or pannus).

B Aortic Position (AVR)

- **Opening Click (OC):** Occurs in early systole immediately after S1 (analogous to an aortic ejection click), separated from S1 by a brief interval.
- **Closing Click (CC):** Coincides with the aortic component of the second heart sound (A2); it is loud, crisp, high-pitched, and frequently audible with the unaided ear.
- **Murmurs:**
  - **Normal:** A Grade 2 to 3/6 harsh, early-to-mid peaking systolic ejection murmur at the right upper sternal border radiating to the carotids is normal in all mechanical aortic valves due to turbulent forward flow across the prosthetic frame. (Note: Historical caged-ball Starr-Edwards valves may also produce a soft diastolic rattle, whereas modern bileaflet and tilting-disc aortic valves have minimal closing backflow not audible as a diastolic murmur.)
  - **Abnormal:** An early decrescendo diastolic blowing murmur along the left sternal border is abnormal in modern mechanical and bioprosthetic aortic valves and indicates pathological aortic prosthetic or paravalvular regurgitation.

II BIOPROSTHETIC VALVES (THE "NATURAL" SOUNDS)

- **Heart Sounds:** Stented or stentless tissue valves (bovine pericardial or porcine aortic) have flexible leaflets; therefore, S1 and S2 sound indistinguishable from native heart sounds with no metallic clicks.
- **Mitral Position:** Normal S1 and S2; a soft Grade 1 to 2/6 mid-diastolic rumble at the apex may be audible, particularly at higher heart rates, because the stented frame has a smaller effective orifice area than a native mitral valve.
- **Aortic Position:** Normal S1 and S2 accompanied by a soft Grade 1 to 2/6 early-peaking midsystolic ejection murmur at the base. Any diastolic murmur in a bioprosthetic aortic valve or holosystolic murmur in a bioprosthetic mitral valve is abnormal.

Valve Type & Position	Normal Closing Sound	Normal Opening Sound	Normal Flow Murmur	Pathological / Red-Flag Findings
Mechanical Mitral (MVR)	Loud metallic S1 (CC louder than OC)	Crisp metallic early diastolic OC (0.07–0.11 s post-A2)	Soft Grade 1–2/6 mid-diastolic apical murmur	Muffled/absent clicks; holosystolic apical murmur (PVL/stuck disc)
Mechanical Aortic (AVR)	Loud metallic A2 (CC louder than OC)	Metallic early systolic OC just after S1	Grade 2–3/6 mid-systolic ejection murmur	Muffled/absent clicks; early diastolic murmur (AR/PVL); late-peaking Grade 4+ systolic murmur
Bioprosthetic Mitral	Normal tissue S1 (no click)	Usually silent (rarely soft mitral OS)	Soft Grade 1–2/6 mid-diastolic murmur	New apical pansystolic murmur (cusp tear/flail or PVL)
Bioprosthetic Aortic	Normal tissue A2 (no click)	Usually silent (no click)	Grade 1–2/6 early systolic murmur	Early diastolic murmur (structural degeneration/PVL) or harsh late-peaking systolic murmur

III ABNORMAL FINDINGS: RED FLAGS FOR PROSTHETIC DYSFUNCTION

- **Muffling, Variability, or Loss of Metallic Clicks:** The single most critical auscultatory red flag in a mechanical valve, indicating Prosthetic Valve Thrombosis (PVT), pannus ingrowth, or endocarditis vegetation restricting occluder motion. Shortening of the A2-to-Mitral Opening Click (A2-OC) interval (to less than 0.06 seconds) also indicates elevated left atrial pressure from prosthetic mitral obstruction or severe regurgitation.
- **New Regurgitant Murmurs:**
  - **Mitral Position:** A new apical pansystolic murmur signifies Paravalvular Leak (PVL) (suture dehiscence) or acute structural valve deterioration (cusp tear/perforation in a bioprosthesis). Note that severe occult mitral PVL may occasionally be acoustically silent or soft if the jet is eccentric and directed posteriorly into a compliant left atrium.
  - **Aortic Position:** A new high-pitched blowing early diastolic murmur at the left sternal border signifies aortic PVL or bioprosthetic cusp prolapse/perforation.
- **Progression of Systolic Stenosis Murmur:** A harsh systolic aortic murmur that becomes progressively louder (Grade 3/6 or greater), longer, and late-peaking with a softened A2 closing sound suggests Prosthetic Aortic Stenosis (thrombosis, pannus, or calcific bioprosthetic degeneration).

IV DYNAMIC AUSCULTATION AND POSITIONAL MANEUVERS

- **Mitral Prosthesis:** Clicks and diastolic flow murmurs are best auscultated at the cardiac apex using the diaphragm (for high-frequency clicks and holosystolic PVL) and bell (for low-pitched mid-diastolic rumbles) with the patient in the left lateral decubitus position.
- **Aortic Prosthesis:** Clicks, systolic ejection murmurs, and abnormal early diastolic regurgitant murmurs are best auscultated at the right upper sternal border and Erb point (left 3rd intercostal space) with the patient sitting up, leaning forward, in held end-expiration.

V PRACTICAL CONSIDERATIONS IN THE INDIAN CLINICAL CONTEXT

- **High Rheumatic Mechanical Valve Burden:** Because a large proportion of Indian patients undergo valve replacement at a young age for Rheumatic Heart Disease, mechanical valves (including the indigenous tilting-disc TTK Chitra valve and bileaflet prostheses) are widely implanted. Serial documentation of crisp metallic clicks at every clinic visit is essential for early bed-side detection of valve obstruction.
- **Hyperdynamic Confounders (Anemia and Pregnancy):** Severe nutritional anemia, pregnancy, or thyrotoxicosis creates a high-output hyperdynamic state that accentuates normal physiological systolic and diastolic prosthetic flow murmurs (and elevates Doppler gradients on TTE); auscultatory and echocardiographic findings must always be correlated with hemoglobin levels and heart rate.
- **Muffled Click as an Acute Emergency:** In patients with erratic INR monitoring or drug non-adherence, a newly muffled or absent prosthetic click with dyspnea must be managed as an acute emergency (Obstructive Prosthetic Valve Thrombosis) requiring immediate Cine-Fluoroscopy and TTE/TEE.
- **Prosthetic Valve Endocarditis (PVE) Vigilance:** Any patient with a prosthetic valve presenting with unexplained fever and a new regurgitant murmur must have at least three sets of blood cultures drawn from separate venipuncture sites prior to empirical antibiotics and undergo prompt Transesophageal Echocardiography (TEE) (Class I) to evaluate for PVE and perivalvular abscess.

KEY REFERENCES

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