THE CARDIAC EXAM

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Medicine Clerkship

LEARNING OBJECTIVES

- Define the Mechanism of Generation, Clinical Significance and Best Listening Areas for:
  - S1/S2
  - S2 Splitting Patterns
  - S3/S4
  - Ejection Clicks (Early and Mid)
  - Opening Snap
- Describe the Grading System for Murmurs
- Compare and contrast the location, pattern of radiation, timing, pitch, shape, quality, and response to common physiologic maneuvers of several murmurs

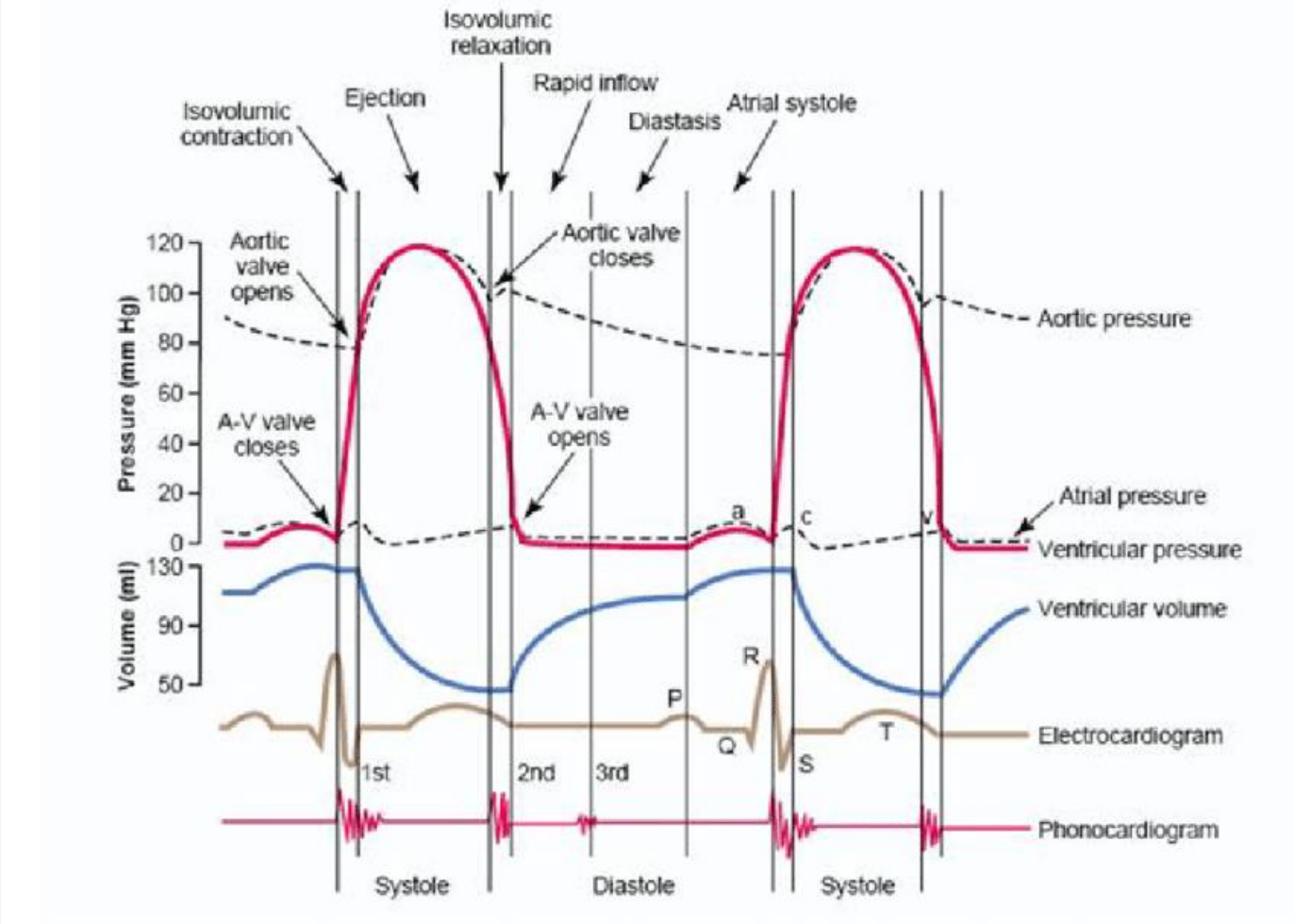
KEYS TO THE CARDIOVASCULAR EXAM

- Stand on the right side of the patient
- Only auscultate over skin, never over clothing
- Quiet room

RULES OF THUMB

- "Benign Murmurs" = S's: short, soft, systolic
- Diastolic Murmurs = Bad
  - ARMS (Aortic Regurgitation, Mitral Stenosis)
- Left-Sided Sounds are Louder than right-sided murmurs
- Right-Sided Sounds increase with inspiration (except PS)
- Intensity does not = severity of valve lesions (ex VSD), but timing does!
- Remember the company the murmur keeps

GENERATING HEART SOUNDS



GENERATING HEART SOUNDS

- S1 = T1+M1
  - Closure of tricuspid and mitral valves
- S2 = P2+A2
  - Closure of pulmonic and aortic valves.

GENERATING HEART SOUNDS, CONTINUED

- Gallops can be right or left-sided
- Best heard with the bell
- Auscultate over PMI for L-sided gallops
- Auscultate over Xiphoid process for R-sided gallops
- "Summation" Gallop = in tachycardia when S3/S4 are heard together, may be louder than S2.

S3

- Blood being "sucked" into the ventricle
- Heard in Sys-Tol-Ic dysfunction
  - Acute MI
  - Dilated Cardiomyopathy
  - Increased volume of ventricular flow (ex MR, AI, VSD, PDA)
  - May be normal in young people, athletes, third trimester of pregnancy
  - "Sloshing In"
  - "Kentucky"
- May be heard every few beats
- Cannot be heard with mitral stenosis (due to tight mitral valve)

S4

- Atrial Kick
  - Heard in Di-A-Stol-Ic dysfunction
  - "A Stiff Wall"
  - "Tennessee"
- Heard post-MI
- May be heard in acute MR (not chronic, with LA enlargement)
- May be heard with first degree AV block

EJECTION SOUNDS

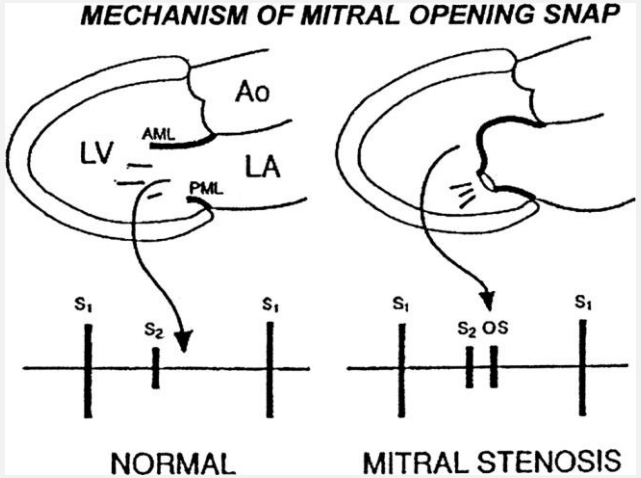
- Rarely the valves can be heard opening (onset of ventricular systole)
- Sounds close to physiologic splitting of S1
- Due to "doming" of the aortic valve
- Aortic Opening Sound:
  - Best heard over the apex or over the aortic area
- Pulmonic Opening Sound:
  - Best heard over L second intercostal area
  - Respiratory variation (decrease with inspiration)

MITRAL VALVE PROLAPSE

- Mid-systolic prolapse of the mitral (+/- tricuspid) valve leaflets into the left atrium
- Often accompanied with mid-late systolic murmur
- Systolic Click can also be heard with:
  - Marfan Syndrome
  - Ostium secundum ASD
  - Papillary Muscle dysfunction

OPENING SNAP OF MITRAL STENOSIS

- Similar to aortic ejection sounds: occurs due to "doming" of the MV leaflets
- The closer the opening snap is to S2 = delayed opening of the MV = more severe mitral stenosis.



DETERMINING S1

- Usually louder over the apex

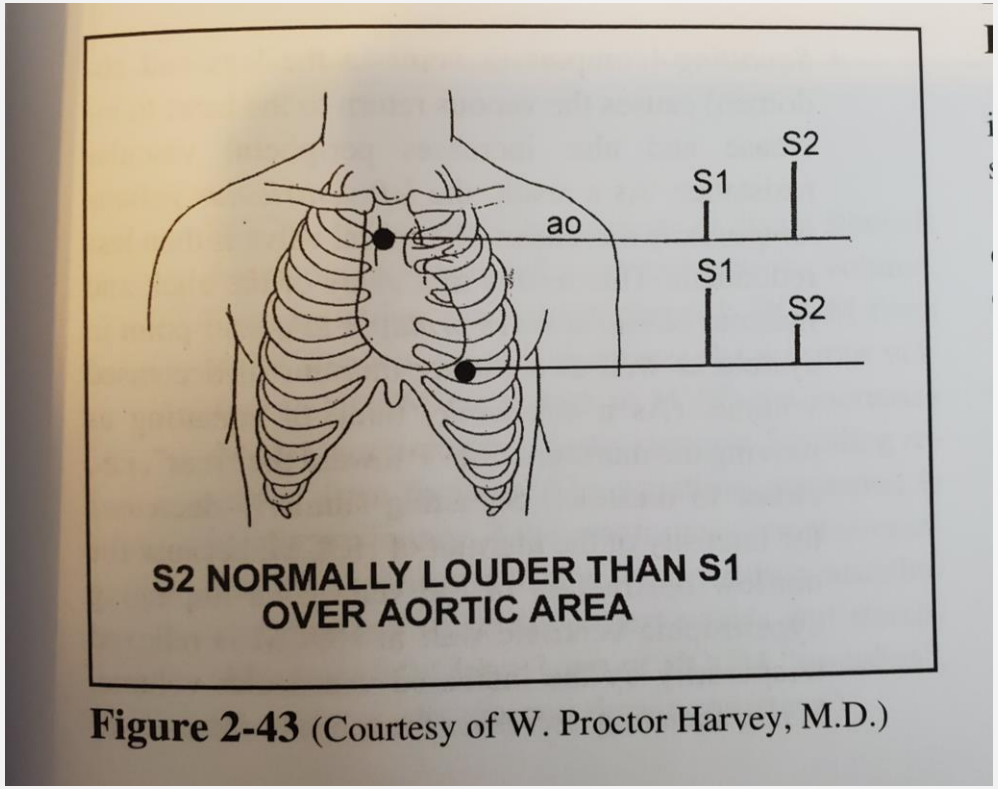


Figure 2-43 (Courtesy of W. Proctor Harvey, M.D.)

S1 IS LOUDER WHEN

- Increased ventricular contraction
- Increased rate of pressure generation in the ventricle
- Heart is closer to the chest wall.
- Hyperdynamic states

- Rheumatic Mitral Stenosis = Loud S1
  - Due to elevated LAP
- Short PR interval on ECG = Loud S1
  - Due to the MV leaflets being wide apart when the QRS hits
- Mitral Valve Prolapse

S1 IS SOFTER WHEN

- Prolonged PR
  - Leaflets are already almost closed when QRS hits
- Acute, Severe AI
  - LV diastolic pressure rises quickly -> premature closure of the mitral valve leaflets
- MR due to lack of leaflet mobility
- Chest configuration reduces auscultation:
  - Emphysema
  - Obesity
  - Large breasts
  - Pericardial Effusion

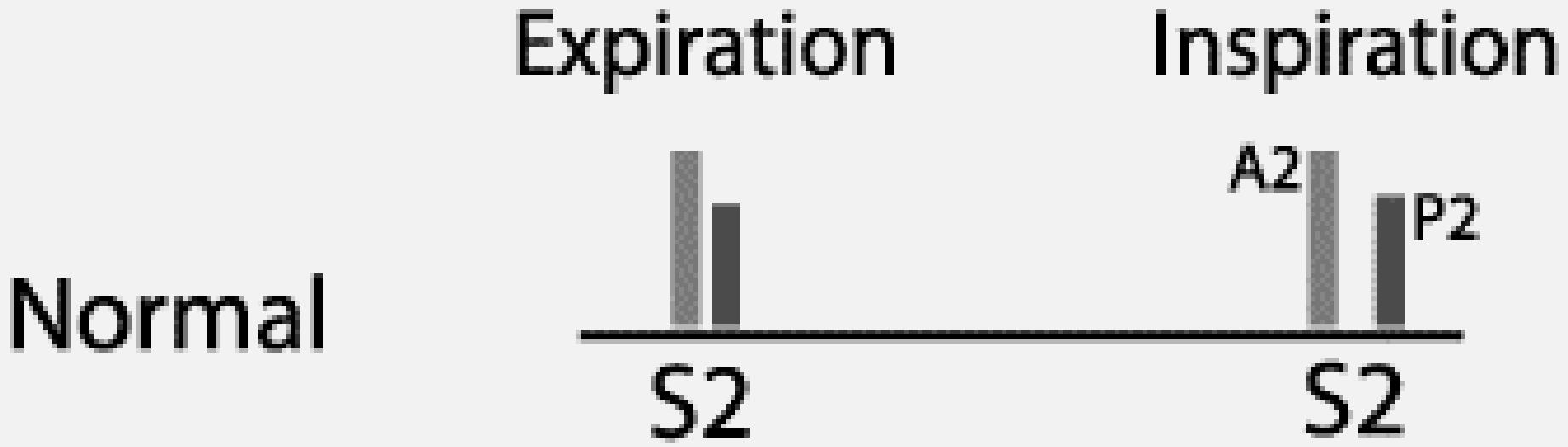
VARIABLE S1: AV DISSOCIATION

- Atrial Fibrillation
- Complete Heart Block
- VT

PHYSIOLOGIC SPLIT HEART SOUNDS

- With Expiration A2 and P2 occur at the same time
- With Inspiration there is increased filling on the right side of the heart, and thus a delay in closure of P2.

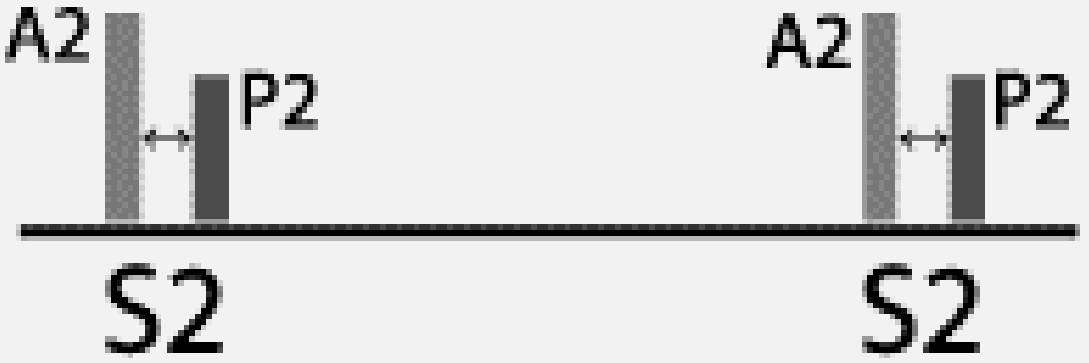
- In patients over age 50 the split sound may be indistinguishable due to LV dysfunction and some degree of AS


Expiration
Inspiration
A2
P2
Normal
S2
S2

FIXED SPLIT HEART SOUNDS

- ASD: Right to left shunting
  - Higher cardiac output through the R sided valves
  - Persistent delay in P2

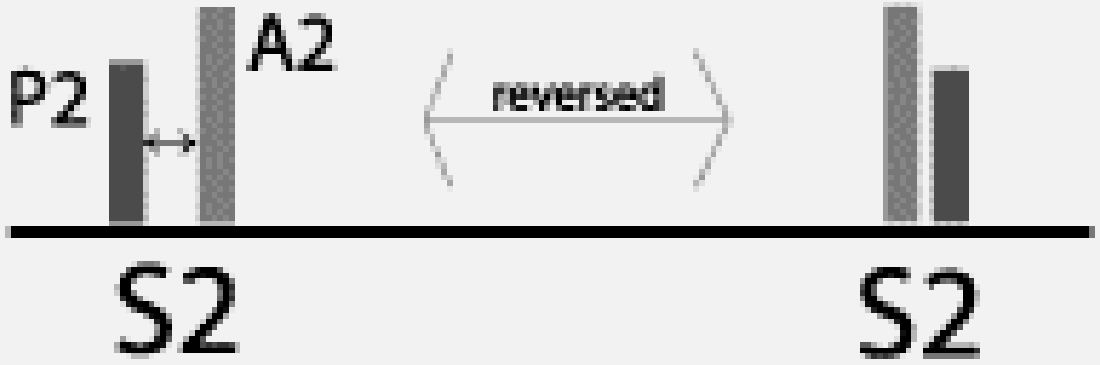
Fixed Splitting



PARADOXICAL SPLITTING

- A2 is slow to occur, P2 remains stable
  - LV is slower to contract (as in LBBB)
  - Increased resistance for the LV (AS, HTN)

Paradoxical Splitting



PERSISTENT SPLITTING

- P2 is always delayed, but more delayed with inspiration
  - RBBB (LV is delayed)
  - Pulmonic Stenosis

Wide Splitting

LOUD P2

- Pulmonary Hypertension

LOUD A2

- Systemic Hypertension

FAINT A2

- Aortic Stenosis
- Faint P2 with pulmonic stenosis

GRADING MURMURS

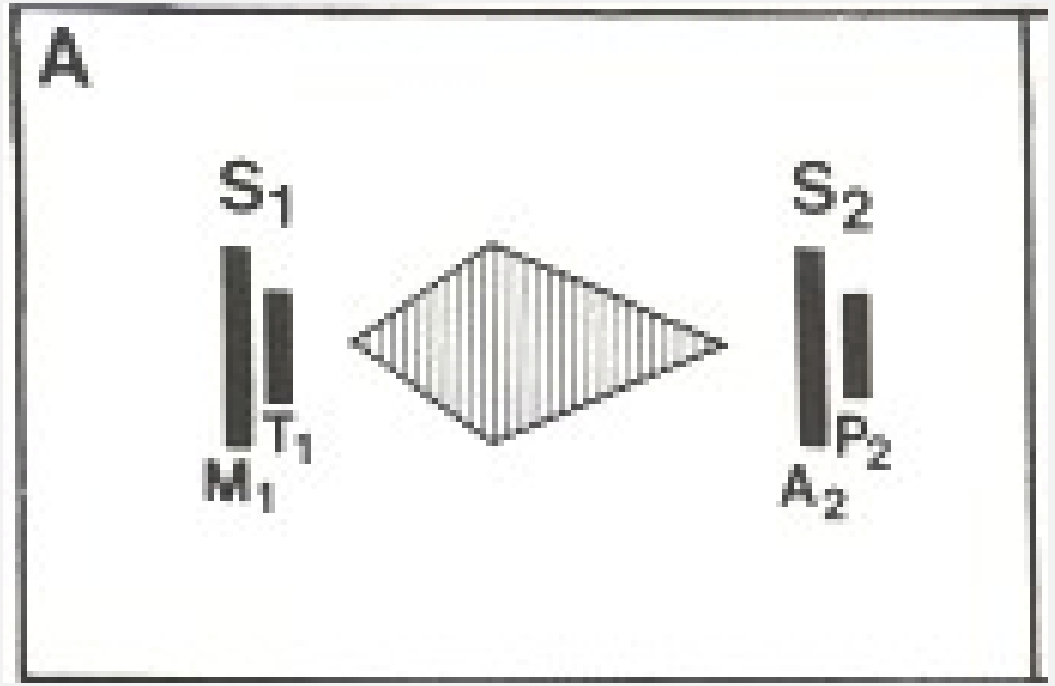
Grade	Description
1	Faintest murmur, heard only with special effort
2	Faint murmur, but heard immediately
3	Moderately loud murmur
4	Loud murmur associated with palpable thrill
5	Very loud murmur heard with part of stethoscope touching chest wall
6	Loudest murmur heard with stethoscope removed from chest wall.

PHYSICAL EXAM MANEUVERS

Maneuver	Physiologic Effect	Murmurs Affected
Passive Leg Raise	Increase venous return -> Increase Preload	Decreases HCM murmur
Squatting	Compresses leg veins -> increased venous return, increased afterload	Delays MVP click and shortens murmur Decreases HCM murmur ("Squashes MVP") Increases AS murmur intensity
Valsalva	Increases intrathoracic pressure -> decreased preload	Moves MVP earlier in systole Increases HCM
Standing	Blood pools in legs -> Decreases preload	Increases HCM Decreases AS murmur intensity
Isometric Hand Grip	Increases peripheral vascular resistance	Increases MR murmur Increases VSD murmur Increases AI murmur

SYSTOLIC MURMURS

SYSTOLIC EJECTION MURMUR



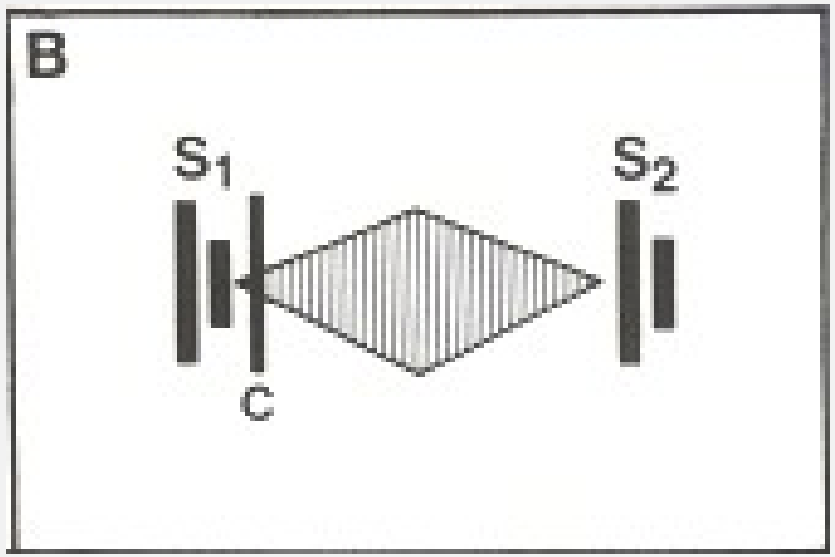
- Early-peaking

AORTIC STENOSIS

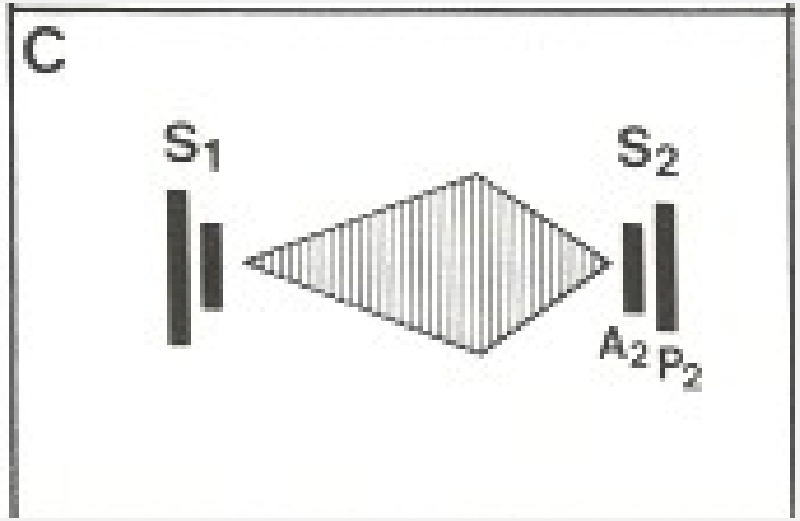
- Systolic
- Radiates to carotids (especially R Supraclavicular Region)
- Louder with increased flow:
  - Following a pause after a premature beat ("post-extrasystolic")
  - Passive leg raise
  - Squatting
- Associated with "pulsus parvus et tardus" (Slow Rising, Late Peaking)
- Gallavardin Phenomenon = musical quality radiation of the AS murmur to the apex.

GRADING AS SEVERITY

- Mild AS: systolic murmur ends before S2
- Moderate AS: Murmur peaks LATER in systole. Delay in A2
- Severe AS: Paradoxical splitting of S2 (versus absent S2).

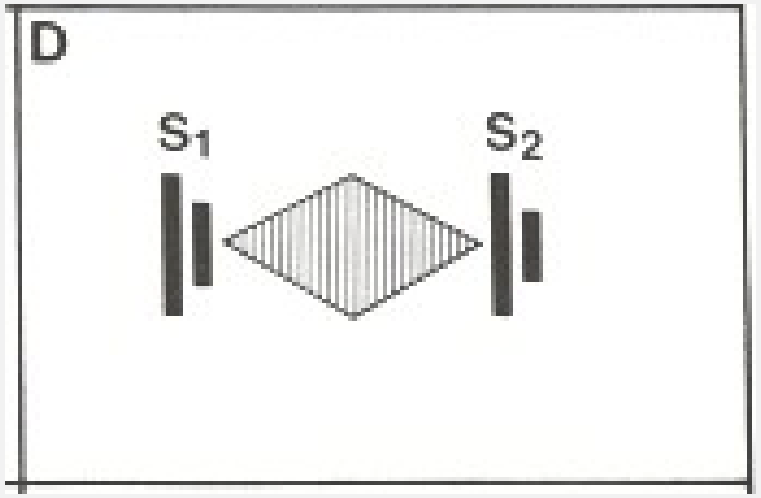


Mild Aortic Stenosis. C = opening click



Severe Aortic Stenosis

HYPERTROPHIC CARDIOMYOPATHY



- Maneuvers:
  - Lounder with standing
  - Louder during Valsalva
  - Softer with squatting
  - Softer with passive leg raise
- Associated with "Triple Ripple" on palpation over the apex
- "Spike and dome" pulse (Quick rising, twin-peaking)

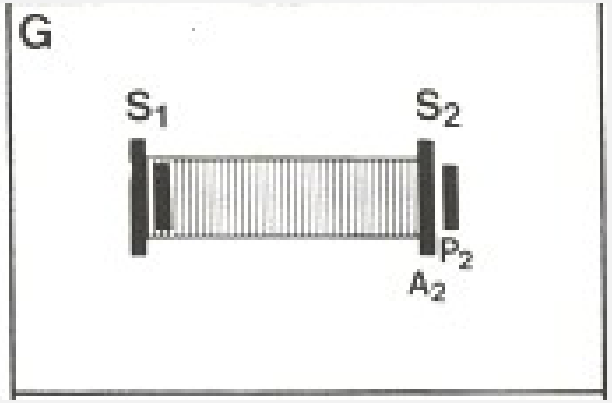
HOLOSYSTOLIC MURMUR?

- Chronic MR
- TR
- VSD

- And it is usually chronic MR…

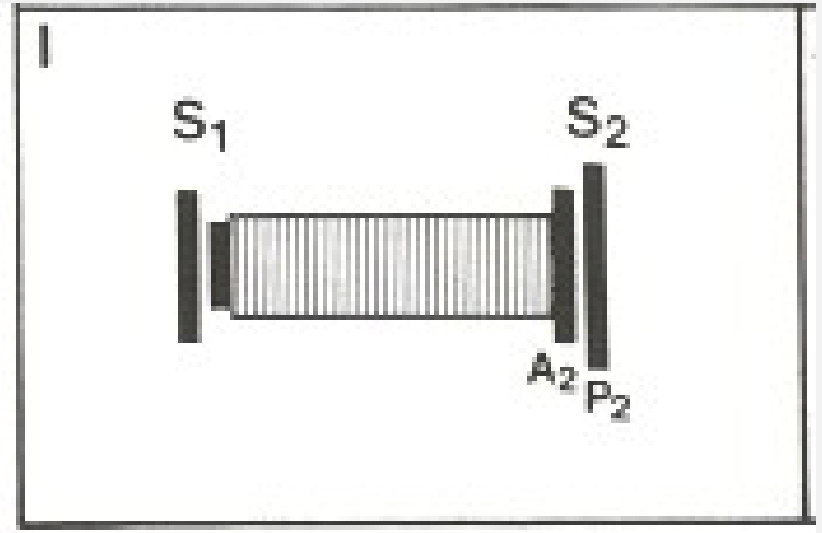
MITRAL REGURGITATION

- Holosystolic, heard best at the apex
- Louder with squatting or isometric handgrip
- Chronic MR: The left atrium has enlarged to accommodate
- Acute MR:
  - Decreasing intensity later in systole
  - Expect some degree of pulmonary edema
- Mild MR: systolic murmur
- Moderate MR: Add an S3 gallop
- Severe MR: Diastolic flow rumble.
- May radiate to the back (if there is prolapse of anterior MV leaflet)



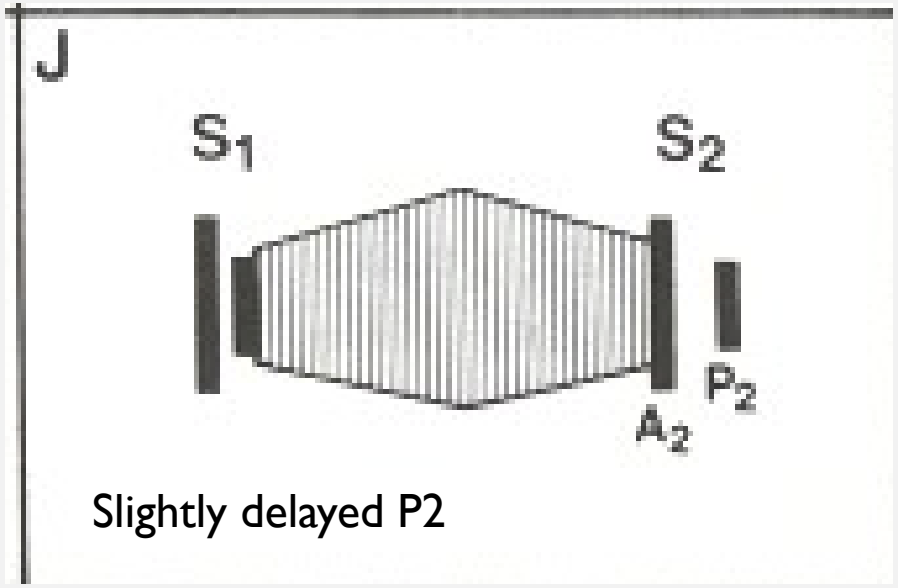
TRICUSPID REGURGITATION

- Holosystolic murmur
- Heard over LLSB
- Caravello's Sign: Louder with inspiration



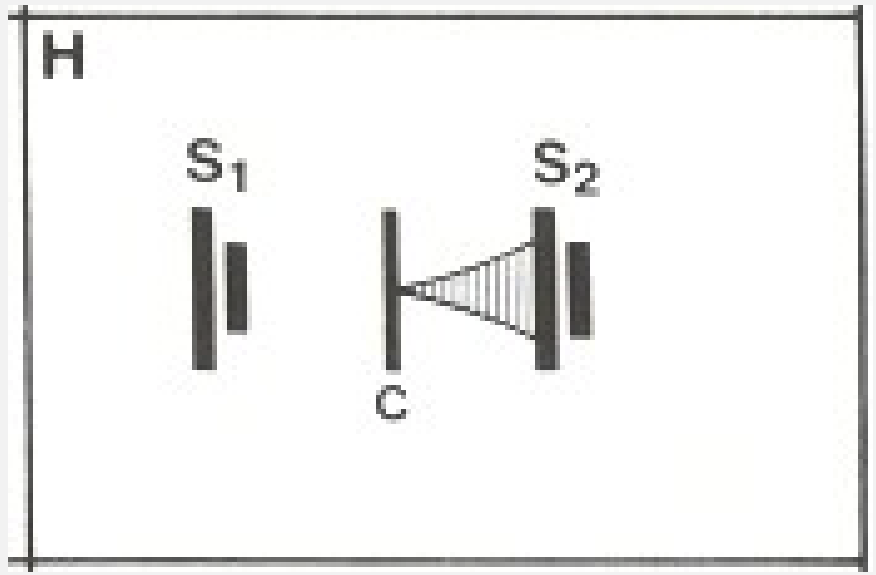
VENTRICULAR SEPTAL DEFECT

- Holosystolic murmur
- Heard best along left sternal border
- Louder with isometric handgrip.



MITRAL VALVE PROLAPSE

- Midsystolic Click moves towards S1 and late systolic murmur starts earlier with standing
- Click moves earlier on inspiration
- Murmur starts later and click moves towards S2 with squatting



DIASTOLIC MURMURS

Always bad.

ARMS

- Early Diastolic Murmurs
  - Aortic and pulmonic regurgitation
- Mid/Late Diastolic Murmurs
  - Mitral and tricuspid stenosis
- Combined Systolic and Diastolic Murmurs:
  - PDA
  - Coronary AV fistula
  - Pulmonary AV fistula
  - Ruptured Sinus of Valsalva aneurysm

AORTIC REGURGITATION

- High frequency
- Decrescendo
- “Blowing” in character
- Easily disguised by ambient noise
- Press the stethoscope in tight to the patient’s skin
- Louder with sitting upright and leaning forward
- Louder with sudden squatting and isometric handgrip

AUSTIN-FLINT MURMUR

- Severe AI
- “Low-pitched rumble at the apex in mid-late diastole”
- Occurs due to the severe AI jet affecting the anterior mitral valve leaflet.
- Severe AI causing mitral stenosis
- Board question favorite!!!!

ACUTE AORTIC DISSECTION

- Unlike acute valvular disease, this AI murmur is heard best over the third right intercostal space (va**L**vu**L**ar AI is heard over the **L** sternal border)
- Alternatively: AI due to the aortic **R**oot occurs on the **R** sternal border

PULMONARY REGURGITATION

- Usually seen in the setting of congenital heart disease vs pulmonary hypertension

MITRAL STENOSIS

- Louder with inspiration
- May require patient being in L lateral decubitus position.
- A2 -> P2 -> Opening Snap
- Earlier opening snap = higher left atrial pressure

CONTINUOUS MURMURS

PDA

- “Machine-like”
- Best heard at the firsta nd second L intercostal space
- Diastolic phase is louder with isometric handgrip

VENOUS HUM

- Heard over R IJ
- Heard in:
  - Children
  - Young adults
  - Pregnancy
  - Thyrotoxicosis
- Due to low RA pressure

NECK VEIN ASSESSMENT

- Internal Jugular Vein does not have valves
- Officially: RAP (in cm water) = 5 + the height from sternal angle to top of water column.
- Patients with very high RAP need to be more upright
- Patients with low RAP need to be more supine

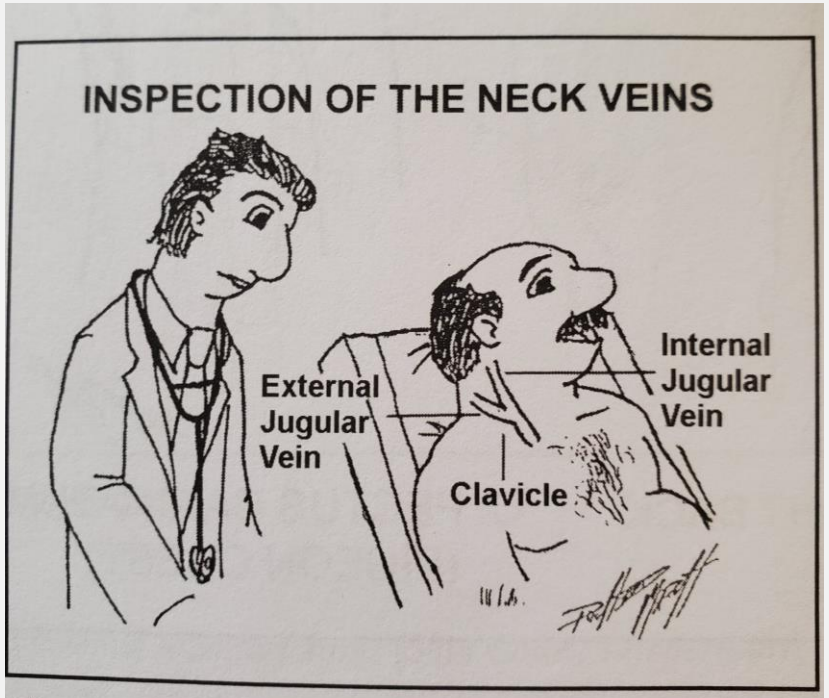


Figure 2-10

NECK VEIN ASSESSMENT

- Venous and Arterial Pulsations will be next to each other.
  - Venous will be lateral
  - In sinus rhythm the venous pulsation will be triphasic
- The "A" wave will occur before carotid palpation
- The "V" wave will occur with carotid palpation

VENOUS WAVEFORMS

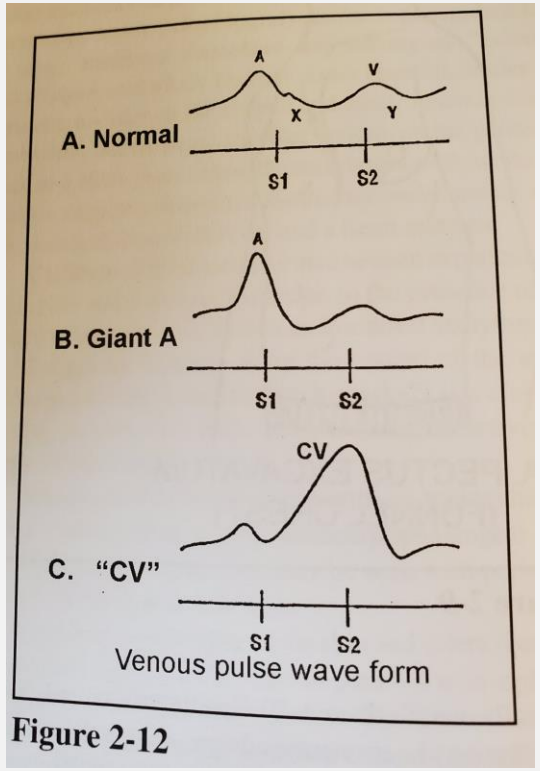


Figure 2-12

- Normal = A > V wave
- "Giant A" = Pulmonary Hypertension from any cause

  ** ABSENT IN AF **

  "Cannon" A waves with AV dissociation
- "CV" = "Large V Waves" = Se**V**ere TR.

  May also represent ASD
- Rapid X/Y descent = constriction

ASSESSMENT OF CHF

- Peripheral Edema and Rales are the least sensitive markers of CHF:
  - Peripheral edema can also be due to lymphatic dysfunction, renal, hepatic dysfunction
  - Chronic CHF → Increased pulmonary lymphatics → fewer rales
- Elevated JVP and the presence of an S3 = the most specific signs for heart failure

HEPATOJUGULAR REFLEX

- Press over the upper abdomen for 10 seconds and watch JVP
- Normal = brief rise and fall in the JVP.
- Abnormal = sustained rise in JVP → Indicates R heart failure, most commonly 2/2 elevated LV filling pressures, but could also be RV infarct.

KUSSMAUL'S SIGN

- Normally: Inspiration → Increased RV filling, but the RV can accommodate
- Constriction: The RV cannot accommodate the increased RV filling, and therefore there is a rise in JVP with inspiration
- May also be seen in decreased RV compliance

REFERENCES

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