Clinical Examination of the Heart

Study Guide:

With respect to skills:

Level 1 = should have confidence in performing the task and can recognize normal signs;

Level 2 = should have performed the task;

Level 3 = should have observed the task performed in real life or on video.

With respect to knowledge:

Level 1 = should understand the subject matter and can apply it to practice;

Level 2 = should have a sound understanding of the subject matter;

Level 3 = should be aware of the importance of the subject matter.

Level of Achievement	1	2	3
1. General inspection	•	-	-
2. Peripheral edema	•	-	-
3. Vital signs: pulse, blood pressure, and respiration	•	-	-
4. Jugular venous pulses and jugular venous pressure	•	-	-
Hepatojugular reflux	-	•	-
5. Examination of the heart	-	-	-
Inspection: apex beat or apical impulse	-	•	-
Palpation: apex beat or apical impulse	-	•	-
Palpation of cardiac thrills	•	-	-
Percussion (of historic interest only)	-	-	•
Auscultation	•	-	-

N.B. *Year 1 and 2 students are expected to recognize normal findings only*, although abnormal findings are also listed for the benefit of students in senior years.

• Clinical examination of the heart should not be limited to examining this organ within the thorax alone because diseases of the heart can leave telltale signs in the general condition of the patient and affect the function of many organ systems. Therefore clinical examination of the heart should include a search for these signs.

General inspection

General inspection can yield many signs that may indicate the presence of heart disease or heart failure.

N.B. Many forms of heart disease are associated with unique signs. This is only a general discussion of peripheral signs. Advanced students should consult a textbook on cardiology for details.

Exercise 01

1. Observe the subject from a comfortable distance and observe his physical well-being, mental state, and respiratory efforts.
2. Pay attention to his color in general and that of his face, lips, ears, distal digits, and mucous membranes in specific.
3. Examine the nail bed of the fingers. Press on the nail until the nail bed blanches; then release the pressure and observe how quickly the nail bed returns to its original pink color.
4. Examine the distal end of the fingers for signs of clubbing.

Normal findings

- Subject should look well and shows no sign of distress.
- A normal subject is mentally alert.
- Respiratory effort should be quiet, cyclical, and smooth.
- Color should be consistent with the patient's ethnic origin and his mucous membrane should look pink. He should not be cyanotic, either centrally or in the periphery. (Cyanotic is the adjective of cyanosis, a condition in which the patient has a bluish discoloration. In central cyanosis there is 5 g/dL or more of deoxygenated hemoglobin in arterial blood – even more in venous blood – and the entire patient looks dusky and the mucous membrane under the eyes, the buccal mucosa and the tongue are blue. In peripheral cyanosis only the fingers, the toes, the lips and the ears are blue due to vasoconstriction in these areas resulting in sluggish blood flow and an increase in the concentration of deoxygenated hemoglobin to 5 g/dl or more in the underlying blood vessels. Peripheral cyanosis is seen in patients exposed to a cold environment or in those with a greatly reduced cardiac output, during which blood flow is diverted from the periphery to vital organs.)
- The nail beds should be uniformly pink. A quick return to normal color following blanching of the nail bed by pressure indicates brisk re-filling of the capillary bed and good peripheral perfusion.

Abnormal findings

- Patient may look unwell, lethargic, exhausted, and breathless in the presence of reduced cardiac output or congestive heart failure.
- Breathlessness may be subtle: occurring only when moving about but not when at rest in an ambulatory patient (decreased exercise tolerance) or only when lying supine but not when recumbent (orthopnea) in a patient in bed.
- Clouded sensorium may be due to greatly reduced cardiac output leading to decreased cerebral perfusion or due to severe hypoxemia.
- Central cyanosis may be of cardiac or pulmonary origin. In the presence of intra-cardiac right to left shunt, there is mixing of deoxygenated venous blood from the right heart with oxygenated

blood in the left heart before the mixture is ejected into the systemic arteries. If the concentration of deoxygenated hemoglobin in arterial blood exceeds 5 g/dL, central cyanosis appears. In the presence of congestive heart failure, pulmonary congestion can interfere with oxygenation of blood in the pulmonary vascular bed so that blood returning to the left heart is no longer fully saturated with oxygen. If de-saturation has occurred to the degree that there is more than 5 g/dL of deoxygenated hemoglobin in arterial blood, the patient will have central cyanosis.

- Pallor or pale looking may be due to anemia. In the absence of anemia, a pale looking face may be due to vasoconstriction associated with a greatly reduced cardiac output.
- Slow capillary re-filling at the nail bed is a sign of vasoconstriction and poor peripheral perfusion.
- Clubbing of the fingers is characterized by a spongy or floating sensation when the base of the nail is palpated. Later on there is swelling of the subcutaneous tissue over the base of the nail and loss of the normal angle between the nail and the nail base. The nail plate becomes more convex and rounded swelling of tissues in the terminal phalanx give it a drumstick appearance. Clubbing of the fingers, and sometimes toes too, is found in cyanotic heart disease and infective endocarditis as well as suppurative intrapulmonary diseases and Crohn's disease or ulcerative colitis.

Peripheral edema

- In right heart failure or congestive heart failure (bi-ventricular failure), the right ventricle fails to eject the volume of venous return it receives and venous congestion results.
- Venous congestion in the periphery manifests itself as "pitting edema". It is so called because when pressure is applied to the affected part with the examiner's finger, the finger will sink into the edematous skin and subcutaneous tissue, leaving a pit like depression. If the patient has been bed-bound, pitting edema appears at the sacral region; if the patient has been up and about, pitting edema appears around the ankle.

Exercise 02

1. Inspect the patient's sacral region and around his ankles for any swelling.
2. Press into the skin over the sacrum with the pulp of your index finger or thumb, whichever is more convenient.
3. Release the pressure and move your finger away to check for any lasting pit like impression on the skin.
4. Repeat the procedure at the medial malleolus. If pitting is present, repeat the procedure up the shin (anterior tibia) and note the level when pitting no longer occurs.

Normal findings

- In a normal person there should not be swelling over the sacrum or ankle.
- The skin overlying those areas should be normal in color and texture.
- Pressure from your finger should not leave any pit like depression in the skin.

Abnormal findings

- Edematous skin looks swollen and shiny.
- In the presence of pitting edema, pressure from you finger will leave a pit like depression in the skin.

- The severity of edema can be described by the depth of the pit in millimeters.
- In the presence of ankle edema, the severity of the edema can be described additionally by how far up the leg pitting edema is present.

Vital signs: pulse, blood pressure, and respiration

- Measurement of vital signs was covered in “PCLM 03: Measurement of Vital Signs”. Students should review the notes from that session. What appears below is only a brief summary.

Normal findings

- Pulse rate should be regular and within the normal limits of 60 – 88 beats per minute. There should be no deficit between the pulse rate palpable at the radial artery and the heart rate determined by auscultation (no pulse deficit). Pulse volume should be normal
- The blood pressure should be within the normal limits of 100 – 140 mmHg systolic and 60 – 90 diastolic.
- The respiratory rate should be normal at 12 – 20 breaths per minute. The pattern should be quiet and not labored.

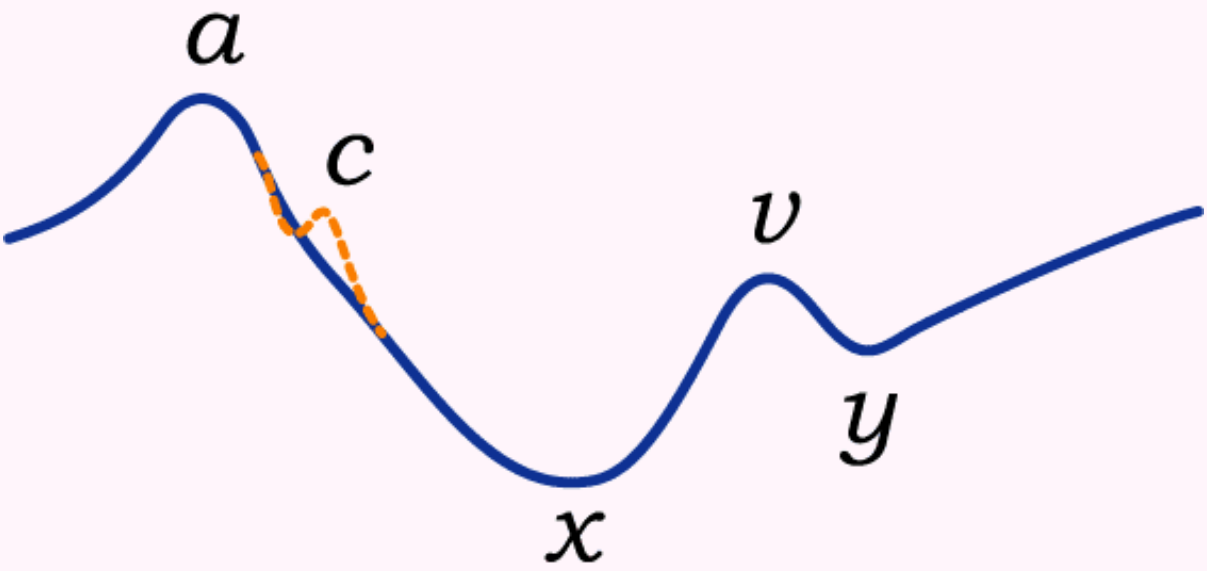
Abnormal findings

- Pulse rate may be normal in some heart disease; it may be increased or decreased in others. An arrhythmia (irregular cardiac rhythm) may or may not be present. In the presence of a decreased stroke volume (and cardiac output), the pulse volume will decrease and the pulse feels thin and thready.
- Blood pressure may be normal or it may be increased in hypertensive heart disease. In the presence of a decreased stroke volume and cardiac output, the blood pressure will fall.
- Pulmonary congestion occurs when the left ventricle fails to eject all of its venous return. As pulmonary venous congestion develops, there are accompanying increases in respiratory rate (tachypnea) and respiratory effort to the point that it causes distress (respiratory distress). In a worse case scenario pulmonary congestion results in fluid transudate appearing in the alveoli (pulmonary edema) and the patient will cough up frothy sputum that is blood tinged.

Jugular venous pulsation

- Jugular venous pulsation and jugular venous pressure means “internal” jugular venous pulsation and pressure.
- Although the internal jugular vein is deep to the sternocleidomastoid muscle, pulsation of the column of blood within the vein is visible beneath the skin.
- The pulsation does not arise from the vein but reflects changes in pressure within the right atrium.
- The right internal jugular vein provides a more direct channel from the right atrium than the left and inspection of the right internal jugular vein for pulsation and pressure is a better choice.
- Inspection of the external jugular vein for pulsation and pressure is a poor alternative to inspection of the internal jugular vein because the external vein has valves and passes through fascial planes. Both factors can mask the transmission of pulse and pressure from the right atrium.

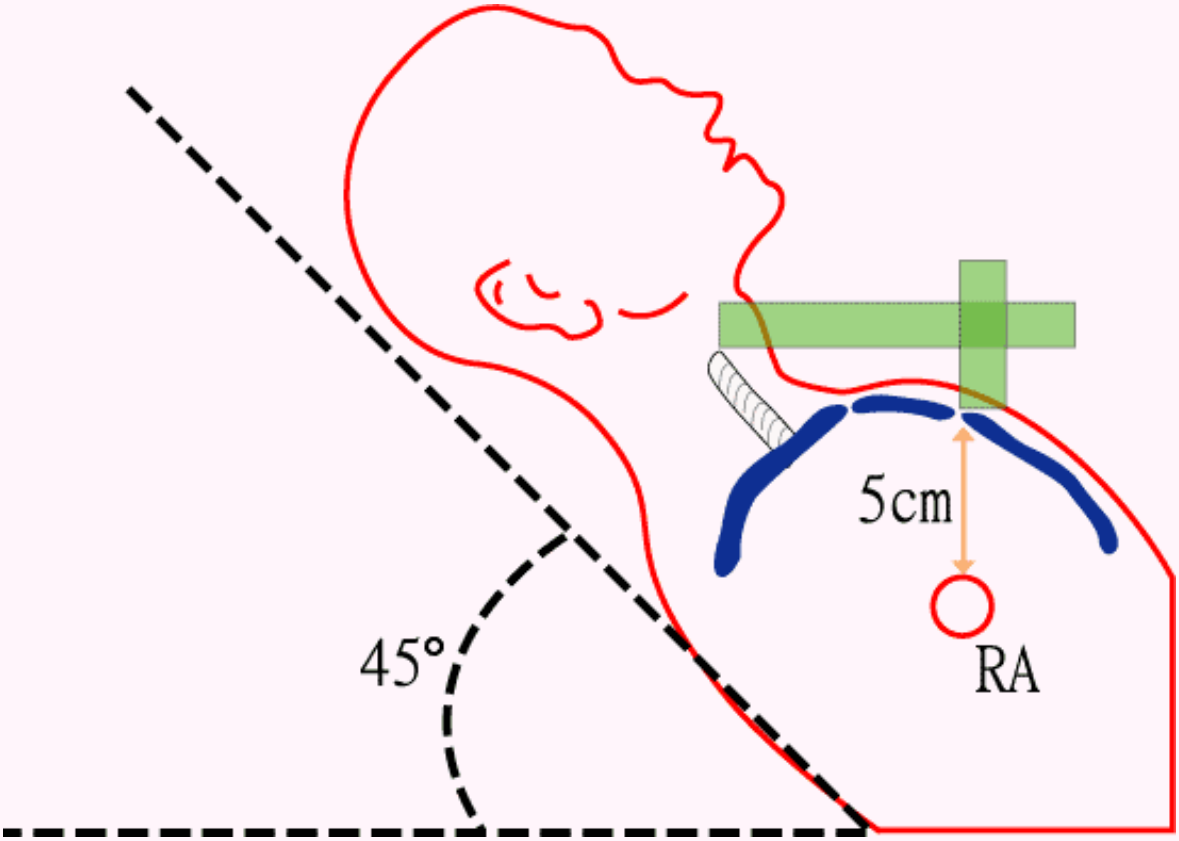
- Three positive waves (a, c, & v) and 2 negative descents (x & y) have been described for internal jugular venous pulsation, although **the *c* wave is so small in a normal subject that it is usually not visible to the naked eye**.



- The positive a wave is the most prominent; it represents right atrial contraction. As the right atrium contracts, venous blood is pumped across the triscupid valve into the right ventricle but backpressure is also transmitted to the valveless internal jugular vein. This backpressure accounts for the a wave.
- Following the a wave is the x descent, which represents the dissipation of the back pressure that is responsible for the a wave.
- The small c wave occurs early during the x descent and corresponds to right ventricular contraction during systole and closure of the tricuspid valve causing a transient pressure rise in the right atrium and the internal jugular veins.
- The v wave represents a steady rise in pressure within the right atrium and internal jugular veins as venous return continues during the rest of ventricular systole when the triscupid valve is closed.
- The v wave is followed by the y descent, which represents the end of ventricular systole, the opening of the triscupid valve, and the passive emptying of blood from the right atrium into the right ventricle.
- After the y descent, the cycle repeats itself.
- Features that distinguish the internal jugular venous pulsation from carotid arterial pulsation include:
    - Internal jugular venous pulsation is a series of 2 or 3 positive waves (depending on whether the c wave is obvious to the naked eye) in each cardiac cycle while carotid pulsation has only 1 positive wave in each cardiac cycle.
    - The pulsating column of venous blood in the internal jugular vein has a definite upper level, above which the vein is collapsed, while the pulsating carotid artery does not have an upper level or head.
    - Internal jugular venous pulsation decreases with inspiration and increases with expiration. This is not the case in the carotid artery.
    - Performing a valsalva maneuver (breathing out forcefully against a closed glottis) increases intra-thoracic pressure and internal jugular venous pulsation. Not so with the carotid artery pulse.
    - Internal jugular venous pulsation is seen at the skin surface but it is not palpable. Carotid pulsation is deeper but it is palpable.

Jugular venous pressure

- The highest point of this pulsating column of blood is called the head. The height of this head varies somewhat with respiration: falls slightly with inspiration when the negative intra-thoracic pressure encourages venous return to the heart; rises again with expiration when the positive intra-thoracic pressure impedes venous return to the heart.
- The mean height of this column (averaged over inspiration and expiration) represents the hydrostatic pressure within the right atrium, the normal magnitude of which is 6 – 10 cm H2O.
- Jugular venous pressure (JVP) is commonly expressed as the vertical height (in cm) of this column of blood (the head) in relation to the sternal angle (angle of Louis).
- With the help of 2 rulers, this vertical height in relation to the sternal angle can be determined by the method of triangulation shown below.



- Since the sternal angle is 5 cm above the right atrium in an adult – irrespective of whether he/she is supine, reclining, or sitting upright – the hydrostatic pressure in the right atrium (in cm of H2O) is equal to the vertical height (in cm) of the column of blood above the sternal angle plus 5 cm.
- In a normal subject, the head of the jugular venous pulse is commonly seen at the level of the clavicle when he/she is reclining at an angle of 45o.
- To put it in another way, a JVP more than 5 cm above the sternal angle is elevated.

Exercise 03

1. Stand on the subject's right side and begin your observation by laying your subject in a 45o reclining position.
2. Turn his head slightly to the left and make sure that it is well supported. (Tensing of the sternocleidomastoid muscle from a poorly supported head can prevent transmission of the internal jugular venous pulse to the skin.)

3. Look across the skin tangentially over the lower half of the neck under natural light and scan that part of the neck for the pulsating column of blood and its head in the right internal jugular vein.
4. If the pulsating column can be seen, ask the subject to breathe in and out slowly and observe the height and the pulsation of the column during this maneuver.
5. Determine the vertical height of the column in relation to the subject's sternal angle by the triangulation method shown. If the vertical height is 3 cm, describe it in the following manner: 3 cm above sternal angle when reclining at 45o.
6. Change the reclining angle and repeat your observation if you cannot see the head of the column.

(**N.B.** If you cannot see the head of the pulsating column of blood in the internal jugular vein, it may be because the hydrostatic pressure in the right atrium is low so that the head lies behind the clavicle. Or, it may be because the hydrostatic pressure is so high that the head of the column has disappeared behind the angle of the jaw, as you may find in a patient with heart failure. Lowering the reclining angle will bring it out in the former and increasing the reclining angle or sitting the patient bolt right up may bring it out in the latter. In either case, always cite the reclining angle of the patient when you describe the vertical height of the jugular venous pressure in relation to the sternal angle.)

Normal findings

- In normal subjects, only the a & v waves and the x & y descents are obvious to the unaided eye.
- Normal JVP is no more than 5 cm above the sternal angle.
- When a subject is reclining at 45o, the head of the internal jugular venous pulse is normally visible at the level of the clavicle.

Abnormal findings

- A notable abnormal jugular venous pulsation is the "cannon wave" seen in complete heart block or complete A-V dissociation. In this condition atrial rate is faster than ventricular rate and a waves can be seen to occur at an independent rate faster than the pulse or apical rate. From time to time atrial and ventricular systole occur simultaneously and the right atrium will contract against a closed tricuspid valve. When that occurs the pressure of right atrial contraction is transmitted backward in total into the jugular veins and produces a giant a wave called the "cannon wave".
- The a waves are absent in atrial fibrillation.
- The a wave is more prominent than usual when right ventricular compliance is low. (When the compliance of a receptacle is low, it is more resistant to taking up volume than one that has normal compliance. That is, a receptacle that has a low compliance requires a higher pressure to increase its volume than one whose compliance is normal.)
- A giant systolic v wave is seen in tricuspid regurgitation (tricuspid incompetence) when there is free flow of blood from the right ventricle back into the right atrium during ventricular systole. (N.B. The giant systolic v wave seen in tricuspid regurgitation is due to regurgitant flow back into the right atrium during ventricular systole. This regurgitant wave occurs in mid-systole and is palpable; it is different from the physiological v wave described above. It has been wrongly named but the practice of calling it a v wave is entrenched and accepted.)
- Raised JVP is most commonly seen in right heart failure in which the normal pattern of venous waves is preserved.
- Elevated JVP is also a sign of fluid overload, even when heart failure is absent.
- Raised JVP can be due to cardiac tamponade or constrictive pericarditis.
- Elevated JVP is also seen in superior vena cava (SVC) obstruction (e.g., Pancoast's tumor).

When JVP is elevated due to mechanical obstruction, the pulsatile waves in the jugular veins are absent.

Hepatojugular reflux

- In right heart failure all systemic organs are congested because the right ventricle fails to eject the venous blood being returned to it. A sign of venous congestion in the liver is hepatojugular reflux. By applying pressure to the epigastrium and indirectly to the liver, more venous return is pushed out of the liver towards the heart. A failing right heart cannot cope with the increased venous return and JVP rises.

Exercise 04

1. Lay the patient in a 45o reclining position as if you are checking JVP.
2. Stand on his right side facing him and note the vertical height of his JVP in relation to his sternal angle.
3. Use the heel of your right hand to apply steady pressure on the epigastric region of his abdomen for 15 to 20 seconds and note the JVP during this procedure. (Since breath-straining against a closed glottis can increase intra-thoracic pressure and JVP, it is important to instruct the patient to breathe normally during this maneuver.)

Normal findings

- In normal subjects, the JVP increases slightly but only transiently and returns to normal even with continued pressure on the epigastrium indicating that the right ventricle is capable of ejecting the increased venous return.

Abnormal findings

- In the presence of right heart failure, the vertical height of the JVP will increase by more than 1 cm and remain elevated for as long as pressure is applied to the epigastrium.

Hepatomegaly and ascitis

- The techniques of liver palpation and checking for ascitis were covered in “PCLM 08 & 09: Clinical Examination of the Abdomen”.
- Abnormal findings associated with heart disease include:
- Hepatomegaly and ascitis are signs of severe right heart failure. In heart failure the enlarged liver remains soft and smooth but is tender.
- The liver may be felt to pulsate in tricuspid regurgitation.

Examination of the chest

- There will be abnormal signs in the respiratory system in the presence of pulmonary congestion. The topic of chest examination is taught in Year 2.

Examination of the heart

N.B. Determining the site of the apex beat (apical impulse) by inspection and palpation and the lateral border of the heart by percussion are age-old techniques of determining heart size. In modern day practice, determining heart size by chest X-ray is more accurate. Nevertheless students should be aware of, though need not be skillful with, these technique

Inspection: Apex beat or apical impulse (Level 2 topic)

- The apex beat results from the apex of the heart tapping against the chest wall when the left ventricle contracts.

Exercise 05

1. Lay the patient supine or slightly head-up if he has orthopnea. (Orthopnea is breathlessness on lying supine, which is relieved by reclining at a more upright posture. This is often found in patients who have heart failure).
2. Stand on the patient's right side, focus on the area of the patient's precordium below and medial to the left nipple, and observe for any regular cardiac impulse that coincide with each of the patient's pulse. (The following maneuvers may help: cast tangential light across that part of chest wall; lowering oneself so that the area of observation is at eye level; ask the patient to hold his breath in full expiration; ask the patient to displace her left breast upward and to the left if she is a woman. Turning the patient on to his left side or sitting him up and leaning him forward may help, but these maneuvers displace the heart and its apex from its normal location in the supine position.)

Normal findings

If seen in a supine subject, the normal impulse is discrete, occupies an area no larger than a ten-dollar coin, and appears at the 5th interspace 2 cm medial to the left mid-clavicular line. It is more obvious in a slender subject; difficult to see even in someone of normal build; and impossible to see in a fat or obese patient.

Abnormal findings

- A discrete impulse that is shifted laterally or medially may be due to mediastinal shift in the same direction.
- A more diffuse impulse that is shifted laterally indicates left ventricular enlargement.

Palpation: Apex beat or apical impulse (Level 2 topic)

Exercise 06

1. Lay the patient supine and stand on his right side as for inspection.
2. Spread the fingers of your right hand and rest the entire palm flat across the precordium, positioning the tip of the middle finger in the 5th interspace just medial to the left mid-clavicular line (or right over the visible apical impulse if you can see one), the tip of the index finger in the interspace above, and the tip of the ring finger in the interspace below.

3. Note the following characteristics of the impulse:
   -The interspaces in which the impulse can be felt;
   -Its location in relation to the left mid-clavicular line;
   -Whether it is a discrete tap or a sustained lift.

Normal findings

- The normal impulse is a small pulsation felt at the 5th interspace medial to the left mid-clavicular line.

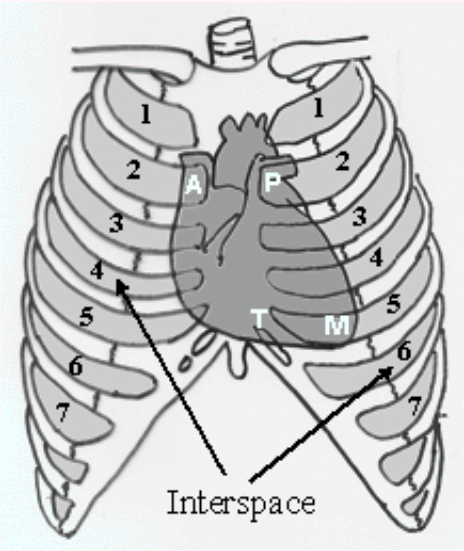
Abnormal findings

- An impulse felt in more than one interspace and shifted laterally indicates left ventricular dilation.
- A stronger than normal pulsation indicates left ventricular enlargement or hypertrophy.

Palpation: Cardiac thrills

- Cardiac thrills are vibratory sensations from turbulent blood flow across valves of the heart. They are described by some authors as the sensation felt over the throat of a purring cat.
- The presence of thrills indicates careful auscultation of the heart for associated murmurs.
- A murmur accompanied by a thrill increase the grading of the murmur to grade 4.
- Thrills may be difficult to feel in heavy-set or obese individuals.

Exercise 07



1. Sit the patient up and stand on his right side.
2. Place your right hand flat across the precordium and use the base of your fingers to feel for vibratory thrills over the 4 classic areas of cardiac auscultation:
   -Right sternal border at the 2nd interspace (aortic area);
   -Left sternal border at the 2nd interspace (pulmonic area);
   -Lower left sternal border (tricuspid area);
   -Apex of the heart (mistral area).
3. If a thrill is felt, note its relationship to the cardiac cycle and the direction in which it radiates.

(**N.B.** The joints at the base of the fingers are more sensitive to vibration sensation than the tip of the fingers. Thrills at the aortic or pulmonic area are best felt with the subject leaning forward and holding his breath in full expiration; thrills at the mistral area are best felt with the patient in the left lateral position.)

Normal findings

- No vibratory thrills is felt in a normal subject

Abnormal findings

- A systolic thrill at the aortic area indicates aortic stenosis; this thrill may also be felt in the sternal notch.
- A systolic thrill at the pulmonic area indicates pulmonic stenosis.
- An apical diastolic thrill indicates mistral stenosis.
- A lower parasternal systolic thrill indicates ventricular septal defect.

Percussion (Level 3 topic: Although popular in the past, few modern day physicians would elect to determine heart size by percussing for the lateral border of the heart. The following section is included for your interest only.)

- Review the section on "Technique of Percussion" in "PCLM: 8 & 9: Clinical Examination of the Abdomen" before you embark on this procedure.
- Percussion of the left lateral heart border can give an indication of the size of the heart. However, a posterior-anterior chest X-ray will give far more accurate information.

Exercise 08

1. Lay the patient supine and stand to his right side.
2. Place your left hand flat across the precordium with fingers parallel to the lateral border of the heart.
3. Start percussing the chest at the 5th interspace from the anterior axillary line and move medially at 1 cm intervals. Note the point at which the percussion note changes from resonant to dull.
4. Repeat the procedure at the 4th and the 3rd interspace.

Normal findings

- Like the apex beat, the left heart border should be medial to the mid-clavicular line at the 5th interspace

Abnormal findings

- In left ventricular dilatation the left lateral border of the heart is shifted more to the left along with the apex beat.

Auscultation (Level 1 topic)

N.B. Review the section on "The Stethoscope" in "**PCLM 02B**: Introduction to Physical Examination" and the classic areas of cardiac auscultation in "PHUS: Surface Anatomy of the Chest".

- Auscultation of the heart, or the chest for that matter, should not be done through clothing because doing so can diminish the heart or breath sounds and can add extraneous confusing noises.
- Always explain to the patient what you are doing and your intentions before you expose his/her chest.
- If you are right handed, stand to the right side of the patient.

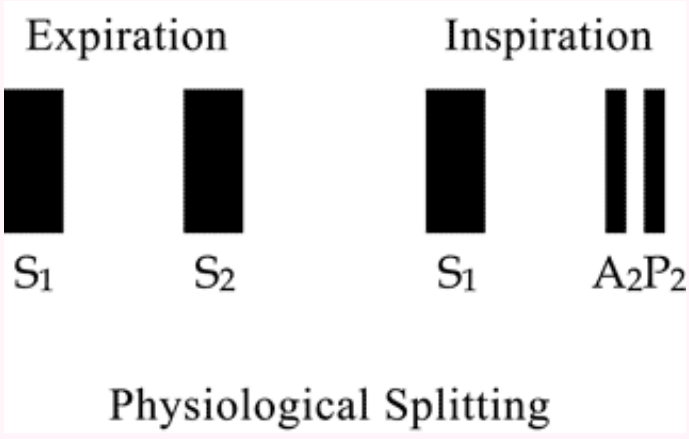
- You can begin auscultation with the patient lying supine but you may have to sit the patent up, lean him forward, or lay him on his left side when listening for specific murmurs.
- Take your time when you listen and close your eyes for added concentration if you desire.
- The first heart sound or S1 (said to sound like “lub”) originates from mistral valve closure occurring at the beginning of ventricular systole. The tricuspid valve closes at the same time but tricuspid valve closure is usually quiet because of the low pressures in the right heart.
- The second heart sound or S2 (said to sound like “dub”) comes from aortic and pulmonic valve closure at the end of ventricular systole.
- The systolic period falls between S1 and S2 and the diastolic period, between S2 and S1.
- At the end of your first lesson you are doing well if you can distinguish the first heart sound (S1) from the second heart sound (S2) and the systolic period from the diastolic period.

Exercise 09

1. Start auscultation by applying the diaphragm firmly to the apex of the heart (the mistral area) or the right sternal border at the 2nd interspace (the aortic area).
2. Listen for the first heart sound S1 and the second heart sound S2. Listen for any change in the characteristics of these 2 sounds during inspiration and expiration.
3. Confirm that you are timing the heart sounds correctly by palpation of the carotid artery gently with your free hand. (S1 precedes the carotid pulse by a small fraction of a second.)
4. Focus on the intervals of the cardiac cycle: systole is the interval between S1 and S2 and diastole is the interval between S2 and S1.
5. Listen for any extra sounds or murmurs that can be heard within the systolic and diastolic intervals.
6. Move on in a systematic manner through all 4 classic areas of auscultation and repeat steps 1 to 5 and compare the loudness of S1 in relation to S2 in these areas.
7. Repeat auscultation of the 4 areas by applying the bell lightly to the chest wall.

Normal findings

- The apical heart rate can be counted in a manner described for pulse rate (see “Pulse rate, heart rate, and rhythm” in “PCLM 03B: Vital Signs”): If heart rate is regular and faster then 15 beats in 15 seconds, count the number of beats over 15 seconds and multiple the result by 4. If heart rate is regular but slower than 15 beats in 15 seconds, count the number of beats over 30 seconds and multiple the result by 2. If the heart rate is irregular, count the number of beats over a full minute. Heart rhythm is normally regular. If it is irregular, determine whether the irregularity is repetitive (regularly irregular) or whether it is totally irregular (irregularly irregular). Heart rate and pulse rate are normally the same. If pulse rate is less than the heart rate, there is a pulse deficit.
- At the apex (mitral area), S1 is usually louder than S2.
- At the aortic and pulmonic areas, S2 is louder than S1.
- S2 has 2 components: aortic valve closure (A2) and pulmonic valve closure (P2). During expiration A2 is inseparable from P2 and S2 is only one sound.
- During inspiration A2 comes earlier than P2 and S2 appears split. This is because of the increase in venous return occurring during inspiration increases right ventricular stroke volume and delays pulmonic valve closure. At the

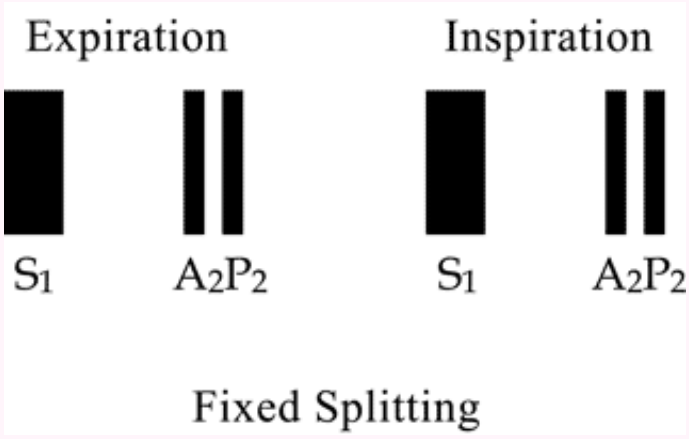


same time pooling of blood in the pulmonary capillary bed during inspiration decreases left ventricular stroke volume and the aortic valves closes earlier than during expiration. This physiological splitting of S2 is commonly heard in young patients and less so in older subjects.
- A low-pitch third heart sound or S3 that occurs early in diastole during rapid ventricular filling is normal in young athletic subjects or healthy pregnant mothers. If heard in patients with heart disease, it indicates abnormal ventricular filling.

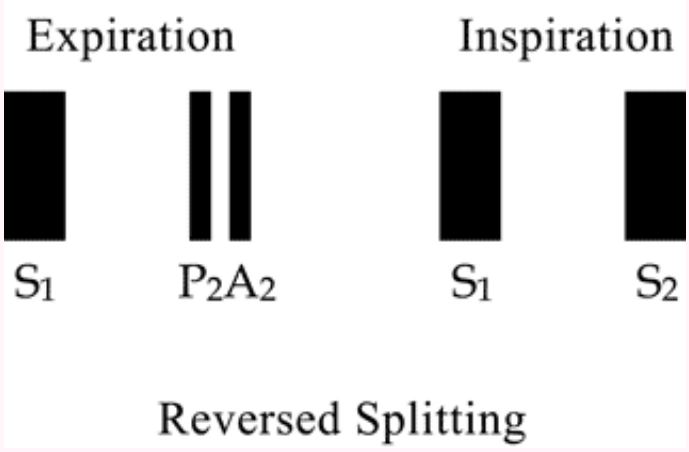
Abnormal findings

(**N.B.** When extra heart sounds or murmurs are heard, determine whether it occurs during systole or diastole. A comprehensive discussion of abnormal heart sounds and murmurs is beyond the scope of this manuscript. The following section deals with general features only. Please refer to a standard textbook for details.)

- Fixed splitting of S2 (i.e., splitting of S2 into A2 and P2 components is heard both during expiration and inspiration) is pathognomonic of atrial septal defect with a left to right shunt.

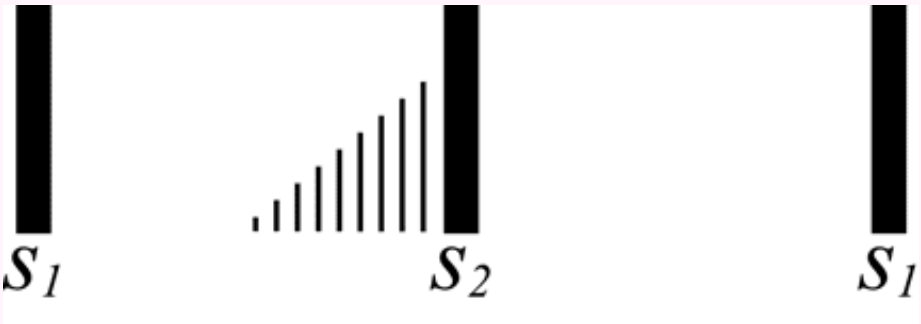


- Reversed splitting of S2 (i.e., splitting of S2 is heard during expiration and no splitting is heard during inspiration) is associated with obstruction of aortic outflow as in subaortic hypertrophic cardiomyopathy. In this instance, aortic valve closure is delayed during expiration because of outflow obstruction and closes after the pulmonic valve (i.e., P2 comes before A2 during expiration). During inspiration P2 is somewhat delayed and A2 comes somewhat earlier as in the normal situation and S2 is no longer split.

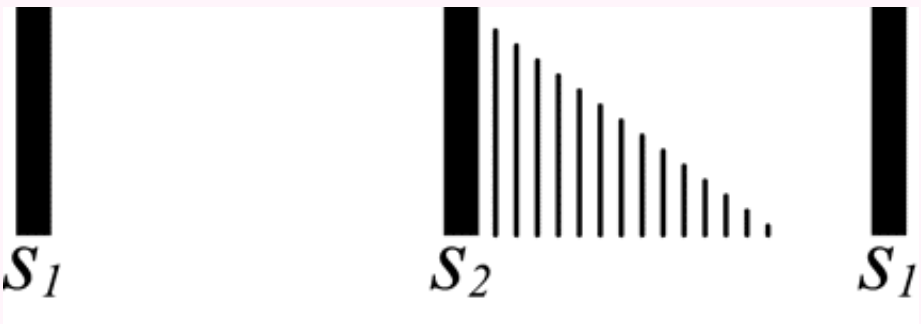


- The low-pitch third heart sound S3 that occurs early in diastole is normal in young and fit healthy subjects but indicates abnormal ventricular filling in patients with heart disease.
- The equally low-pitch fourth heart sound S4 occurs later in diastole and is due to atrial contraction pumping blood into a stiff left ventricle. It is always abnormal. (S4, being dependent on atrial contraction, is absent if the heart is not in sinus rhythm.)
- A high-pitch opening snap can be heard at the beginning of diastole in some patients with mistral stenos is.
- A high-pitch ejection click, occurring early in systole following S1, is sometimes heard over the aortic or pulmonic valve when these valves are diseased.
- A mid-systolic click is commonly associated with mistral valve prolapse.
- Murmurs should be described according to their timing within the cardiac cycle (systole or diastole). Terms commonly used are: systolic, pansystolic (holosystolic), early diasolic, mid-diastolic, presystolic (late in diastole and just before S1), continuous.

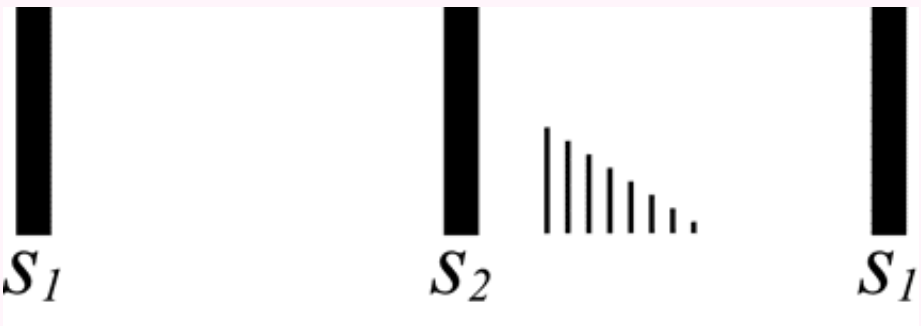
A pansystolic (holosystolic) murmur



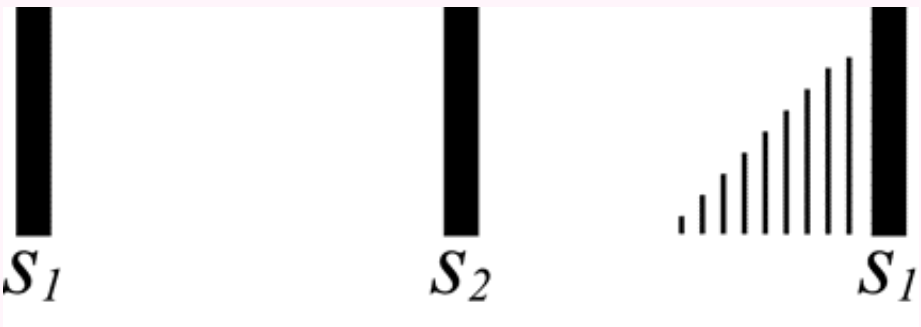
A late systolic murmur



An early diastolic murmur

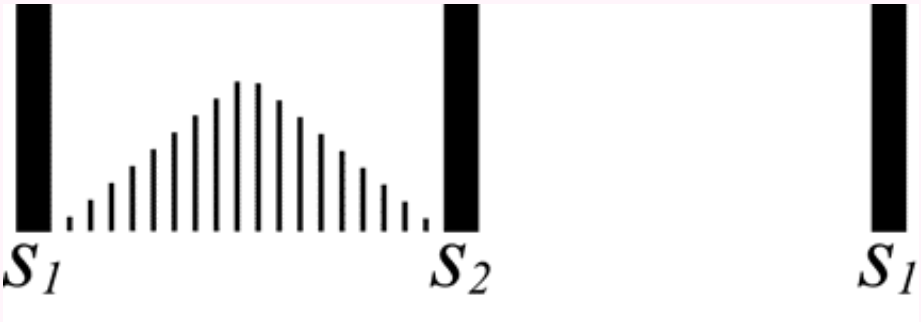


A mid-diastolic murmur



A late diastolic (presystolic) murmur

- Murmurs should also be described by their acoustic characteristics. Examples are the crescendo-decrescendo or diamond shape (intensity rising to a peak and then falling off) ejection murmur of aortic stenos is and the diastolic rumble of mistral stenos is with pre-systolic accentuation.



A systolic ejection (crescendo-decrescendo or diamond shape) murmur

- Murmurs should also be described by their direction of radiation. The ejection systolic murmur of aortic stenos is radiates to the neck; that of pulmonary stenos is to the left shoulder; and the systolic murmur of mistral regurgitation into the left axilla and the lower left chest at the back.
- Murmur should be graded according to their loudness:
    - Grade 1 – just audible when the room is quiet and the patient holding his breath;
    - Grade 2 – audible but faint or quiet;
    - Grade 3 – readily audible but not accompanied by a thrill;
    - Grade 4 – easily audible and accompanied by a thrill; (thrill may not be easily palpable in a heavy set or obese patient);
    - Grade 5 – very loud;
    - Grade 6 – loud enough to be heard without a stethoscope; the examiner only has to put his ear close to, but not on, the patient's chest.
- Pericardial rub is heard in acute pericarditis. It is a friction rub that sounds like rubbing sand papers together and heard both in systole and diastole.