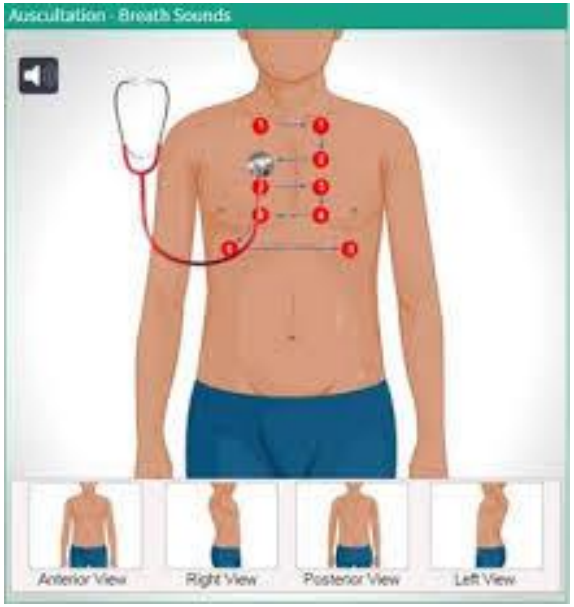
Percussion and auscultation of the chest



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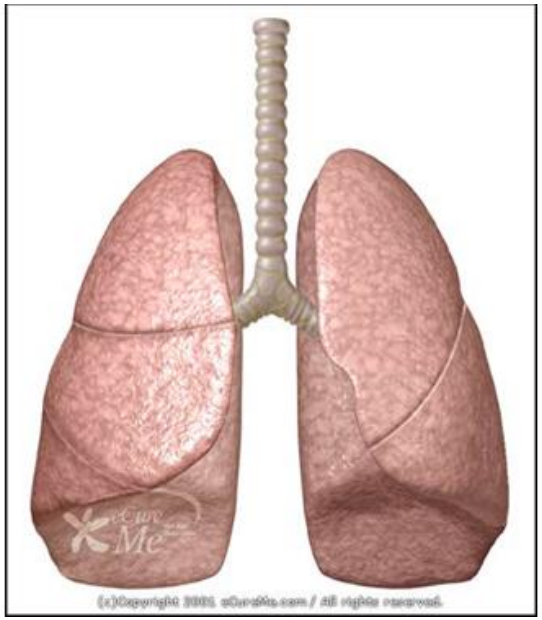
Surface anatomy lung fissures

Oblique fissure

Oblique fissure starts at the second dorsal spine posteriorly and passes obliquely around the chest to end at the 6th costal cartilage anteriorly. It separates upper from lower lobes

Transverse fissure

Transverse fissure presents on the right side, stars at the 4th costochondral junction and passes laterally until it meets the major fissure in the midaxillary line. It separates upper from middle lobes.



2- Surface anatomy of the lung

Anterior border

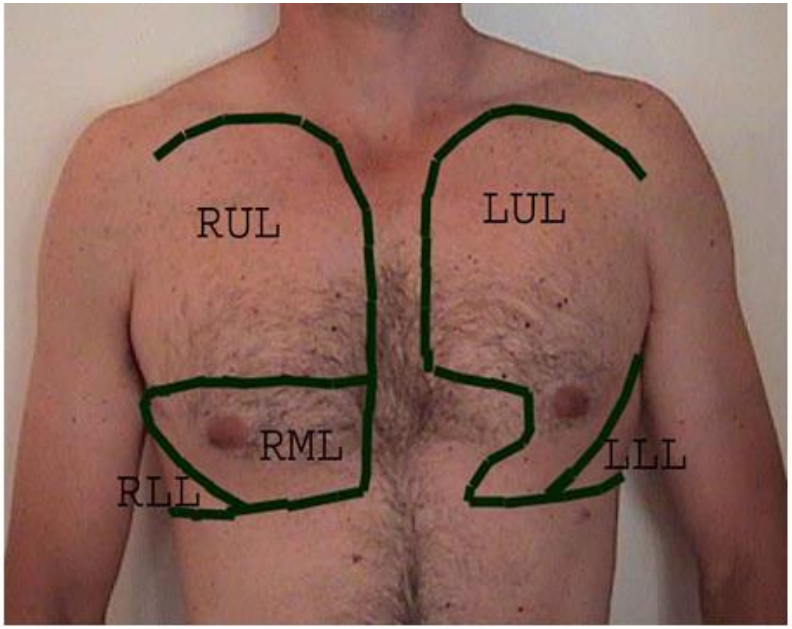
It starts one inch above the medial third of the clavicle, and passes downward and medial behind sternocalvicular joint to reach the middle line at sternal angle. In the right side, it descends in the middle line to reach the level of the 6^{th} costal cartilage. On the left side it reaches the 4^{th} costal cartilage and then deviates for about one inch to the left of the sternum to reach the level of the 6^{th} costal cartilage.

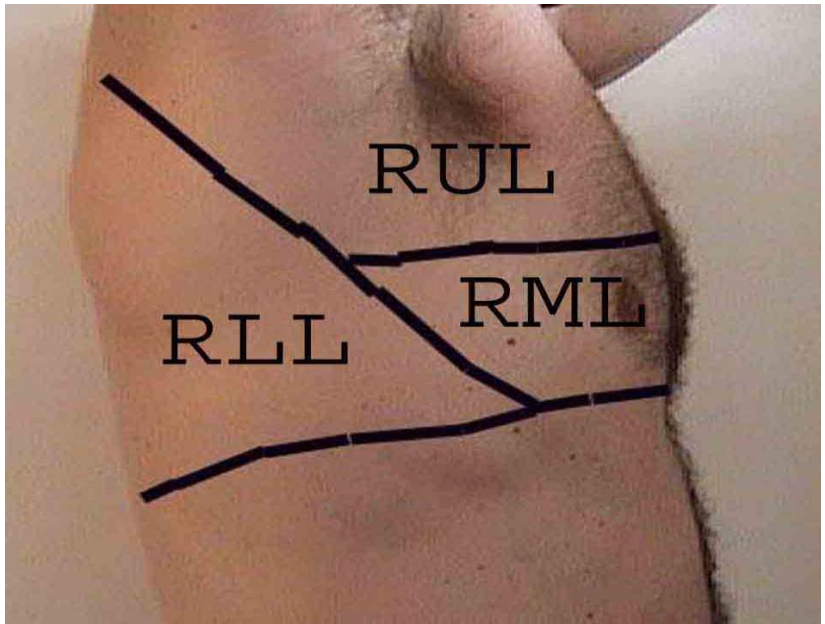
Inferior border

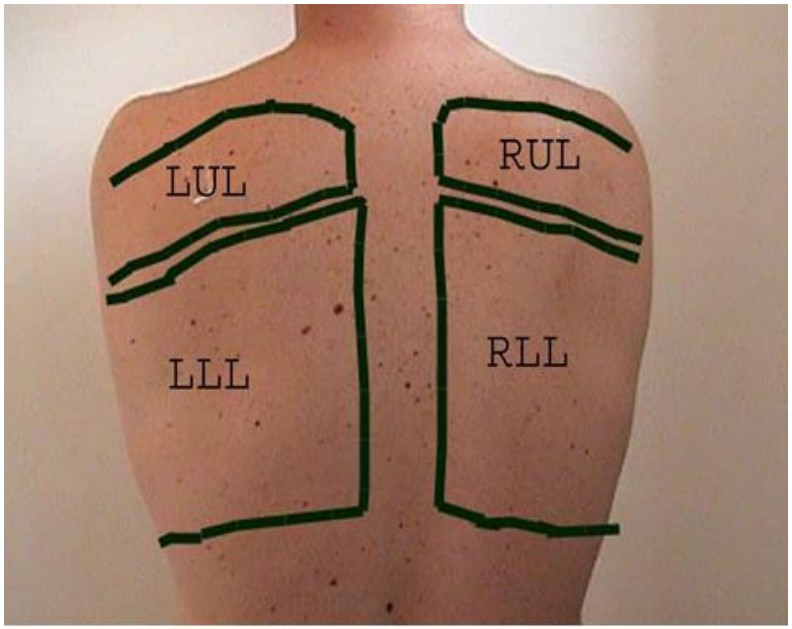
It starts from the 6^{th} costal cartilage round the chest passing through 6^{th}, 8^{th}, and 10^{th} ribs in the midclavicular, midaxillary, and infrascapular lines respectively.

Right lung has 3 lobes upper and meddle (separated by the transverse fissure) and lower lobes (separated from upper and middle lobes by oblique fissure)

Left lung has 2 lobes upper and lower lobes (separated by oblique fissure).







Lines of the chest

Midsternal Line: A vertical line down the middle of sternum

Parasternal Line: A vertical line along lateral edge of sternum

Mid-Clavicular Line: A vertical line from middle of clavicle

Anterior Axillary Line: A vertical line along anterior axillary fold

Mid-Axillary Line: A vertical line at mid point between anterior and posterior axillary line.

Posterior Axillary Line: Along post axillary fold

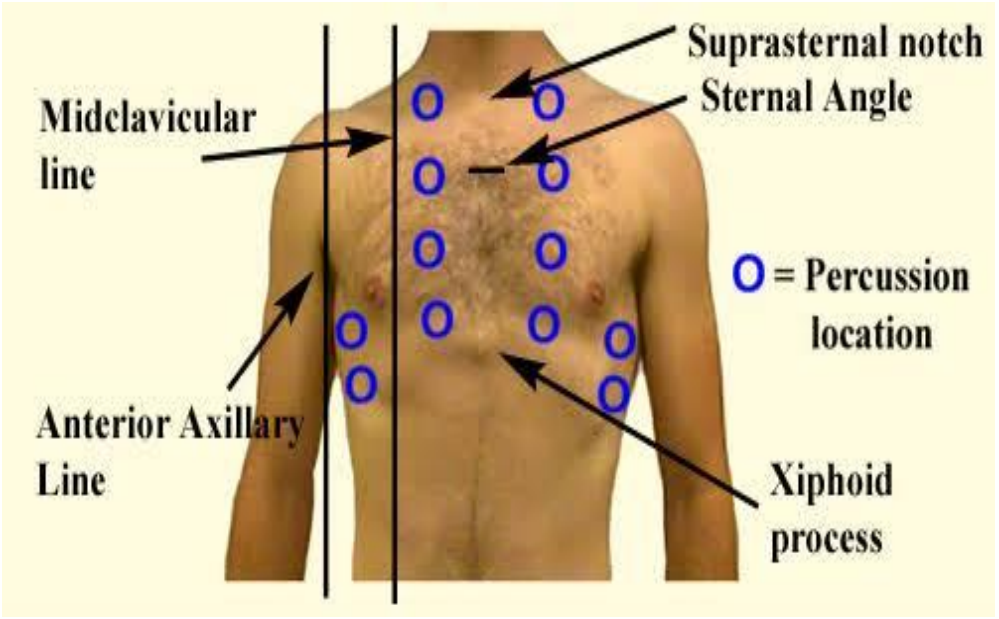
Scapular Line: Inferior angle of scapula

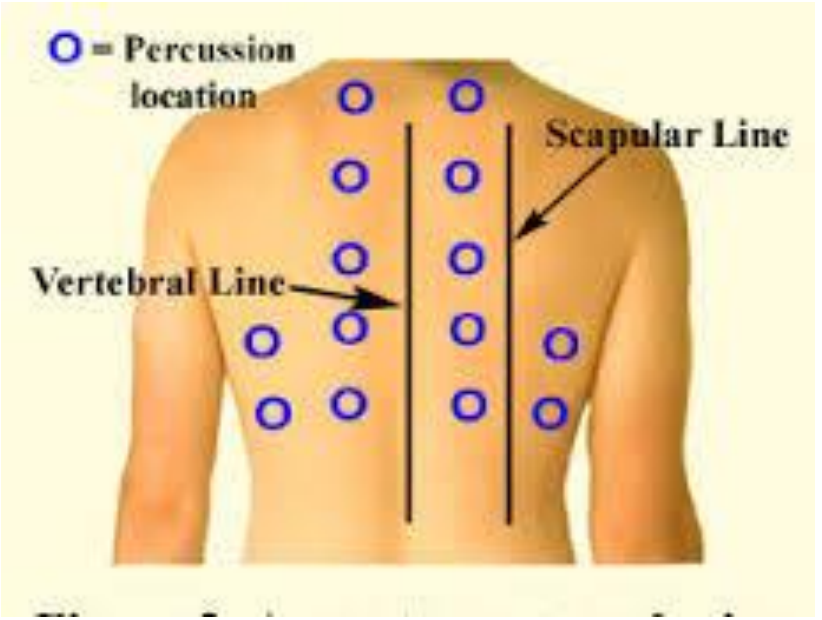
Vertebral line: Over spinous processes in the midline

Important Landmarks

Anteriorly: angle of Lewis → 2nd intercostal spaces

Laterally: the 1st palpable space is the 4th intercostal spaces
Posteriorly: inferior angle of the scapula → 7th intercostal





- **Rules of percussion**
- Always percuss from resonant to dull except Kronig's isthmus.
- Light percussion for the lung (except back), lower border of the liver & bare area of the heart while deep percussion for deep structure (as liver, heart), back and obese patients.
- Percussion is done by tapping the distal phalanx of the middle finger (plexor finger) sharply and briefly at the middle phalanx of the middle finger of the other hand (pleximeter finger).
- Movement starts from the wrist joint not from the elbow.
- Percussion notes must be compared on both sides choosing exactly equivalent areas.

Assessment techniques

Percussion sounds

- Flatness - bone or muscle
- Dullness - heart, liver, spleen
- Resonance - air filled lungs (hollow)
- Hyperresonance - emphysematous lung (hyperinflated)
- Tympany - air-filled stomach (drumlike)

Steps of percussion

Liver Percussion

(by heavy percussion except lower border)

Detection of the upper border of the liver by heavy percussion starting from the 2nd intercostal space at the right midclavicular line downward.

Heart percussion

- **Percussion to the right of the sternum** at the intercostal space above that the upper border of liver or at the 4th intercostal space in cases with lung hyperinflation. Normally there is no dullness to right of the sternum. .
- **Percussion over the base** (upper border) of the heart by deep percussion over the left and right 2nd intercostal space medial to midclavicular line. Normally the 2nd spaces are resonant.
- **Percussion of left border of the heart** by deep percussion from the axilla inwards; first in the space of the apex and next in the spaces above. Normally no dullness

Percussion over the bare area of the heart (uncovered by the lung) by light percussion.

Bare area has 3 borders: right border (formed by midline from 4th to 6th ribs), left border (formed by line running from middle line opposite the 4th costal cartilage to 6th rib in parasternal line) and inferior border (formed by line running from 6th rib in parasternal line to middle line opposite the 6th costal cartilage). Normally bare area is dull.

percussion over the lower part of the sternum. Normally there cancellous resonance (cancellous percussion).

Lung percussion

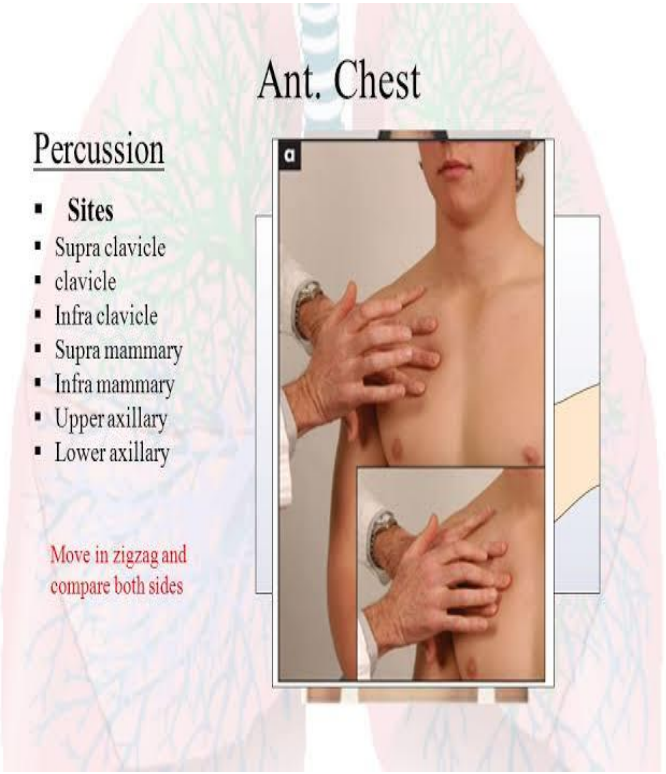
(by light percussion except the back)

Front percussion: The patient lies in supine or semi-recumbent position with arms slightly abducted. Percuss directly over the clavicle & compare bilaterally.

Percuss over infraclavicular area (from the clavicle to the 2nd intercostal spaces) and compare bilaterally.

Percuss space by space from 2nd intercostal (IC) spaces to 6th IC spaces.

Lateral percussion: The patient raises his hands above his head to get access to the 4th space.



Back percussion:

The patient sits with his arms folded across the front of the chest to draw the scapulae laterally as far as possible.

Percuss over supraspinatus area (above the spine of the scapula) with your hand horizontal.

Percuss over interscapular area (between the two scapulae at paravertebral line) with your hand vertical.

Percuss space by space at infrascapular line from 7th to 10th space, and then do tidal percussion.

Special areas

Kronig's Isthmus :

- It is a band of resonance representing lung apex.
- ***Laterally*** it is marked by a line joining 2 points:

1. The junction of the medial 2/3 of the clavicle with the lateral 1/3.
2. The junction of the medial 1/3 of the scapular spine with the lateral 2/3.

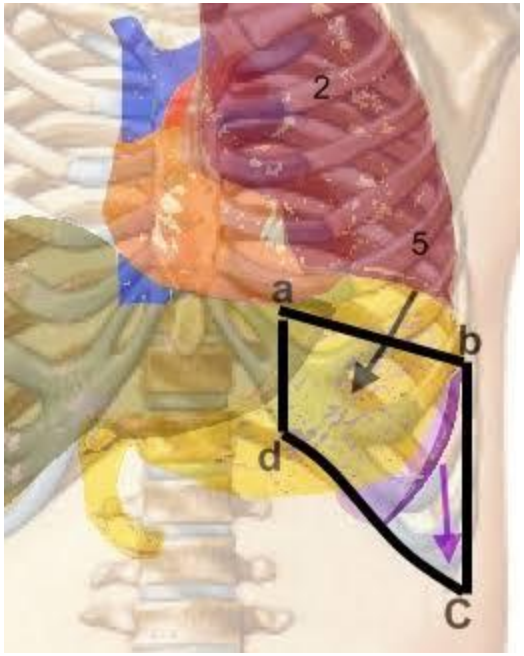
- ***Medially*** marked by a line between the sternal end of clavicle and the 7^{th} cervical spine.

Traube's area

is an area of tympanitic resonance overlying the air bubble in the fundus of the stomach.

It is bounded by:

- Right border: extends from the apex (in 5th intercostal space at midclavicular line) to the tip of the 8th costal cartilage. It coincides with lower border of the left lobe of liver.
- Left border: corresponds to a line crossing the left midaxillary line at 9th, 10th. 11th ribs. It coincides with the anterior border of the spleen.
- Upper border: corresponds to a line connecting the apex to 9th rib in the midaxillary line. It coincides with the base of the left lung.
- Lower border: corresponds to left costal margin from 8th costal cartilage to the 11th rib in the left midaxillary line



Special techniques

Tidal percussion

Definition: The lower border of lung resonance at the back is carefully noted in full inspiration and full expiration.

The distance between both represents the range of movement of the diaphragm.

Value:

1- Limited movement on both sides in emphysema.

2- It can differentiate between dullness caused by supra-diaphragmatic and infra- diaphragmatic lesions. Infra- diaphragmatic lesions is expected when the level of dullness moves downwards with inspiration

3- In diaphragmatic paralysis the level of dullness moves upwards with

Shifting dullness

Definition: The upper border of fluid dullness is marked while changing the position of the patient.

Value: It can differentiate between pleural effusion & hydropneumothorax as in hydropneumothorax, the fluid level changes up and down as the patient leans forwards and backwards.

Causes of dullness

Causes of dullness at the right border of the sternum

1. Right atrial enlargement
2. Pericardial effusion
3. Aneurysm of the aorta
4. Sub-diaphragmatic lesion (subphrenic abscess, liver abscess)

Causes of dullness over the left 2nd space

1. Pulmonary artery dilatation (pulmonary hypertension, aneurismal dilatation of pulmonary artery, post-stenotic dilatation)
2. Pericardial effusion
3. Space-occupying lesions in the superior mediastinum

Causes of dullness over the right 2nd space (Aortic area)

1. Dilatation of ascending aorta, and post-stenotic dilatation
2. Huge aneurysm of the aortic arch
3. Space-occupying lesions in the superior mediastinum

Causes of dullness at the left border of the heart (outside the apex)

1. Left ventricular enlargement
2. Ventricular aneurysm
3. Pericardial effusion

Causes of widen bare area of the heart

1. Right Ventricular enlargement
2. Pericardial effusion
3. Lung collapse

Causes of resonant bare area of the heart

1. Emphysema
2. Left-sided pneumothorax, pneumo-mediastinum

Causes of dullness over Kronig's isthmus

1. Consolidation, fibrosis, collapse
2. Pleural thickening (pleural cap)
3. Apical pulmonary

Causes of dullness in traub's area:

1-From above: Lt pleural eff., Pericardial eff.

2-From left : Splenomegally

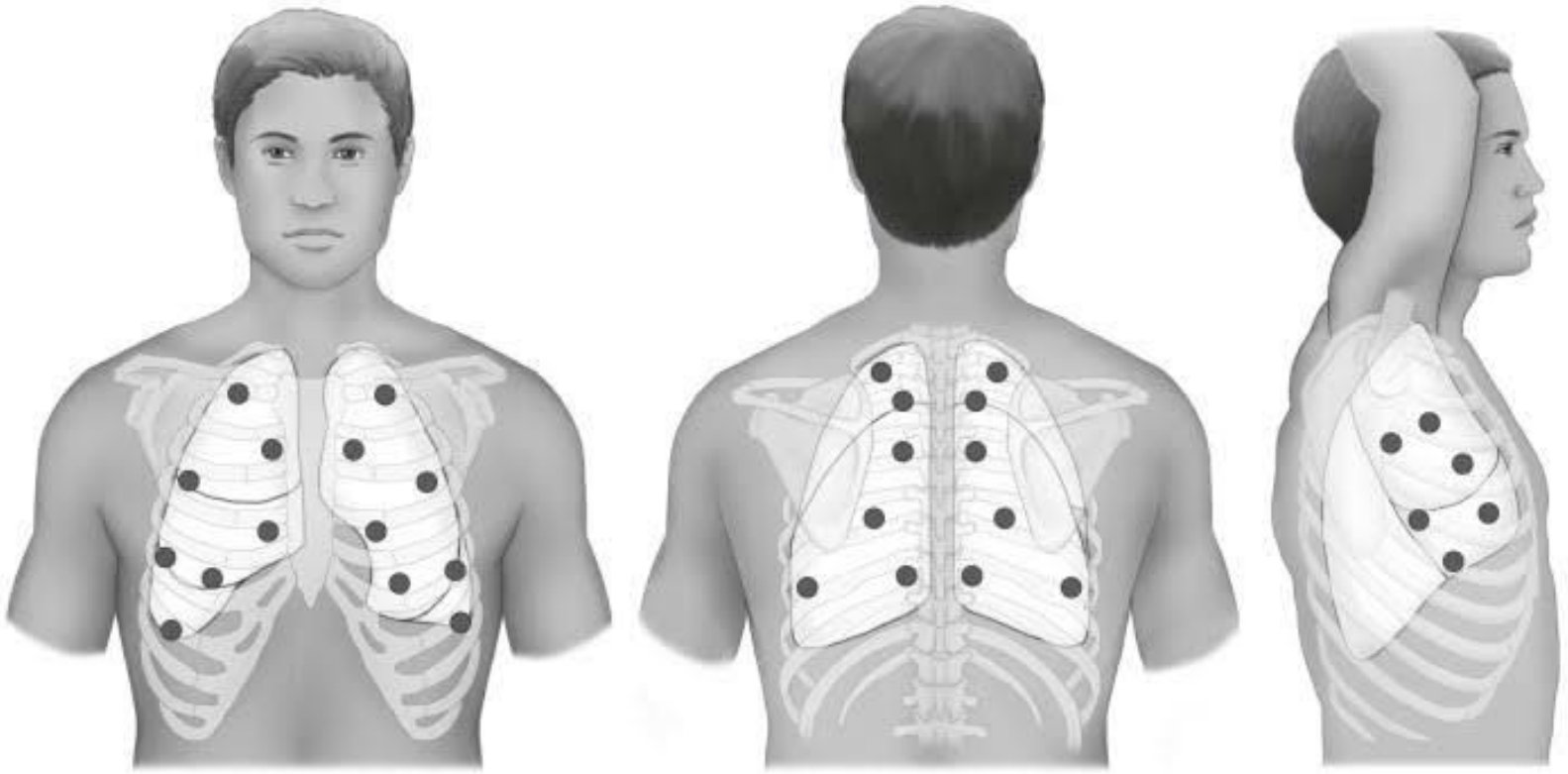
3-From Right : Hepatomegally

4-From below:

- -Full stomach
- -Gastric tumour
- -Ascites
- -Pregnancy
- -Subpherinic abcess
- -Retroperitoneal neoplasm
- -Complete situs inversus

Auscultation

Auscultation sites



How Auscultation is performed

- The patient should be seated or lying comfortably in a position that allows access to all lung fields.
- Auscultation is done in a systematic, side-to-side and cephalocaudal (head to toe) fashion.
- Breath sounds should always be compared symmetrically (e.g. listen first to left side and then the right side).
- Sounds should be auscultated on the anterior and posterior segments of the chest wall. (In full pulmonary examinations, the lateral side is auscultated as well).

What should we auscultate for?

Breath sound

- Intensity
- Character:
  - Vesicular breathing
  - Vesicular breathing with prolonged expiration
  - Bronchial breathing

Adventitious sounds

- Crepitation
- Wheeze
- Pleural rub

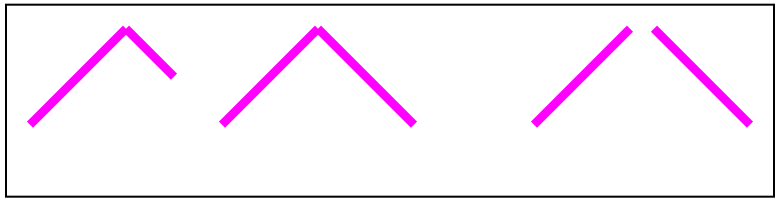
Breath sounds

Normal Lung Sounds

- Created by turbulent air flow
- Inspiration
  - Air moves to smaller airways hitting walls
  - More turbulence, Increased sound
- Expiration
  - Air moves toward larger airways
  - Less turbulence, decreased sound
- Normal breath sounds
  - Loudest during inspiration, softest during expiration

The major types of breath sounds are:

- Vesicular breath sounds
- Bronchovesicular sounds
- Tubular



1. Tracheal (heard over trachea)
2. Bronchial
3. Amphoric and cavernous breath sounds

All breath sounds are indeed tubular, changing into vesicular when filtered by alveolar air (high-frequency or low-pass filter).

Alveolar air acts as an equalizer and eliminates high-frequency (louder) components > 200 Hz while preserving low

Vesicular Breath Sounds

- Characters –
  - Characteristic rustling or breezy
  - Intensity of inspiration more than expiration
  - Longer duration of inspiration
  - Lower pitch of expiration
  - No pause between inspiratory and expiratory sound

- Normally heard all over the chest except, over larynx, trachea and lower cervical vertebrae, over and around the upper part of sternum, 3rd and 4th dorsal vertebrae

Intensity:

(1) Increased normally in children and called puerile breathing

(2) Decreased normally in women and older patients with shallow breathing

(3) Decreased abnormally in:

airway obstruction (either generalized as severe asthma, emphysema or localized as FB),

restrictive lung (ILD),

pleural diseases (as pleural effusion, pneumothorax, and pleural thickening) and

chest wall diseases

Vesicular breath sound with prolonged expiration

Characters:

like vesicular breath sound but expiration is unduly prolonged due to decreased elastic recoil of the lung and increased resistance to the airflow

Causes:

(1) Loss of lung elastic recoil as in emphysema

(2) Increased airflow resistance as in bronchial asthma and emphysema

Bronchial breath sound

Character:

(1) Inspiration is equal to loud expiration.

(2) A short pause is present between inspiration and expiration.

(3) The respiration high frequency loud, hollow and blowing.

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Distribution

Normally heard over trachea and main bronchi.

It reflects the absence of the alveolar air and its replacement by liquid that better transmit high frequency sounds.

This occurs in alveolar collapse with patent bronchus (as in compression collapse, relaxation collapse) and alveolar fluid-filling (as in consolidation).

So, it indicates patent airways in a setting of airless alveoli with good conducting media.

Types and causes:

1. High-pitched (tubular) BB: loud resemble the sound of air blowing over a hollow pipe. They are present only normally on the manubrium. Heard abnormally over consolidation as in pneumonia and collapse with patent bronchus (as in: 1-lung compression by large pleural effusion & tension pneumothorax. 2- massive collapse due to peripheral obstruction of the bronchi with secretion

2. **Medium-pitched (bronchial) BB:** heard over -consolidation collapse, collapse with patent bronchus, bronchopneumonia and cavities surrounded by consolidation.

3. **Low- pitched BB:**

- Cavernous breathing: like blowing through a cupped hands, and heard over cavity with relaxed wall
- Amphoric breathing: like blowing over a mouth of a bottle, and heard over cavity with tense wall, and tension pneumothorax.

D'espine sign:

bronchial breathing heard below 2nd dorsal spine in adults and 4th dorsal spine in children denoting mediastinal lymphadenopathy, fibrosing mediastinitis

Broncho-vesicular breath sound

Characters: They have half-way characteristics between tracheal and vesicular sounds:

- Like tubular sounds, they have long and well-preserved expiration.
- Like vesicular sounds, they lack a silent pause between inspiration and expiration.
- They are softer/lower-pitched than tubular sounds, but harsher/higher-pitched than vesicular as broncho-vesicular sounds undergo some physical changes of filtering of high-frequencies by crossing only a thin mantle of alveolar air.

Causes: Normally heard over parasternal and parascapular areas. Abnormally heard over early consolidation and thin pleural effusion partially compressing the alveoli but not the bronchi. They also heard over pulmonary fibrosis and resolving pneumonias

Vocal resonance

Spoken voice is tested while the patient says 44 in Arabic or 99 in English.

Comparison of the equivalent parts of the chest on each side must be performed rapidly noting intensity and change in quality. Normally, the spoken voice is muffled and indistinct.

Whispered voice is next tested. Normally, the whispered sound is indistinct.

Bronchophony: the spoken voice sounds are louder and distinct.

Whispering pectoriloquy:

the whispered sound is louder and distinct.

Both bronchophony and whispering pectoriloquy are detected over consolidation, cavity and pneumothorax.

Augophony (eugobronchophony):

the spoken voice assumes a nasal quality.

Ask the patient to say "E", it will be heard "A".

It was thought to be detected over pleural effusion and large pneumothorax.

A change in sound-filtering properties of consolidated lungs accounts for the presence of augophony, which does not require, as often stated, the presence of an overlying pleural effusion

Adventitious sounds

Rhonchi

Definition:

musical continuous sounds produced by bronchial obstruction usually occur in expiration**.**

Mechanism:

air passing through the narrowed bronchi vibrates. As a result, the bronchial walls also vibrate and produce the characteristic sound of rhonchus

Types:

- High-pitched or sibilant rhonchi (wheeze): due to narrowing of small bronchi
- Low-pitched or sonorous rhonchi (rhonchi): due to narrowing of large bronchi

Causes:

- Generalized bronchial narrowing (as in chronic bronchitis and bronchial asthma)
- Localized bronchial narrowing (due to foreign body or tumour)

Feature	Wheeze	Rhonchi
Sound	Continuous (> 250 msec); high-pitched musical sound; usually polyphonic	Continuous (> 250 msec); low-pitched musical sound; mostly polyphonic
Cause	Vibration of small airways at point of closure	Vibration of large airways at point of closure
Phase	Almost always inspiratory and occasionally expiratory	Almost always expiratory and occasionally inspiratory
Effect of cough	May change with cough	Clear at least temporarily
Causes	Asthma or extrinsic compression of airway by foreign body, tumor, or secretion	Acute bronchitis, COPD, extrinsic compression of airway or obstruction of the airway by foreign body , tumor, or secretion

Crepitations

Definition:

Non-musical discontinuous explosive short sounds with crackling quality usually occur in inspiration. Sometimes they are only heard after coughing (post-tussive crepitations), but they may disappear or become less numerous after prolonged cough.

Mechanism:

1. Rupture of fluid films or bubbles: This is responsible for coarse crackles and occurs whenever air flows through large central airways coated with thin secretion
2. Reopening of partially collapsed distant airways with sudden equilibration of intra-airway pressure: The partial collapse of distal airways is due to high interstitial pressure, the result of either scarring (interstitial fibrosis) or fluid (pus, blood, serum).

Classification:

Crepitations can be classified according to timing and intensity

Timing:

- **Early and mid-inspiratory crackles:** are coarse, loud, low-pitched, scanty, gravity-independent, well transmitted to the mouth, produced by bubbling of air through thin secretion in large and medium-sized airways (as in bronchitis and bronchiectasis). They are mostly heard over the central chest, both anteriorly and posteriorly. They resolve with coughing and can not be extinguished with posture.

- **Late inspiratory**: are fine, soft, high –pitched, profuse, gravity-dependant, poorly transmitted to the mouth produced by reopening of partially collapsed distant airways. They can be extinguished by a change in posture but not by coughing. They strongly associated with restrictive process.
- **Pan-inspiratory:** bronchiectasis, pulmonary oedema, consolidation

Intensity:

1. Fine crepitations: high-pitched sound simulated by rubbing a lock of hair between fingers. They did not clear with a cough. They are caused by pulmonary congestion (bilateral basal), early pneumonia, and early TB
2. Medium-sized crepitations: Pulmonary oedema
3. Coarse crepitations: low-pitched sound simulated by bubbling liquid. They may clear with a cough. They are caused by bronchiectasis, resolving pneumonia, and advanced TB
4. Bubbling crepitations: deep coma and dying patients (death rattles)

Feature	Fine crackles	Coarse crackle
Sound	Explosive interrupted sounds (< 250 msec); higher in pitch, simulated by rubbing a lock of hair between the fingers	Explosive interrupted sounds (< 250 msec); lower in pitch, simulated by bubbling liquid
Cause	Sudden opening of previously collapsed alveoli and small airways	Sudden opening of previously collapsed bronchi and large airways; air bubbling through secretion
Phase	End-inspiration	Early or pan-inspiration or often expiration
Cough	Does not clear	May clear
Causes	Pulmonary fibrosis, pneumonia and heart failure	Acute and chronic bronchitis, pulmonary edema, and bronchiectasis

Pleural Rub

- Non-musical sound, usually longer and lower pitch than lung crackles.
- Discontinuous or continuous brushing sounds.
- Occurs during inspiration and expiration.
- Sounds like the creaking of old leather.
- Caused by coarsened surface of the normal pleura, due to fibrin deposits, thickened or inflamed or with neoplastic cells