

Heart Sounds & murmurs



Physiology
Team437

Index:

Red: important

Grey: extra information

Green: doctor's notes

yellow: numbers

Purple: only in female slides

Blue: only in male slides

Physiology 437 teamwork



MED437
KING SAUD UNIVERSITY

OBJECTIVES

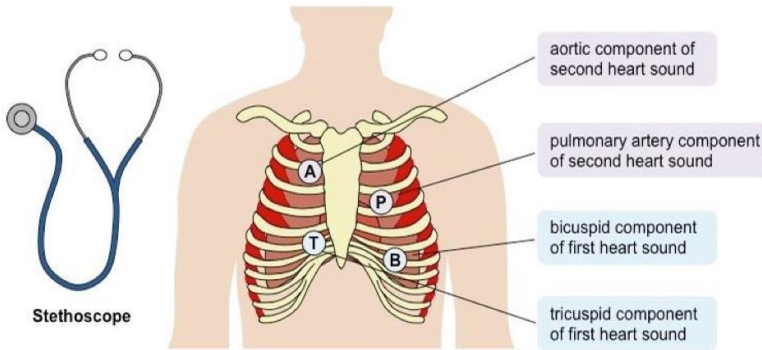
by the end of this lecture you will be able to:

- ▶ List the major types of normal heart sounds
- ▶ Understand the physiological basis for the production of normal heart sounds
- ▶ Understand the pathophysiological basis for the production of heart murmurs.

Heart Sounds Windows

- ▶ Detected over anterior chest wall by 2 methods:-
 1. Auscultation (Stethoscope).
 2. Phonocardiography (sound recording device).

- ▶ 4 heart sounds can be detected:
 - 1st & 2nd heart sounds (usually audible).
 - 3rd & 4th heart sounds (sometimes detected).



ONLY in male's slides:

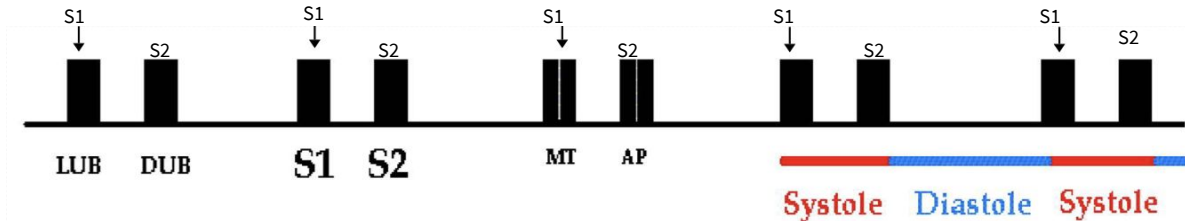
- Ventricular Systole is between First and second heart sounds.
- Ventricular diastole is between Second and First Heart sound.

- ▶ Aortic area:
2nd Rt costal cartilage.
- ▶ Pulmonary area:
2nd Lt intercostal space.
- ▶ Mitral (bicuspid) area:
5th Lt intercostal space crossing mid-clavicular line, or 9cm (2.5-3 inches) from sternum.
- ▶ Tricuspid area:
lower part of sternum towards Rt side.

S1	Due to closure of the A-V valves.	Recorded at the beginning of the 'isovolumetric contraction phase.'	It marks beginning of ventricular systole.	Long in duration 0.15 sec. Of low pitch (LUB). Its is heavier when compared to the 2nd heart sound.	(25-35 Hz) ~(25-45 Hz)	Best heard at Mitral & Tricuspid areas.
S2	Due to closure of semilunar valves.	Recorded at the beginning of the 'isovolumetric relaxation phase'.	Marks the beginning of ventricular diastole.	Short in duration .. 0.11-0.125 sec. ~(0.12 sec) Of high pitch (DUB). Soft & Sharp (compared to the 1st heart sound)	50 Hz.	Best heard at Aortic & Pulmonary areas.

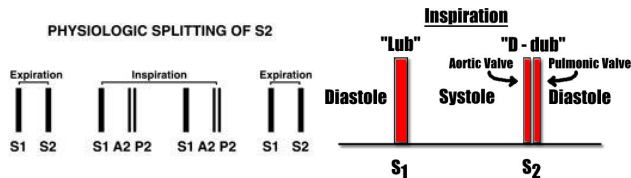
Splitting of the 2nd Heart Sound

- ▷ S2 splits physiologically into 2 sounds during inspiration = Physiological Splitting.
- ▷ This splitting occurs due to delay closure of pulmonary valve.



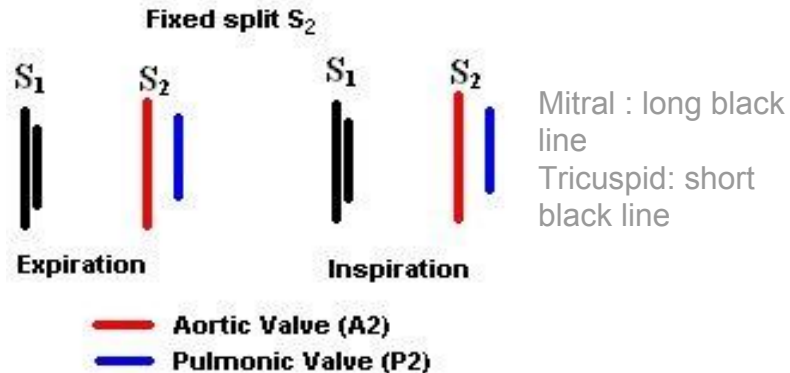
▶ Physiological splitting of S2

1. During inspiration, the aortic valve closes before pulmonary valve → reduplication (physiologic splitting of S2).
2. The increased venous return to the right side of the heart delays closure of the pulmonary valve. The right ventricle has more blood than usual to eject and it thus takes more time.
3. No splitting of the second heart sound is normally seen during expiration.



▶ Fixed splitting of S2

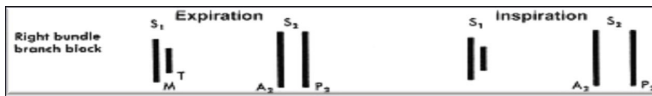
1. Splitting of S2 is heard in both during inspiration and expiration, with the aortic valve closing before the pulmonary valve.
2. This is heard in cases of ASD.(atrial septic defect)



▶ **Wide splitting of S2**

A split in the second heart sound during inspiration may become wider and the split may also be seen during expiration if:

1. There is a delay in the closing of the pulmonic valve (as would be seen in right bundle branch block due to delay in right ventricular depolarization and contraction).



2. The aortic valve closes earlier than normal (this is seen with either mitral regurgitation or ventricular septal defect).



▶ **Paradoxical (reversed) splitting of S2**

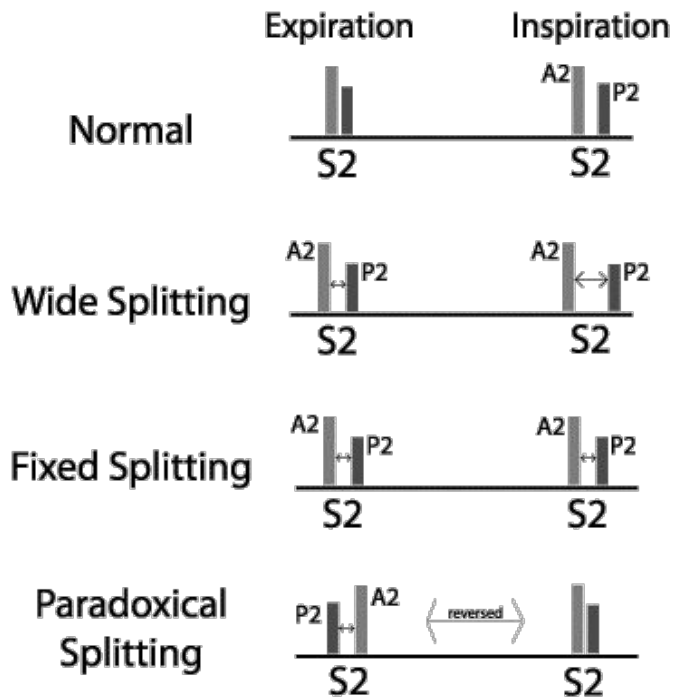
Reversed (paradoxical) splitting of the second heart sound is typically heard during expiration, with the pulmonary valve closing before the aortic valve. No splitting is apparent during inspiration, since the pulmonary valve is closing earlier (relative to the aortic valve) than normal.

This may be caused by the following:

1. Delayed onset of left ventricular systole (example: left bundle branch block).
2. Prolonged left ventricular systole (examples: aortic stenosis, severe hypertension, left-sided congestive heart failure).
3. Early onset of right ventricular systole (example: Wolff-Parkinson White syndrome).

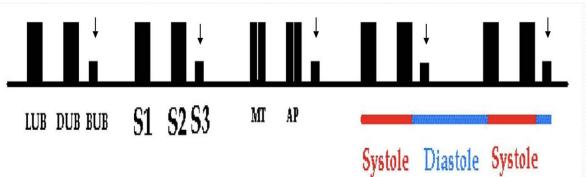
Types of S2 Splitting...

Extra Figure



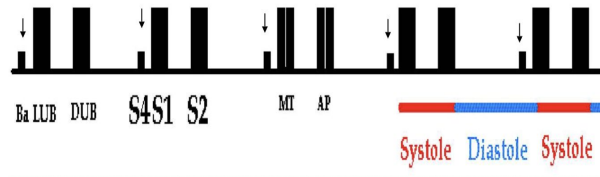
3rd Heart Sound = S3

- Recorded during the 'rapid filling phase' due to rush of blood into the ventricle.
- S3 is usually not audible (very low pitch.)
- 0.05 sec.
- Frequency: 20-30 Hz
- Heard in children (?).
- Best heard at Mitral area.



4th Heart Sound = S4

- Recorded during 'atrial systole' (just before S1).
- S4 is usually not audible (very low pitch.)
- 0.04 sec.
- Frequency: < 20 Hz.
- Heard in elderly (?).
- Best heard at Mitral area.



ONLY in male slides:

- Third and Fourth heart sound are low pitched sounds therefore not audible normally with stethoscope
- S4 may be heard in elderly but is usually pathologic in the young. (opposite of S3)

Significance of Heart Sound

Important for diagnosis of heart murmurs.

Abnormal extra heart sounds heard during the heartbeat cycle .

Produced by turbulence (abnormal patterns) of blood flow through the heart & its valves.

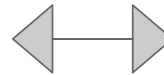
Murmurs are longer than heart sounds.

Valve	Abnormality	Timing of Murmur
Aortic or pulmonary	Stenosis	Systolic
	Insufficiency	Diastolic
Mitral or tricuspid	Stenosis	Diastolic
	Insufficiency	Systolic

ONLY in male slides

What make noise in the heart

Closure of valves of the heart



Increased intra-cardiac hemodynamics

1)Atrio-ventricular (Mitral & Tricuspid) valves= (S1)

Blood striking the left ventricle = (S3, S4)

Semilunar (Aortic & Pulmonary) valves= (S2)

- Increased flow across normal valves.
- Turbulent flow through an abnormal valve.
- Turbulent flow through septal defect.



Murmurs

Physiological VS Pathological Murmurs

Physiological Murmurs:	Pathological Murmurs:
Increase blood flow across normal valves:	Turbulent flow through abnormal valves, or septal defect.....Congenital?
e.g.:- <ul style="list-style-type: none"> ○ Pregnancy ○ Hyperthyroidism ○ Anemia ○ Fever ○ Children 	e.g.:- <ul style="list-style-type: none"> ○ Tight valve (stenosis) (narrowing): the valve does not open properly. ○ Leaky valve (regurgitation or insufficiency): The valve fails to close completely, and hence causing backflow or leaks of the blood across the insufficient valve. (Valvular insufficiency is also known as Regurgitation or Incompetency). ○ A combination of Stenosis and Insufficiency.

How to describe Heart Murmurs

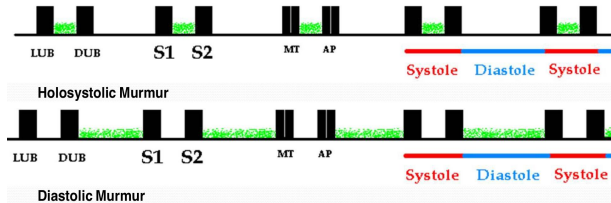
- ▶ Timing (systolic or diastolic)
- ▶ Shape
- ▶ Location
- ▶ Radiation
- ▶ Intensity
- ▶ Pitch
- ▶ Quality

ONLY in male slides:
Gallop:
Three or four sounds are spaced to audibly resemble the pace of a horse, the extra sounds occurs after S2.

1- Timing

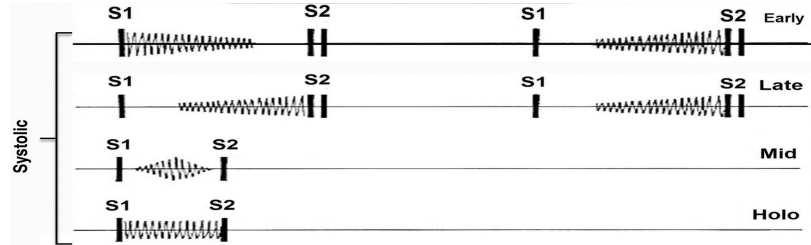
Murmurs are described according to their position in the cardiac cycle:

- ▶ Systolic.
- ▶ Diastolic.
- ▶ Continuous.



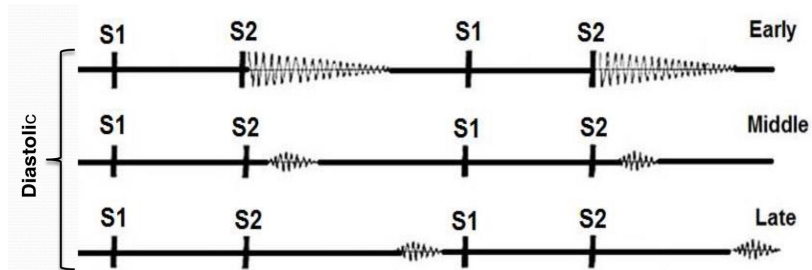
Systolic murmur

- Between S1 & S2
- Classified as early, mid, late, holosystolic



Diastolic murmur

- Between S2 & S1
- Classified as early, mid, late



2- Shape

Murmurs are described according to the waxing & waning of the sound.

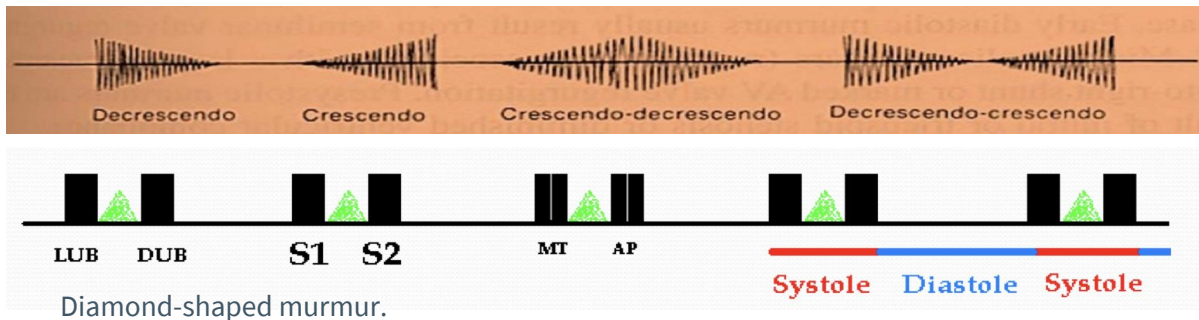
Crescendo (grows louder)
> increasing intensity

Decrescendo
> decreasing intensity

Decrescendo-crescendo

Crescendo-decrescendo (diamond shaped)
> increasing then immediate decreasing intensity.

Plateau (uniform)
> the intensity of the murmur remains uniform throughout.



Describing a Heart Murmurs.....Cont

3- Radiation

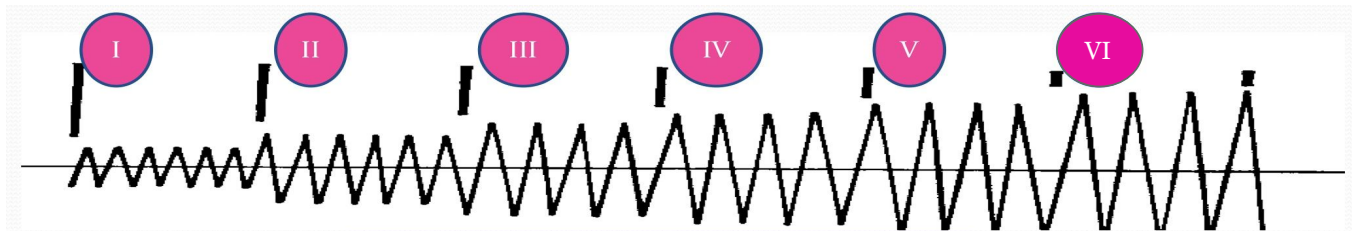
Reflects intensity of the murmur & direction of blood flow.

4- Location of maximum intensity (of heart murmurs)

Determined by the site where the murmur originates; e.g. Aortic, Pulmonary, Tricuspid, & Mitral listening areas.

5- Intensity

Graded on a (6) point according to Levine scale:



Classification of murmurs by loudness

Grade one:

- Lowest intensity
- Very faint

Grade two:

- Low intensity
- Quiet but heard immediately

Grade three:

- Medium intensity
- Moderately loud

Grade four:

- Medium intensity
- Loud
- Thrill

Grade five:


- Loud intensity
- Heard with stethoscope partly off the chest
- Thrills

Grade six:

- Loudest intensity
- No stethoscope needed
- Thrills

5- Intensity...cont.

Grading Of Heart Murmurs	
1	Soft murmur heard in quiet surroundings.
2	Soft murmur heard in noisy surroundings.
3	Prominent heard murmurs.
4	Loud murmur with a thrill.
5	Loud murmur heard with edge of the steth tilted against the chest + thrill
6	Loud murmur heard 5-10 mm from the chest + thrill.



A **thrill** is a slight palpable vibration felt by the hand over the chest wall.

Describing a Heart Murmurs.....Cont

6-Pitch:

- ▷ High
- ▷ Medium
- ▷ Low

7- Quality:

- ▷ Blowing
- ▷ harsh (hard)
- ▷ resonant (rumbling) & musical

8- Others:

- Variation with respiration.
 - Murmurs increasing with expiration originate with left side (aortic or mitral) valves, while murmurs increasing in intensity with inspiration originate with tricuspid or pulmonary valves.
- Variation with position of patient.
- Variation with special maneuvers:
 - Valsalva (forced expiration) → Murmurs ↓ in length (duration) & intensity (of most murmurs)

Systolic Murmurs

- ▷ Early Systolic
- ▷ Mid Systolic
- ▷ Late Systolic
- ▷ Pansystolic (holosystolic)

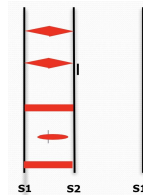
Derived from harsh & turbulence in blood flow.

Associated with:

- 1) Increased flow across normal valve.
- 2) Increased flow into a dilated great vessel.
- 3) Increased flow across an abnormal valve, or narrowed ventricular outflow tract.
 - e.g. aortic /pulmonary stenosis.
- 4) Increased flow across an incompetent AV valve.
 - e.g. mitral/tricuspid regurgitation.
- 5) Increased flow across the inter-ventricular septum.
 - e.g. VSD.

Common Systolic Murmurs and Timing

- 1) **Aortic stenosis** – ejection murmur.
- 2) **Pulmonary stenosis** – ejection murmur (+2nd split)
- 3) **Mitral / Tricuspid regurgitation** – holosystolic.
- 4) **Mitral valve prolapse** – mid-late systole.
- 5) **Ventricular septal defect (VSD)** – holosystolic.



ONLY in female slides

Ejection (Mid- Systolic) Murmurs:

Most common kind of heart murmur. Usually crescendo-decrescendo.

They may be:

- 1) **Innocent:** Common in children & young adults.
- 2) **Physiological:** Can be detected in hyper-dynamic states.
 - e.g. anemia, pregnancy, fever & hyperthyroidism.
- 3) **Pathological:** Secondary to structural CV abnormalities.
 - e.g. Aortic/pulmonary stenosis, Hypertrophic cardiomyopathy & mitral prolapse.

Pan-Systolic (Holosystolic) Murmurs:

Pathological murmur.

Begins immediately with S1 & continues up to S2

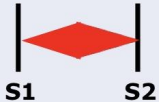


Heard with:

- ▶ Mitral/tricuspid regurgitation.
- ▶ Ventricular septal defect (VSD)

Systolic Murmurs

ONLY in female slides

Video of (Heart Murmurs)
Duration (12) mins

	Aortic Stenosis	Mitral Prolapse	Mitral Regurgitation
Cause	Obstruction of flow from LV into ascending aorta.	Bulging of 1 or 2 mitral valve leaflets into LA during LV systole.	Retrograde flow from LV into LA through an incompetent mitral valve.
Timing	Mid-systolic murmur.	Mid-late systolic murmur.	Holosystolic murmur.
Location	Best heard on aortic area, radiates along carotid arteries.	Best heard at the apex.	Best heard at apex, radiates to left axilla.
Character	Harsh, loud, may have associated with thrill, "ejection click."	Mid systolic click.	Soft, high-pitched, blowing.
Association	Old age, bicuspid aortic valve, rheumatic fever.	~5% normal population, asymptomatic, ? Sudden death.	MV prolapse, or myxomatous degeneration, rheumatic heart disease, endocarditis.
			

Diastolic Murmurs

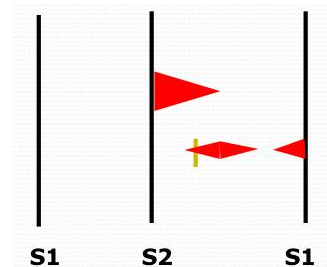
- ▶ Almost always indicate heart disease.

Two basic types:



1. **Early decrescendo diastolic murmurs:**
Signify regurgitant flow through an incompetent semilunar valve.
e.g. aortic/pulmonary regurgitation.
2. **Rumbling diastolic murmurs in mid- or late diastole:**
Suggest stenosis of an AV valve.
e.g. mitral/tricuspid stenosis.

In Summary Common Diastolic Murmurs & Timing

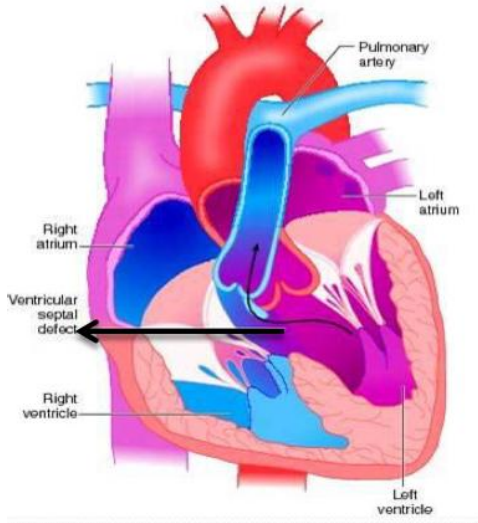
- ▶ Soft, blowing, gurgle
1. Aortic regurgitation → early diastole.
 2. Mitral stenosis → mid to late (pre-systolic) diastole.



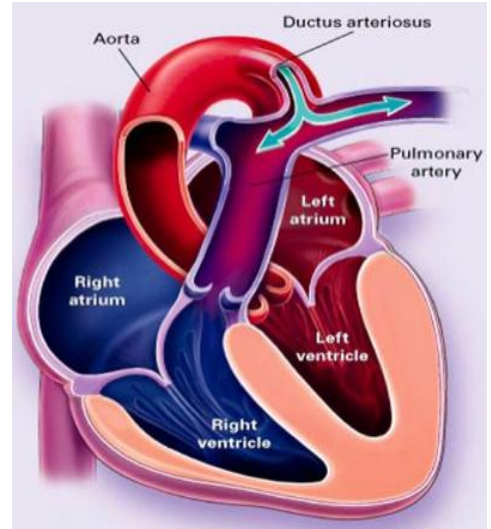
Diastolic Murmurs

	Aortic Regurgitation	Mitral Stenosis
Cause	Retrograde flow from aorta into LV through incompetent aortic cusps.	Obstruction of flow from LA to LV (Valve becomes narrowed, thickened & calcified).
Timing	Diastolic (early) murmur.	Diastolic (mid-diastolic, or pre-systolic) murmur.
Location	Best heard at 2nd-4th left intercostal spaces.	Best heard at apex.
Character	High-pitched, blowing, decrescendo.	Low pitched (heard with bell).
Association	Aortic root degeneration, rheumatic heart disease, VSD with aortic valve prolapse (kids).	Rheumatic fever.
		

Murmurs of Ventricular Septal Defect & Patent Ductus Arteriosus

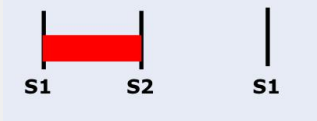
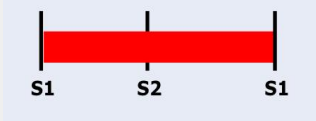


Ventricular Septal Defect



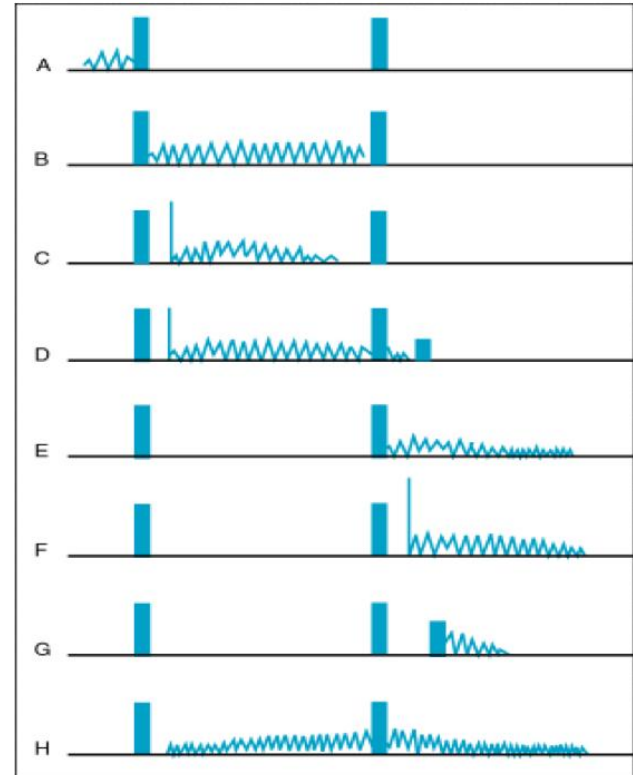
Patent ductus arteriosus

Murmurs of Ventricular Septal Defect VS Patent Ductus Arteriosus

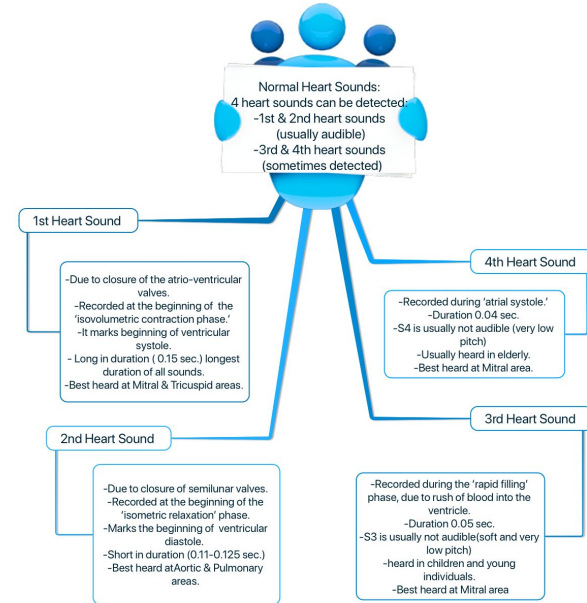
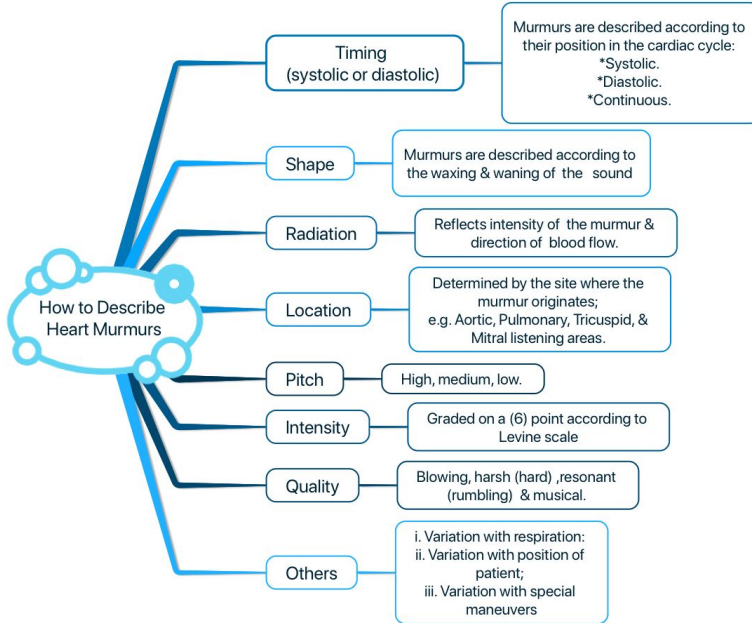
	Ventricular septal defect	Patent ductus arteriosus
Cause	A congenital condition associated with abnormal blood flow between the left ventricle and the right ventricle	Failure of closure of duct (<u>ductus arteriosus</u>) between pulmonary artery & aorta
Timing	Holosystolic murmur, may be diastolic murmur due to turbulent flow through mitral valve	Continuous murmur
Location	Best heard at tricuspid area	Best heard at upper left sternal border
Character	A medium pitched murmur fills all of systole	Machine-like.
Association	Volume overload of right ventricle	Left to right shunt, cyanosis
		

Summary

- A. Presystolic murmur.
 - Mitral/Tricuspid stenosis.
- B. Mitral/Tricuspid regurge.
- C. Aortic ejection murmur.
- D. Pulmonic stenosis (spilling through S2).
- E. Aortic/Pulm. diastolic murmur.
- F. Mitral stenosis w/ Opening snap.
- G. Mid-diastolic inflow murmur.
- H. Continuous murmur of PDA.



Summary



Heart Murmurs					
Systolic murmur	Early	-			
	Mid (Ejection)	Aortic stenosis: Narrowing of aortic outflow tract causing obstruction of flow from left ventricle into ascending aorta	Location Best heard at aortic area, radiates along Carotid arteries	Character Harsh ,loud, may have associated thrill, "ejection click."	Association Older age, bicuspid aortic valve, rheumatic fever.
	Late	Mitral Prolapse: Bulging of one or both mitral valve leaflets in left atrium during left ventricular systole (it's mid-late systole)	Best heard at the apex region	Mid systolic click	5% normal population, asymptomatic, sudden death
	Holo (Pan)	Mitral Regurgitation: Retrograde flow from left ventricle to left atrium through an incompetent mitral valve	Best heard at apex radiates to left axilla	Soft, high pitched, blowing	Mitral valve prolapse, mitral valve myxomatous degeneration, myocardial infarction, rheumatic heart disease, cardiomyopathy, endocarditis.
Diastolic murmur	Early	Aortic Regurgitation: Retrograde flow from aorta into LV through incompetent aortic cusps	Best heard at 2 nd – 4 th left intercostal spaces	High pitched, blowing, decrescendo	Aortic root degeneration, rheumatic heart disease, VSD w/aortic valve prolapse(kids.)
	Mid	Mitral Stenosis: Obstruction of flow from LA to LV because of a narrowed mitral orifice (Valve becomes thickened & calcified) (it's mid-late systole)	Best heard at apex	Low pitched (heard with bell of stethoscope), opening snap after closure of aortic valve	Rheumatic fever
	Late	-			
Continuous murmur		Patent Ductus Arteriosus: Failure of closure of the duct between pulmonary artery &	Upper left sternal border	Machine like	Left to right shunt, cyanosis

Quiz

1. Closure of AV valves causes which sound?

- A- S3
- B- S2
- C- S4
- D- S1

2. Aortic regurgitation is best heard at which location?

- A- apex of heart
- B- pulmonary area
- C- 2-4 left intercostal spaces
- D- aortic area

3. 4th lead of ECG (V4) is on the same location of:

- A- aortic area
- B- mitral areas
- C- pulmonary area
- D- tricuspid area

4. S1 sound is soft at which condition?

- A- bradycardia
- B- tachycardia

5. This sound is usually heard in children:

- A- S1
- B- S2
- C- S3
- D- S4

6. Which heart sound has long duration:

- A- S1
- B- S2
- C- S3
- D- S4

Quiz

7. physiological splitting of S2 sound is heard at:

- A- inspiration only
- B- both inspiration and expiration
- C- expiration only

8. which of the following causes a mid-late systolic murmur?

- A- aortic regurgitation
- B- aortic stenosis
- C- mitral regurgitation
- D- mitral prolapse

9. which valvular abnormality causes the disappearance of pressure difference between LA and LV?

- A- aortic regurgitation
- B- aortic stenosis
- C- mitral regurgitation
- D- mitral stenosis

Thank you for checking our work

Team Leader:

العنود سلمان

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 سعود العطوي
 سيف المشاري
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Any questions?

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