Chest Imaging

Imaging modalities of the chest include:

- Plain X-Ray.
- Computed Tomography (CT).
- Magnetic Resonance Imaging (MRI).
- Ultrasound.
- Radio-isotope studies.
- Angiography .

x-ray

Importance of chest x-ray

- Diagnosis and follow up of chest and heart diseases.
- Routine examination before employment.
- Routine pre-operative examination.
- Follow up malignancy.
- Medical checkup.

Advantages of X-Ray:

➡It is a cheap and simple technique.

➡It has lower radiation compared to CT scan.

➡X-rays are widely used by radiologists.

Disadvantages of X-Ray:

➡It does not provide 3D information.

➡Bones can block significant diagnostic data as it absorbs the radiation.

➡Due to its radiation, it mutates cells which causes ionization. This often leads to cancer.

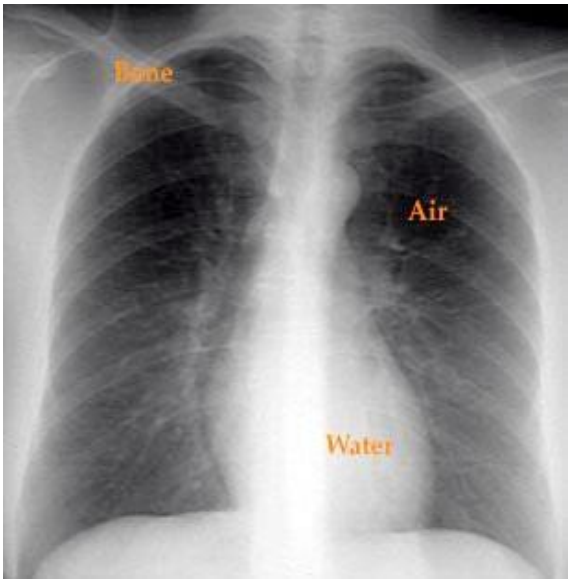
➡It does not produce the best image but medium quality image.

Different tissues in our body absorb X-rays at different extents:

Bone- high absorption (white).

Tissue- somewhere in the middle absorption (grey).

Air- low absorption (black).



N.B. Conventional radiographs should be performed as the initial imaging study in all patients with thoracic disease.

What is the technically adequate x-ray?

The recognition of proper radiographic technique on frontal radiographs involves assessment of basic features: penetration (exposure), rotation (Pt. position), and inspiration (breath).

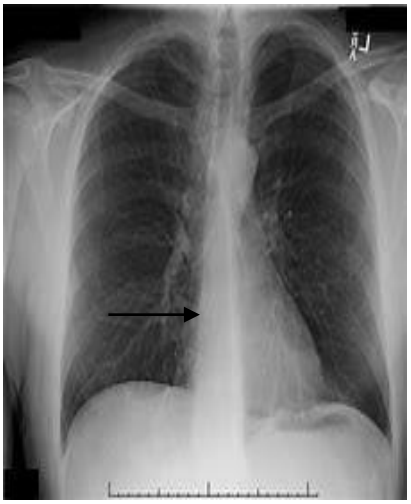
-Penetration.

-Inspiration.

-Rotation.

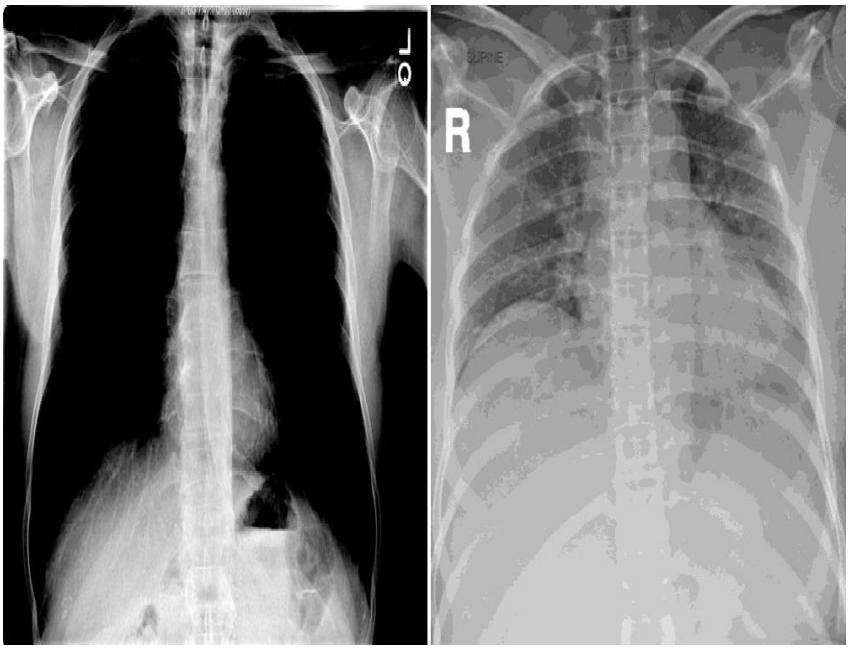
Penetration :

You should be able to just see the thoracic spine through the heart (arrow).



-If the film is under penetrated the pulmonary markings are more prominent.

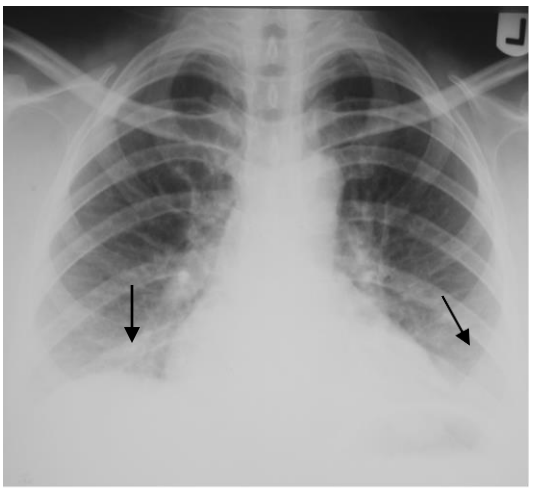
-Over penetration results in loss of visibility of low- density lesions.



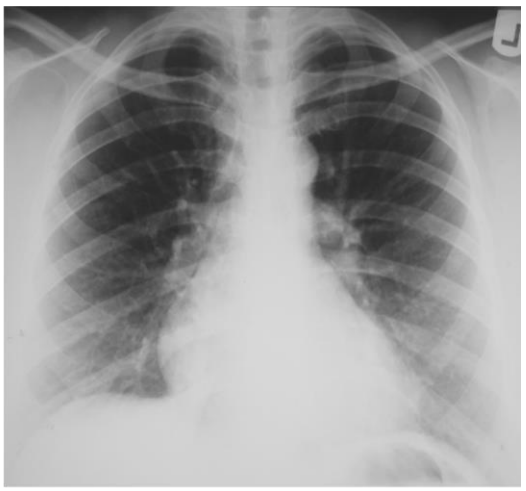
Over penetrated under penetrated

Inspiration:

-About 10 ribs posterior visible is an excellent inspiration.



Inadequate inspiration

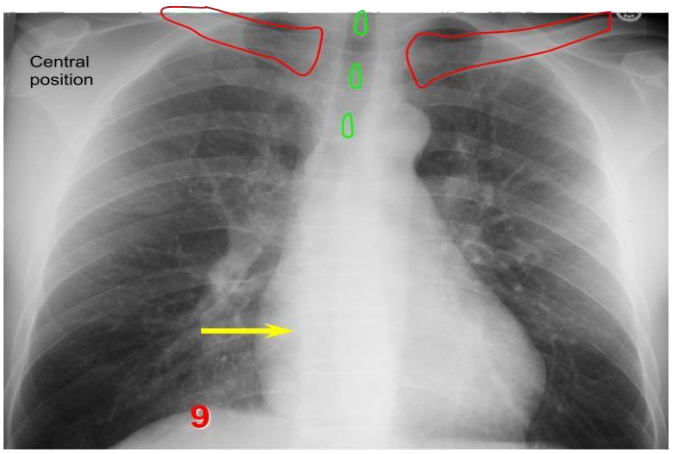


Adequate inspiration

-Poor inspiration will crowd lung markings and make it appear as though the patient has airspace disease (arrows).

Rotation:

If the spinous process of the vertebral body is equidistant from the medial ends of each clavicle ,there is no rotation.



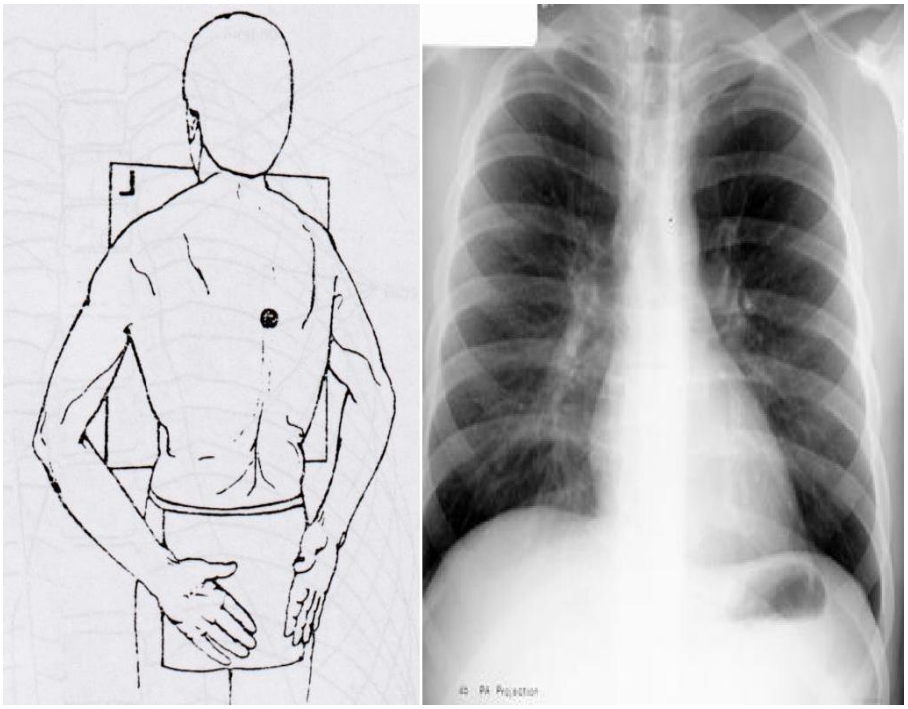
A-P versus P-A

-In the PA film, the heart is closer to the film and thus less magnified.

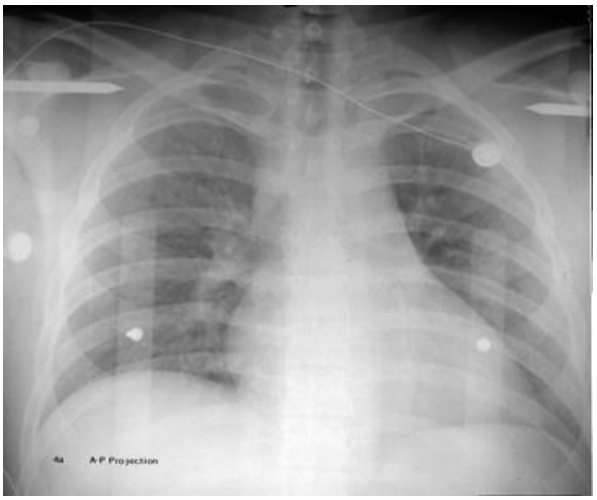
(the standard chest x-ray film is PA)

-In an AP film, the heart is farther from the film and is more magnified.

(portable chest x-rays (in ICU) are almost always done AP)

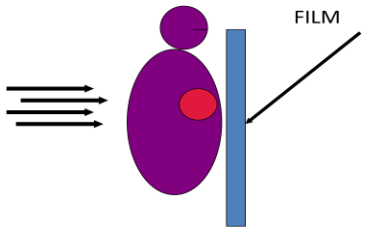


Chest x-ray , postero-anterior view ,no magnification of the heart size .



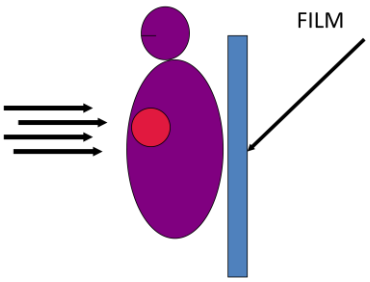
Chest x-ray antero-posterior view with magnification of the heart size.

PA (Postero-anterior)



In postero-anterior view the patient is facing the film with x-rays penetrate through the back of the patient on to the film.

AP or (Antero-posterior)



In antero-posterior view (AP) the x-rays penetrate through the front of the patient on to the film.

Lateral view:

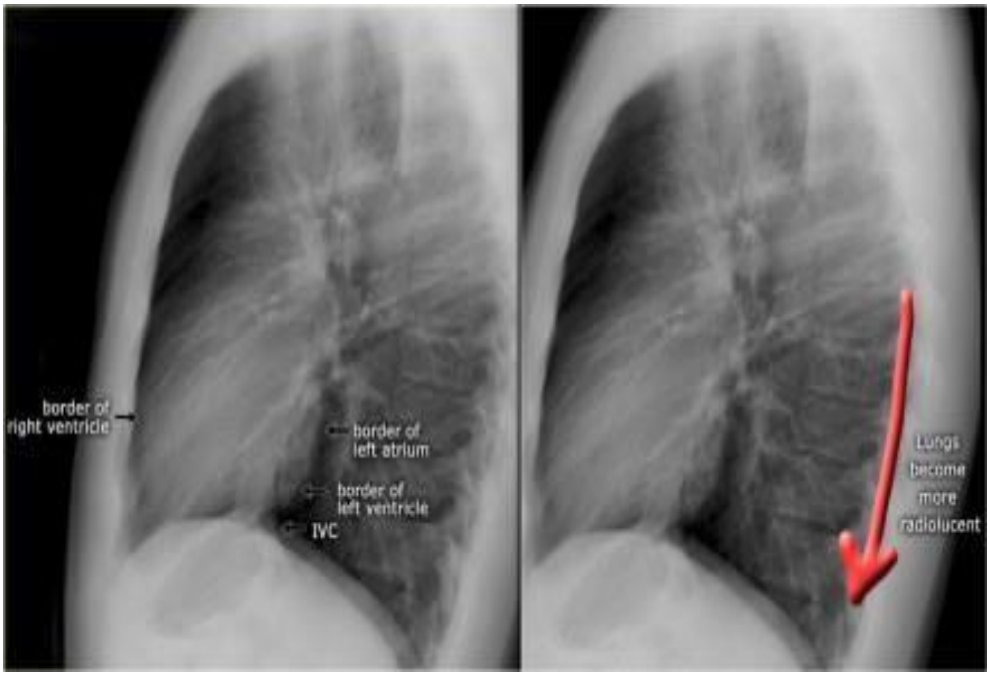
-Posteroanterior (PA) and lateral chest radiographs are the mainstays of thoracic imaging.

-The **lateral chest view** may be performed as an adjunct to a frontal chest radiograph in cases where there is diagnostic uncertainty.

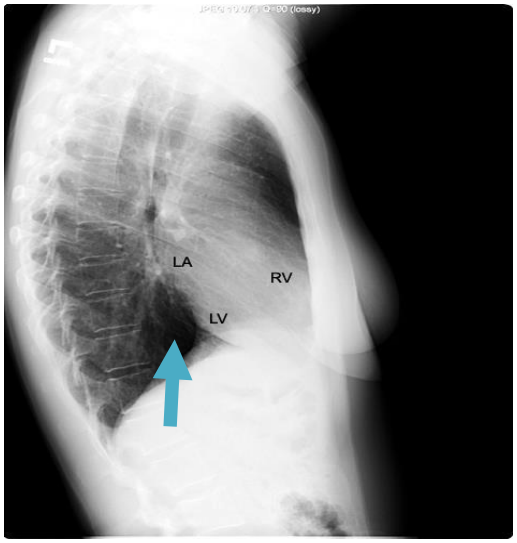
-On a normal lateral view the contours of the heart are visible and the IVC is seen entering the right atrium **(a)**.

-The retrosternal space (arrow) should be radiolucent (black), since it only contains air.

-As you go from superior to inferior over the vertebral bodies they should get darker, because usually there will be less soft tissue and more radiolucent lung tissue (red arrow) **(b)**.



(a) (b)



Lateral chest x-ray, showing the cardiac chambers and the retro-cardiac space (arrow).

Criteria of a good x-ray of the chest:

-Patient is central:

A- Sterno-clavicular junction is equidistant from midline (spinous process).

B- Mediastinum 2/3 to the left and 1/3 to the right.

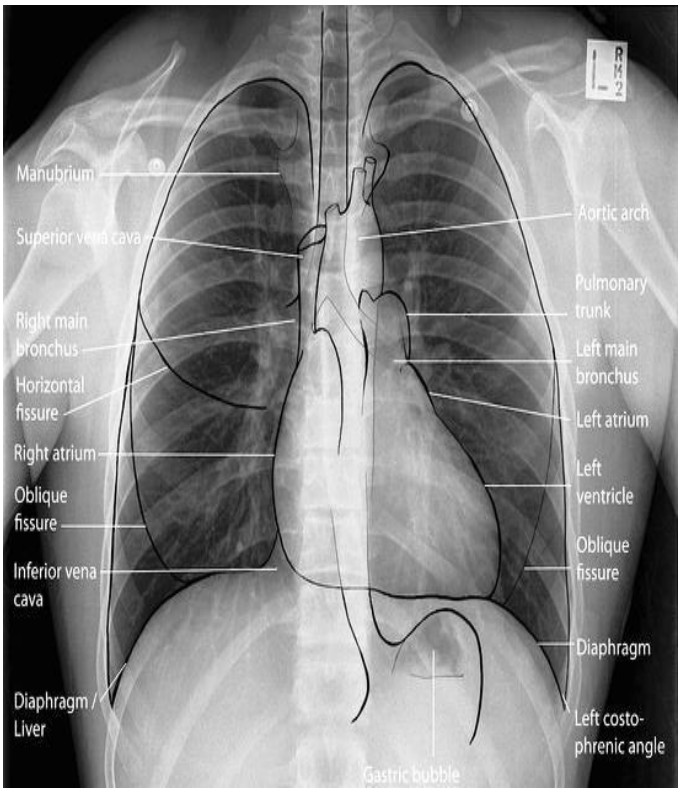
-Lung apices are seen .

-Diaphragm should be found at the level of 5 to 7 ribs anterior and 8 to 10 ribs posterior.

-Costo-phrenic and cardio-phrenic angles are seen.

-Scapulae should be away of the lung fields.

-Vertebral bodies are just visible through the heart.



Systematic approach:

- Lungs and hila.
- Diaphragm and pleural surfaces.
- Heart and mediastinum.
- Bones .
- Soft tissues.
- Abdomen and

neck.

1-Lungs and hila:

Hilum:

-Normal hilar opacities are predominantly caused by the pulmonary arteries and should be symmetric in size and density.

-Left hilus is higher than right hilus.

Lung fields:

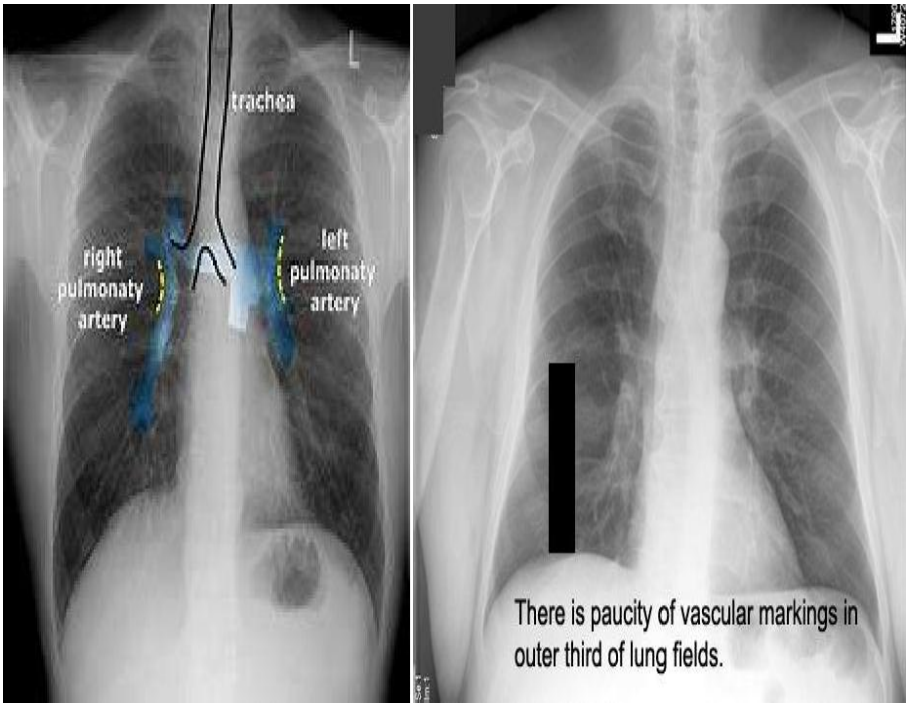
- The opacity of the lungs as visualized radiographically is attributable solely to the presence of the pulmonary vasculature and enveloping interstitial structures.

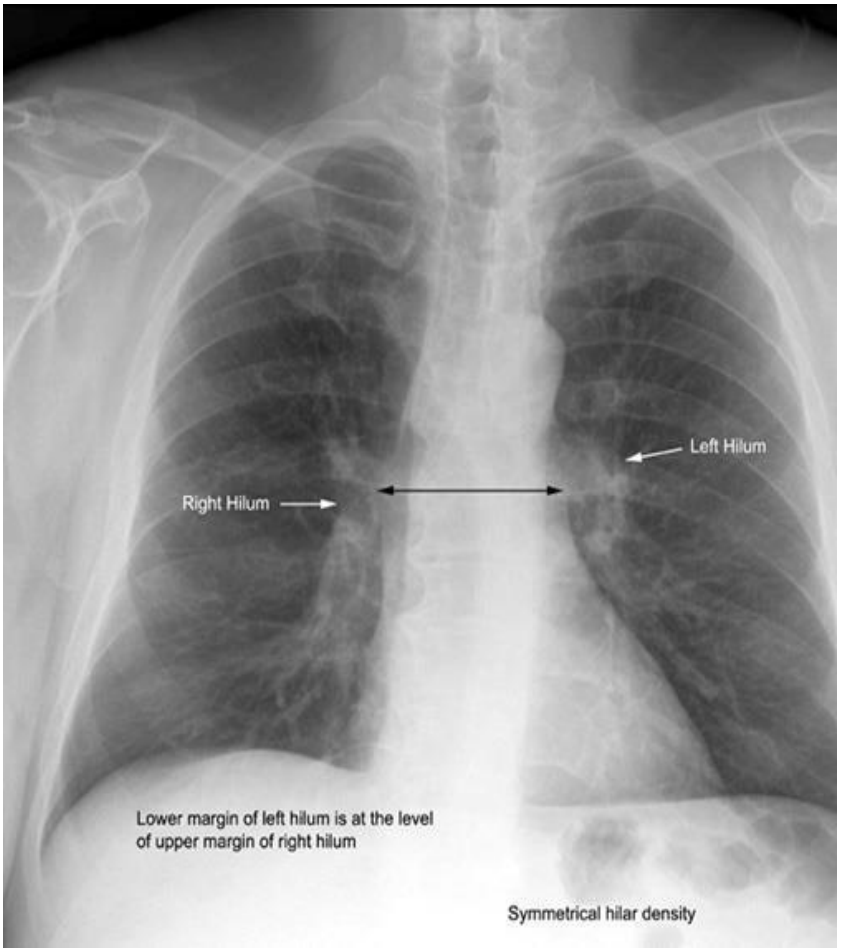
- The opacity of the lungs increases inferiorly in women as a result of summation of overlying breast tissue.

Blood vessels:

-Both arteries and airways diminish in caliber as they divide.

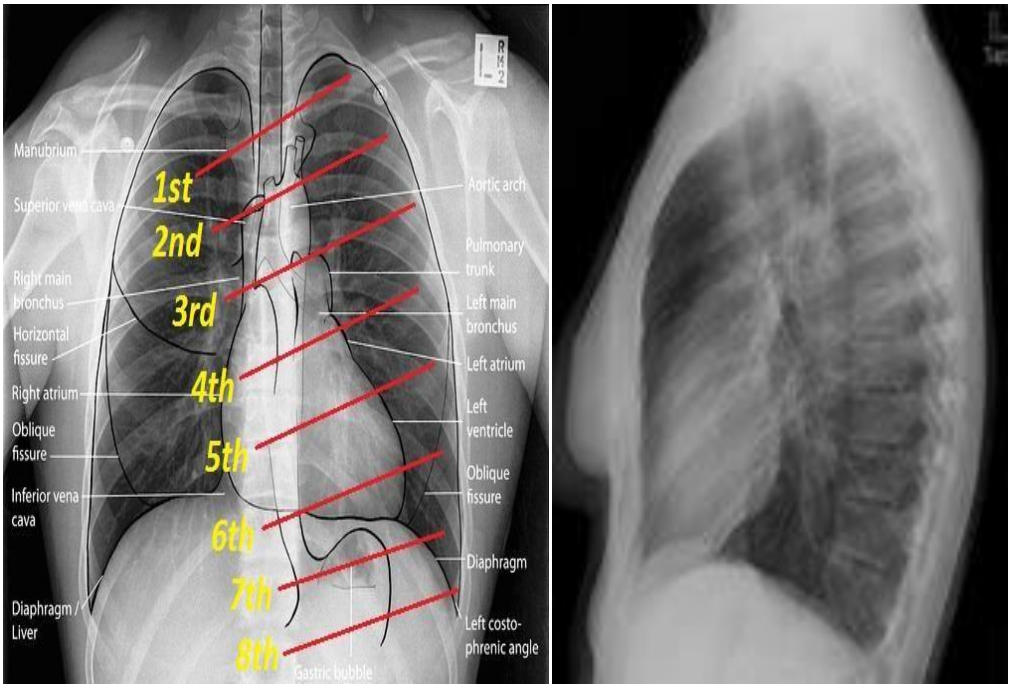
-40% obscured by other tissues.


trachea
right pulmonaty artery
left pulmonaty artery
There is paucity of vascular markings in outer third of lung fields.

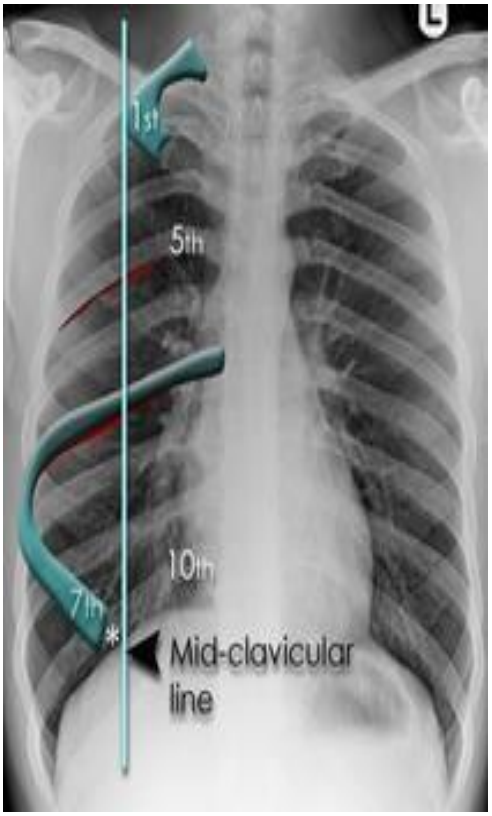

Left Hilum
Right Hilum
Lower margin of left hilum is at the level of upper margin of right hilum
Symmetrical hilar density

2- Bony skeleton:

- The bones visible on a chest X-ray include the ***clavicles, the ribs, the scapulae, part of the spine,*** *and* ***the proximal humeri*** (upper arms).
- Of these only the ***clavicle*** is seen in entirety.
- The ***sternum*** is also included on a frontal view, but overlies other midline structures and so is obscured.
- Ribs: The ribs play a role in assessing the adequacy of inspiration taken by the patient.
- The anterior end of approximately 5-7 ribs should cut the diaphragm in the mid-clavicular line.
- Less than this indicates an incomplete breath in, and more than 7 ribs or flattening of the diaphragm, suggests lung hyper- expansion.



Chest x-ray (P-A), how to count ribs anteriorly, lateral view can confirm any abnormality in the sternum.



posterior ribs(RT.), anterior ribs (LT.)

3- Soft tissues:

Whenever you look at a chest X-ray, have a look at the soft tissues, especially around the neck, the thoracic wall, and the breasts.

-Breast shadow.

-Supra-clavicular areas.

-Axillae.

-Tissues along sides of breast.

4- Diaphragm and pleural surfaces:

-Diaphragm:

-The right diaphragm is slightly higher than the left.

- The liver is located immediately inferior to the diaphragm on the right.

-The stomach bubble can be seen below the left hemidiaphragm.

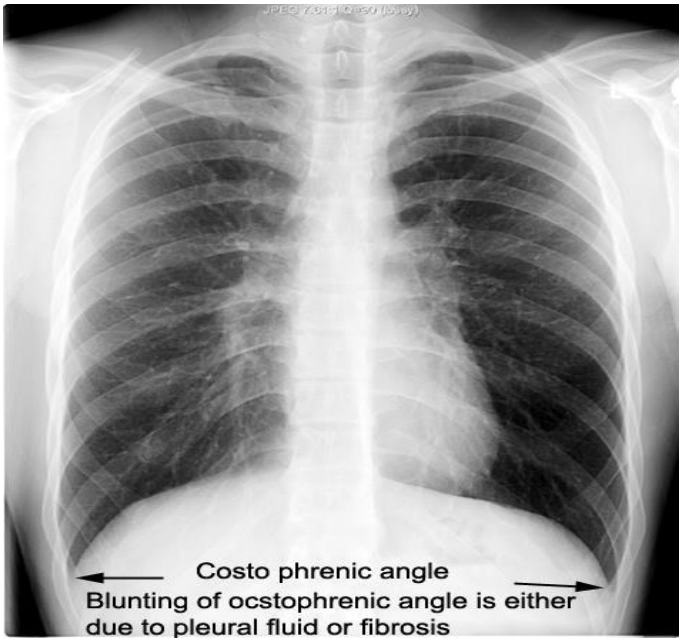
-Medially the hemidiaphragms form an angle with the heart
- the cardiophrenic angles.

-Dome shaped.

-CP angles:

-An angle is formed by the lateral chest wall and the dome of each hemidiaphragm.

- These angles are known as the costophrenic angles.

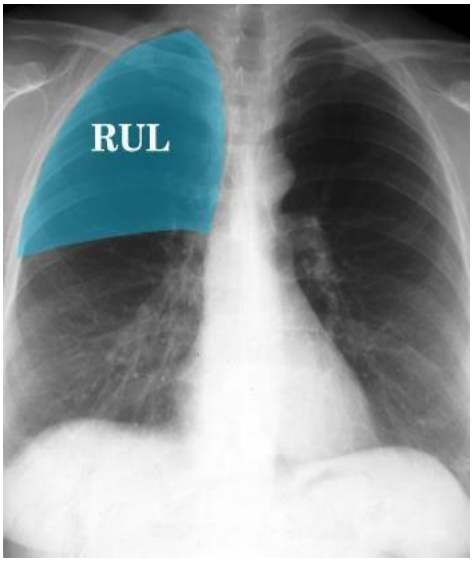


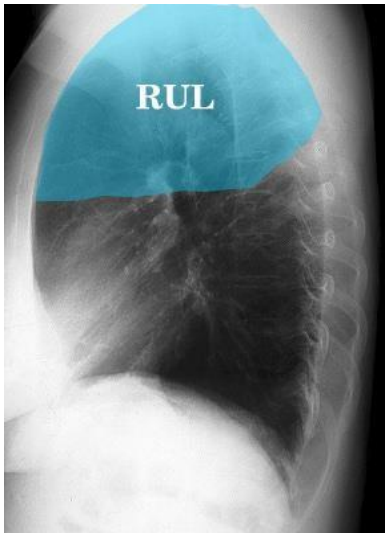
-Normally pleura is not visible:

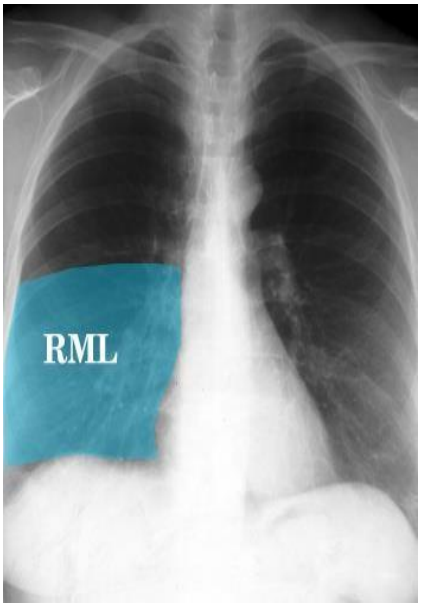
- The surface of the visceral pleura that covers the lung, is continuous with the visceral pleura that covers the fissures.

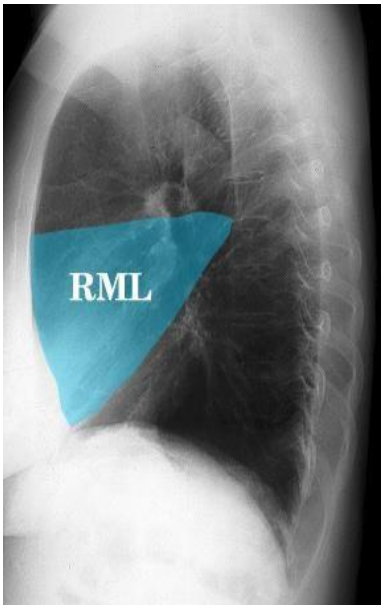
-The left lung is divided into two lobes, upper and lower. These lobes have their own pleural covering and these lie together to form the oblique (major) fissure.

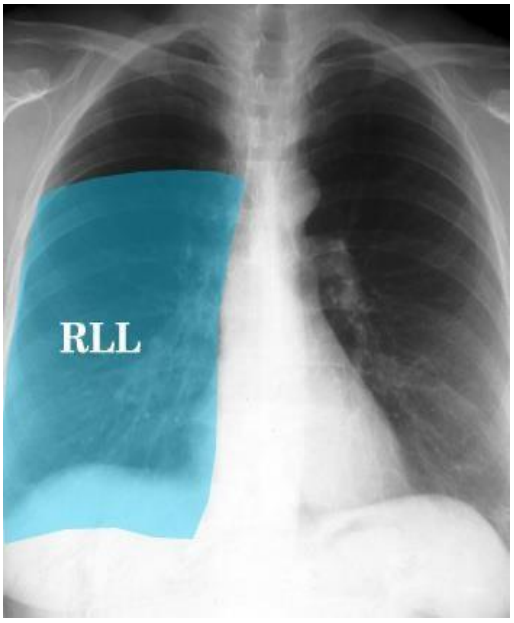
-In the right lung there is an oblique fissure and a horizontal fissure, separating the lung into three lobes - upper, middle, and lower.
Each lobe again has its own visceral pleural covering.

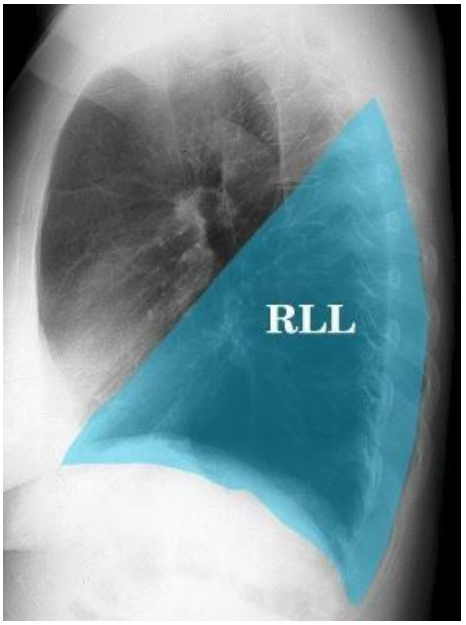

RUL

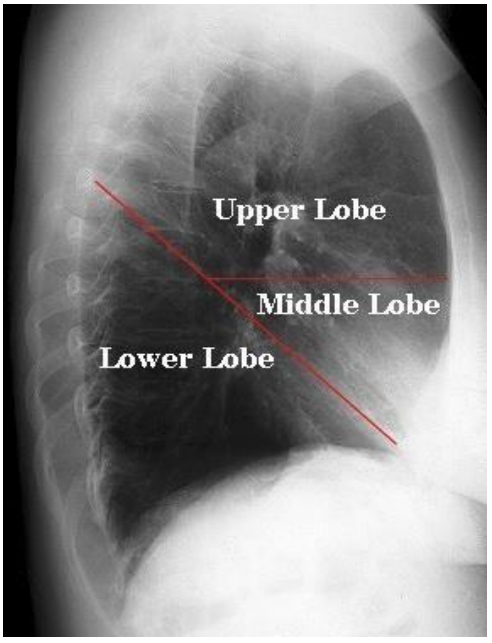

RUL

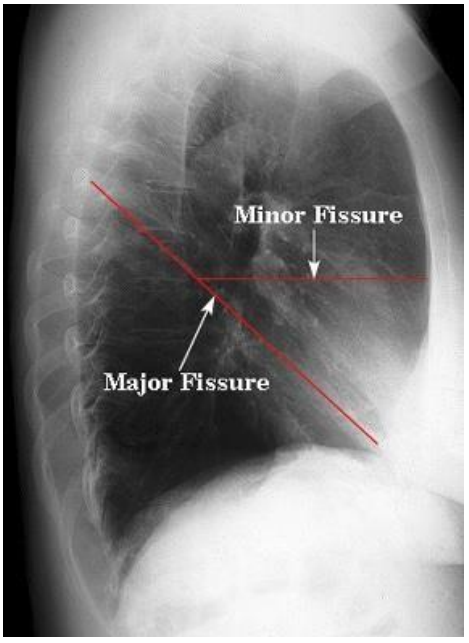

RML

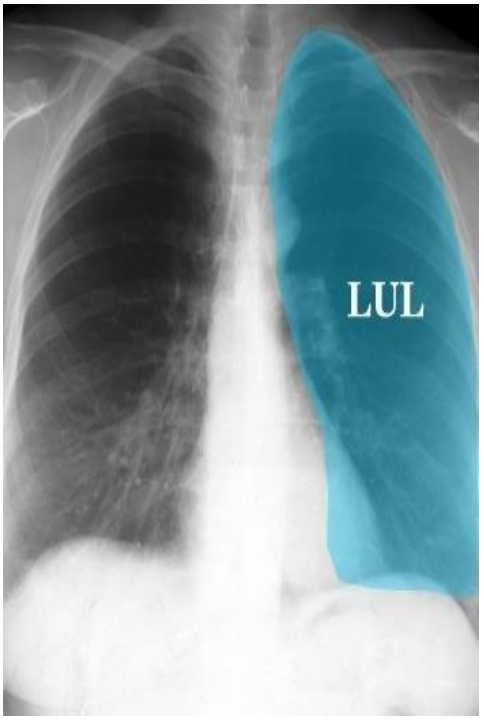

RML

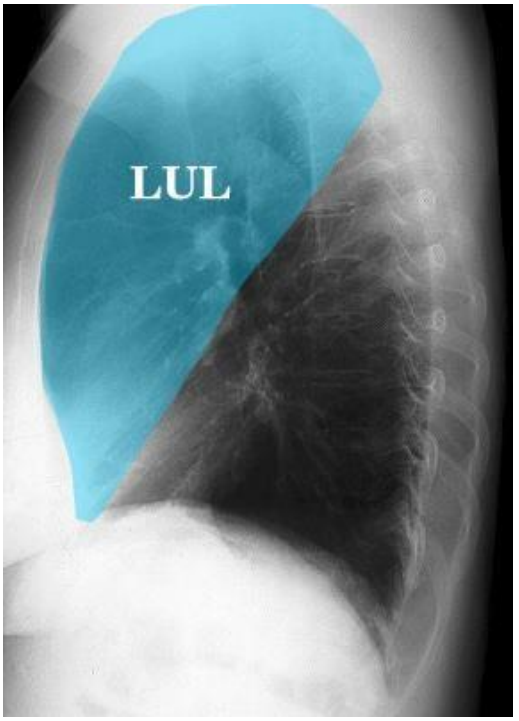

RLL


RLL


Upper Lobe
Middle Lobe
Lower Lobe


Minor Fissure
Major Fissure


LUL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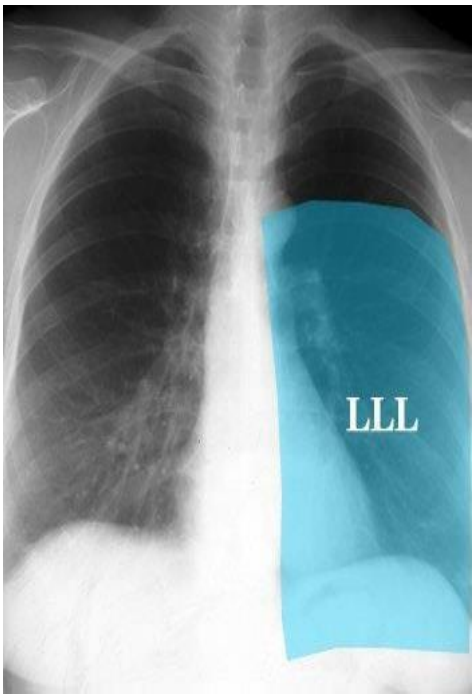
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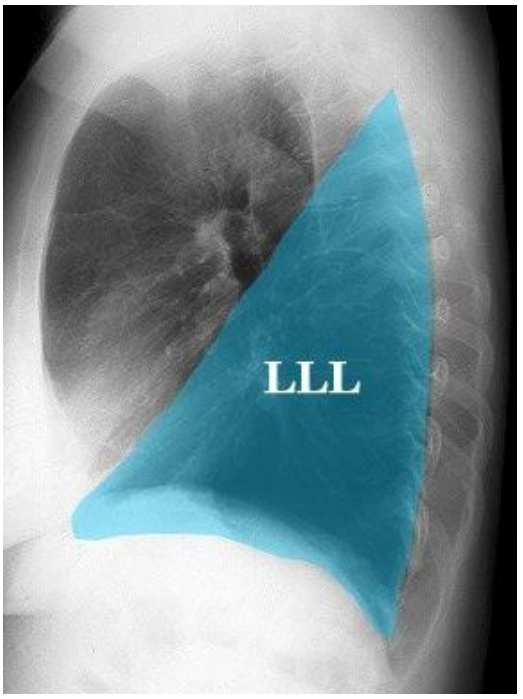
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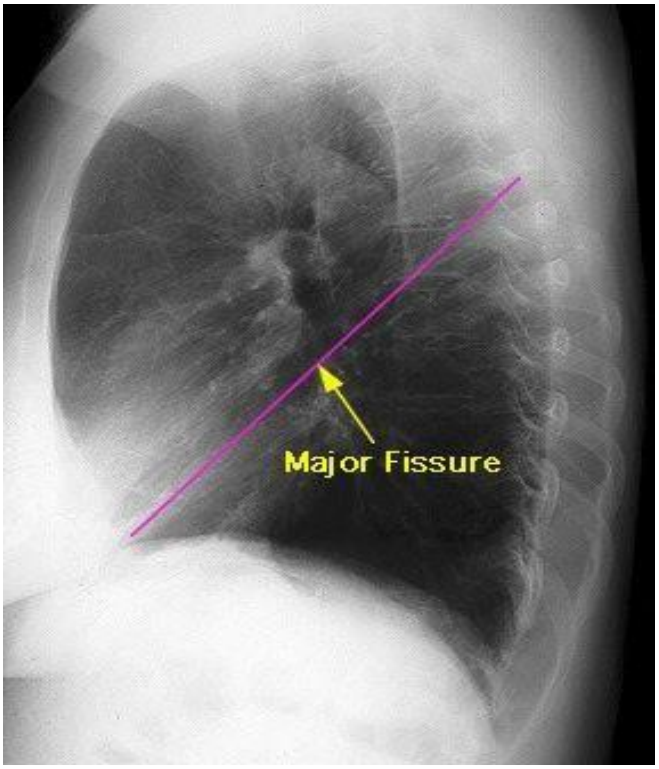


Mediastinum and heart:

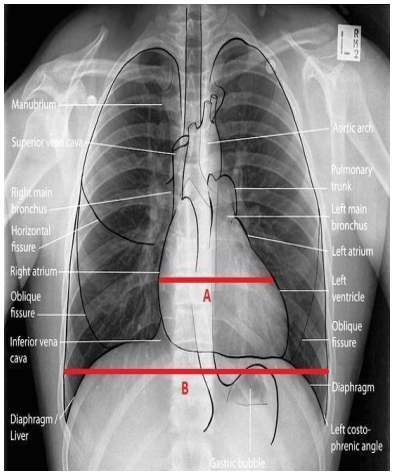
-Heart size on P-A:

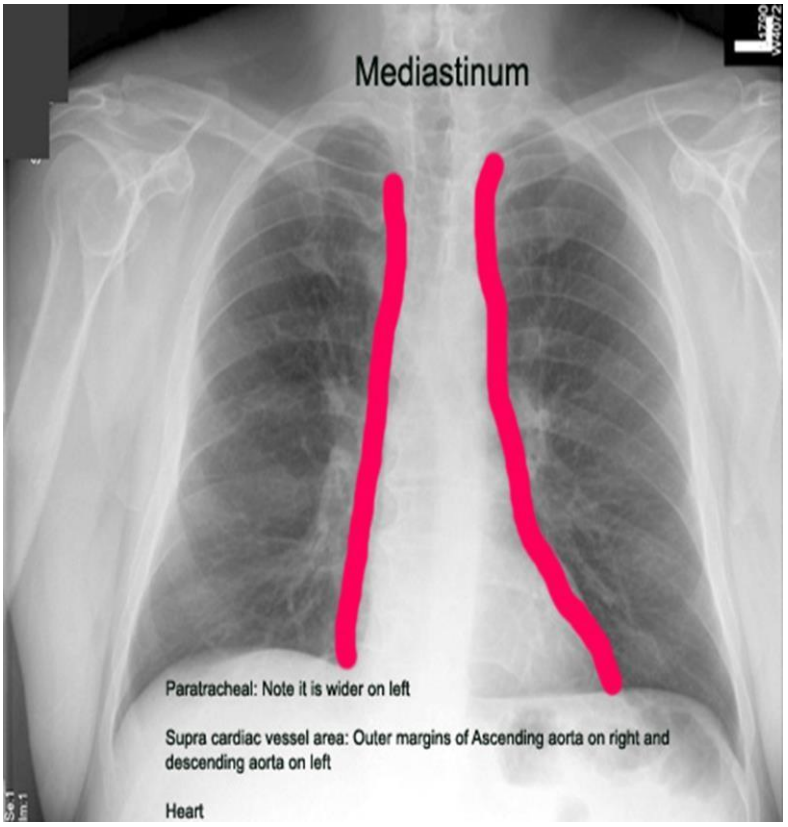
- Heart size is measured in relation to the total thoracic width - the Cardio- Thoracic Ratio (CTR).

- A CTR of greater than 1:2 (50%) is considered abnormal, in P-A view only.

-Rt. side . The right heart border is formed by the right atrium.

-Lt. side. The left heart border is formed mainly by the left ventricle.





-The **mediastinum** itself contains the heart and great vessels (middle mediastinum) and potential spaces in front of the heart (anterior mediastinum), behind the heart (posterior mediastinum) and above the heart (superior mediastinum).

-These potential spaces are not defined on a normal chest X-ray.

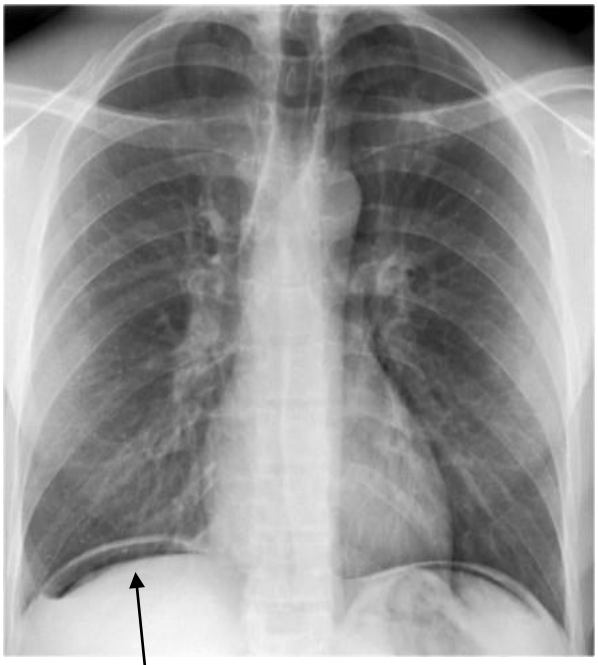
-The trachea passes to the right of the aorta and so may be slightly off mid- line to the right.

Abdomen and neck:

Abdomen:

-Gas bubbles in the stomach: The stomach bubble is under the left hemidiaphragm.

-Air under diaphragm: free air under the diaphragm indicates ***a bowel perforation***, unless when the patient had recent abdominal surgery and there is still some air left in the abdomen, which can stay there for several days.

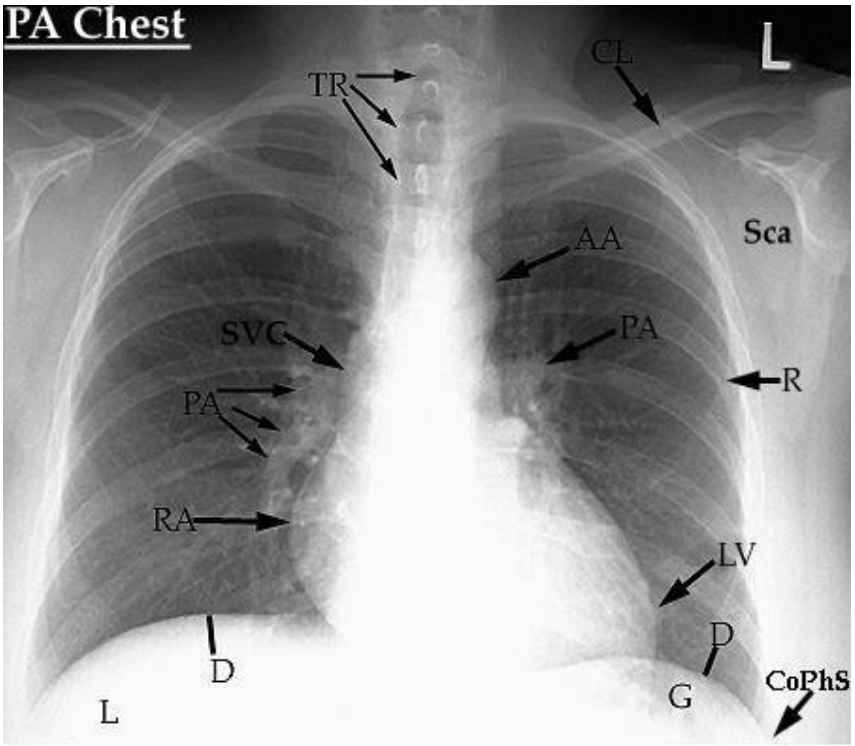


Chest x-ray showing air under diaphragm

Neck: Soft tissues, last cervical & first thoracic vertebrae.

Cardiac borders:

- Right cardiac border >> SVC, rt. pulmonary trunk, rt. atrium, IVC.
- Left cardiac border >> aortic Knuckle, left pulmonary trunk, lt. atrial appendage, cardiac waist, left ventricle.

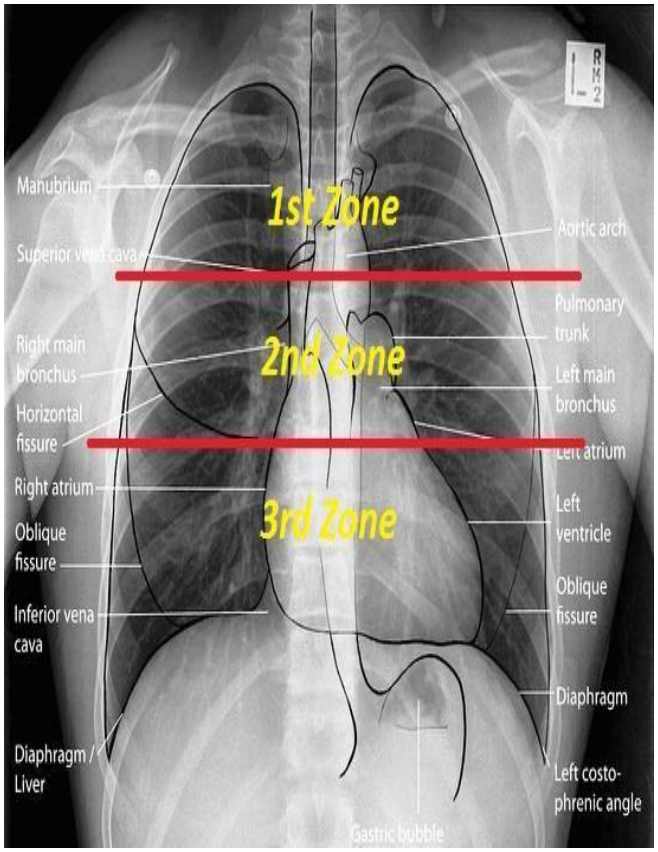


PA=Pulmonary Artery
TR=Trachea
CL=Clavicle
AA=Aortic Arch
SVC=Superior Vena Cava
RA=Right Atrium
CoPhS=Costophrenic Sulcus

LV=Left Ventricle
D=Diaphragm
G=Gastric Air Bubble
L=Liver
Sca=Scapula
R=Rib

Silhouette sign:
*Anterior: middle lobe consolidation/ collapse.
*Posterior: apicoposterior segment of left upper lobe consolidation/collapse.

Lung zones



UP to 2nd rib anterior =1st zone.

From 2nd to 4th rib anterior = 2nd

zone. From 4th to 6th rib anterior= 3rd

zone.

-When describing the lungs it is conventional to divide them into three zones - upper, middle and lower.

- Each of these zones occupies approximately one third of the height of the lungs.

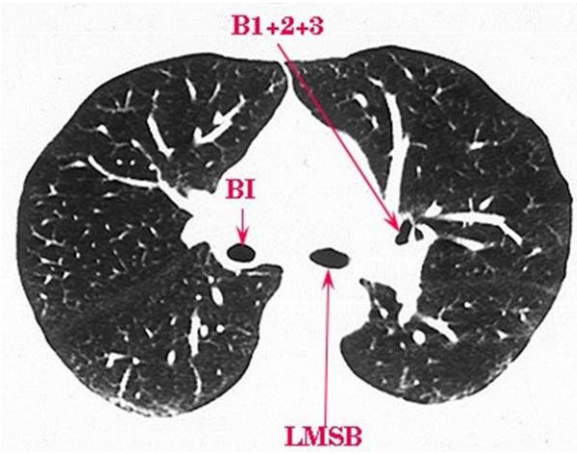
-The lung zones do not equate to the lung lobes. For example the lower zone on the right consists of middle and lower lobes.

Hidden areas.

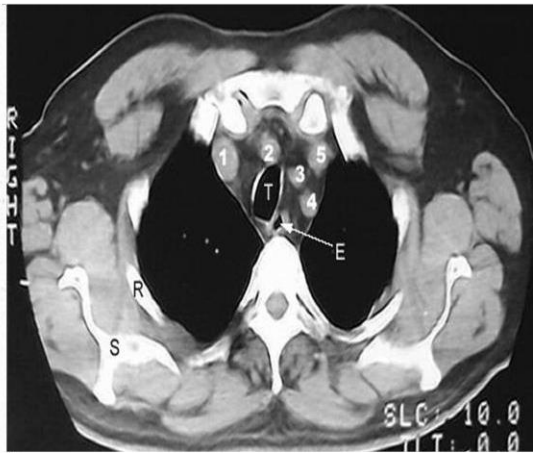
1. Lung apices.
2. Both hilae.
3. Retrocardiac.
4. Subdiaghragmatic.

CT of the chest

Lung window



Mediastinal window



Role of CT:

-Main further investigation for most CXR abnormality (e.g. nodule/mass) or to exclude disease with normal CXR.

-Main investigation for (Pulmonary embolism, Aortic dissection, trauma)

-***Transthoracic needle biopsy*** guided by CT, fluoroscopy, or US is a diagnostic technique utilized in selected patients with pulmonary, pleural, or mediastinal lesions

MRI

Advantages:

- NO RADIATION.

-Multiple planes (sagittal, coronal, axial and oblique) .

-Common indications:

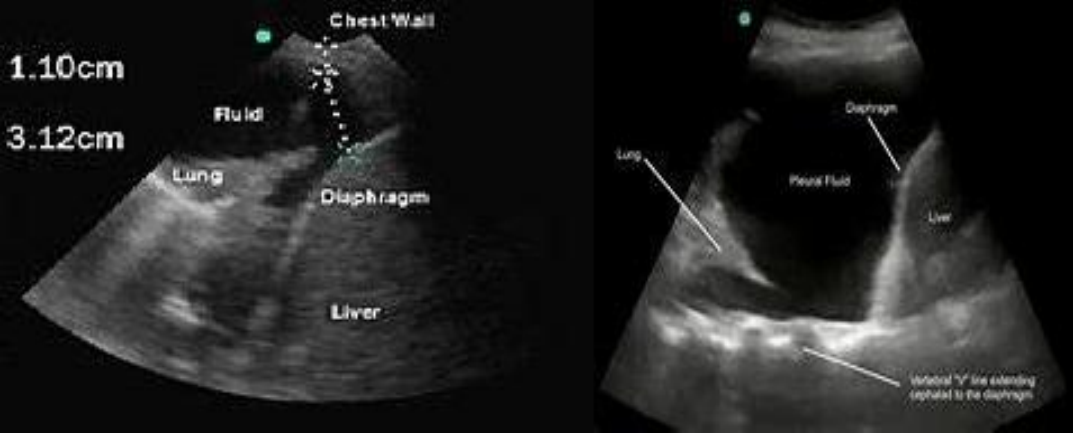
-Pancoast tr.

- Brachial plexus.

- Cardiac.

-Vascular.

-Usually targeted examination (unlike CT).



Pulmonary angiography

-Diagnostic arteriography has mainly been replaced by angio-CT.

-Pulmonary angiograms are only performed in cases where angio-CT is suboptimal or equivocal.

Ultrasound

-Transthoracic US is now commonly used for the detection, characterization, and sampling of pleural, peripheral parenchymal, and mediastinal lesions.