2

Team Medicine

Investigations Of Lung Diseases

Writer: Sama Al Ohali
Reviser: Alanood Asiri
Team Leader: Alanood Asiri

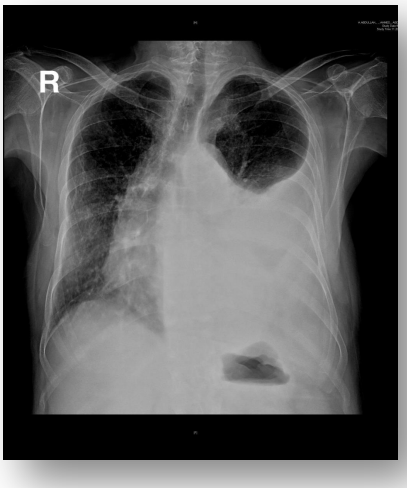
431 Teams
medical students

■ Important notes ■ doctor notes ■ our slides

SOB=Shortness Of Breath
*** Always pay attention to clinical scenario so you do not make mistakes ardor dangerous or unnecessary diagnostic tests.**

Pulmonary Diagnostic Procedures

A) Thoracentesis
B) Chest tube
C) Pleural biopsy
D) Bronchoscopy
E) Pulmonary function tests
F) Computed tomography (CT)
C) Lung Scans: V/Q

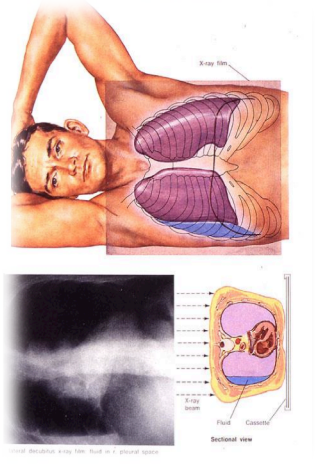


Case1: Patient presented with SOB as well as fever for the Last week. Respiratory examination revealed diminished Breathing sounds and stony dullness on percussion.
Oxygen saturation is 90% on room air.
On x-ray we see a massive pleural effusion. The fluid is Pushing the mediastinum to the opposite side.
The white opacity is the pleural fluid.

Diagnosis is left sided Pleural effusions (acute)

How to approach this patient? You want to do thoracocentesis…
To ensure safety, you should know first the clinical status of your patient.

1- Should assure the patient is comfortable
2- ABCs, manage his hypoxia, insert an IV line, and assure his blood pressure
3- You should order certain tests before doing an invasive procedure – CBC → not to see WBCs for infections…but you want to look at the platelets and assess coagulation to see if the patient is thrombocytopenic, which can complicate such procedures with bleeding…
4- Take consent and explain procedure to patient
5- Also to ensure safety, in hospitals with old settings, another x-ray in Lateral Decubitus View (see figure): if the fluid or opacity is more than 2cm thickness, then this is relatively safe and you can insert the needle and aspirate.



Nowadays however, doctors use an ultrasound probe right away and with one second you can diagnose the patient with pleural effusion as well as measure how far your needle will go inside.

6-ONLY NOW YOU CAN PERFORM THORACOCENTESIS SAFELY!
7- take caution if the patient is on mechanical ventilation, the positive pressure may push the lung towards the needle and cause pneumothorax.
8- if the patient has loculated effusion, thoracocentesis with real time imaging guidance

A) Thoracentesis

1- Appearance (the most important)
2- Gram stain, and cultures
3- pH
4- Chemistry (glucose, amylase, LDH, protein) • Cytology

1- when you do the thoracocentesis, the first thing you want to spot is the appearance…
If pus → infection. (you must act quickly)
If blood → hemorrhagic pleural effusion (you must act quickly)
If semilunar → (you can relax and think)
2- you can do gram stain within minutes if you suspect pneumonia and you are not sure whether it is simple parapneumonic effusion or complicated parapneumonic effusion.
Simple: patient has pneumonia, but organism is not found in the pleural cavity
Complicated: patient has pneumonia, and organism is invading the pleural cavity
The management is different for each. Also, we send it for culture (but will take time, more than 5 days)
3- pH is important information
4- why do we send it for amylase? The origin of amylase is pancreas or esophagus. So someone who vomits repeatedly can perforate his esophagus and can develop pleural effusion containing amylase. The patient in this case should undergo esophageal repair.

Separation of Transudates from Exudates

How to differentiate? Measure protein in pleural cavity and at the same time measure proteins in serum.

Transudative (low in proteins): transudates are ultrafiltrates of plasma with intact capillary
endothelial barrier – causes include CHF, end-stage liver disease, nephrotic syndrome, protein-losing enteropathy, hypoproteinemia of any cause, superior vena cava syndrome and glomerulonephritis;
exudates (high in proteins) occur when inflammation
leads to increased capillary permeability – causes include pneumonia (parapneumonic effusion), malignancy, pulmonary tuberculosis, pancreatitis, ovarian neoplasm (Meig's syndrome), collagen vascular disease (SLE, RA), pulmonary infarction, intra-abdominal abscess, drug-induced and uremic pleuritis

Transudate	Exudate
$\frac{pleural\ fluid\ protien}{serum\ protien} < 0.5$	$\frac{pleural\ fluid\ protien}{serum\ protien} > 0.5$
$\frac{pleural\ fluid\ LDH}{serum\ LDH} < 0.6$	$\frac{pleural\ fluid\ LDH}{serum\ LDH} > 0.6$
Pleural fluid LDH < 2/3 of normal upper limit	Pleural fluid LDH > 2/3 of normal upper limit

Gross appearance is pus or Gram stain positive or pH below 7.20
This is empyema and you need to drain

We need to drain if there is pus or blood quickly because you can prevent healing by fibrosis, which is a dangerous complication. (fibrothorax)

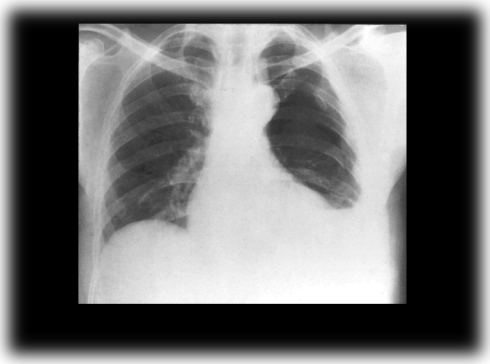
So right away you insert a chest tube to drain blood or pus NOT A SMALL CATHETER.

B) Chest tube (NOT chest catheter)

Indication for chest tube insertion
- Empyema
- Complicated parapneumonic effusion
- Symptomatic pleural effusion
- Hemothorax
- Pneumothorax

Complication of Thoracentesis
- Pneumothorax (nowadays is very rare (<.5%) with the ultrasound guidance)
- Bleeding (check platelets and coagulation) + (the needle must be inserted above the ribs because the vessels are below, to avoid laceration of vessels)
- Infection
- Hypotension
- Hypoxemia
- Air embolism
- Splenic laceration
- Post expansion pulmonary edema (if you drain more than 1500 ml)

Case: 40 years old patient with history of fever over the past few months
And weight loss 3kilos/month. Oxygen saturation is normal on room Air. BP is normal. Respiratory examination reveals diminished lung sounds and strong dullness on the bases of the lungs.
x-ray shows white opacity and obliteration of left costophrenic angle



Diagnosis is pleural effusion (chronic)

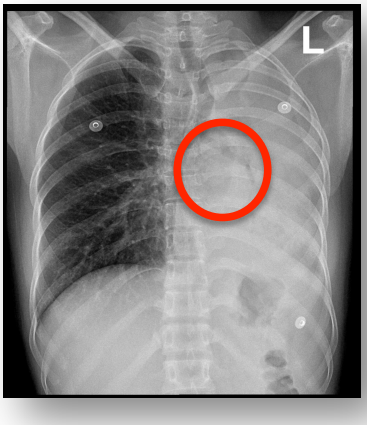
How to confirm the diagnosis? As we said grab an ultrasound probe and See it
What to do next? You follow exactly the same technique in first case. (ABCs, CBC, platelets….etc)

So you do thoracocentesis and you find exudative simple pleural effusion, no pus nor blood. But history is not simple pneumonia, this is something going on for 3 months, as well as weight loss. YOU MUST THINK OF TB & CANCER. CHRONIC PRESENTATIONS ARE TAKEN VERY SERIOUSLY. If acute presentation, then it is ok to just give antibiotics. However, in chronic cases you must do more investigations.
You cannot diagnose TB and cancer based on thoracocentesis. THE GOLD DIAGNOSTIC TEST IS PLEURL BIOPSY.

C)Pleural biopsy

- Granulomatous disease (TB)
- Malignanancy (cancer)

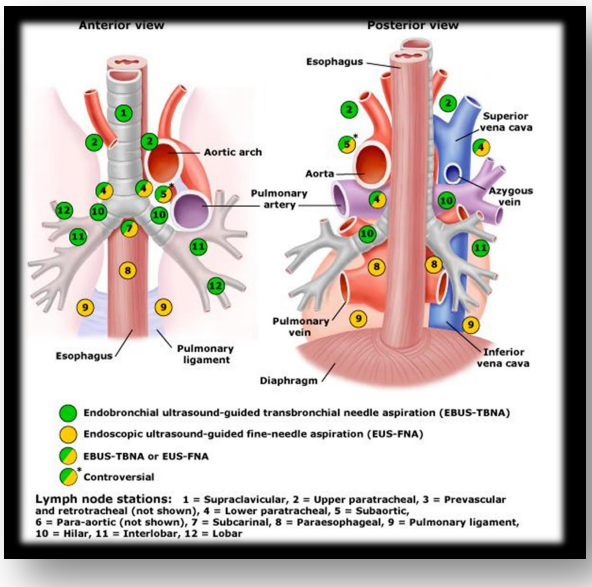
TWO approaches to get a biopsy:
1-Blinded insertion of a needle to get a biopsy.
2-thoracoscopy → insert a scope into the pleural cavity. You can drain some of the fluid and at the same time look inside the pleural cavity and see exactly where the lesions are and take biopsy from them.



Case: patient presented with SOB over the past 12 hours.
Patient denied any history of fever or cough or weight loss. Respiratory examination revealed diminished breathing sound in the affected zone, as well as dullness on percussion. BP is normal, oxygenation is 88%.
CXR shows mediastinum is pulled toward the affected site. (ABSOLUTE CONTRAINDICATION OF THORACENTESIS). In the left side, you can see something obstructing the airways causing this presentation. (when you deal with pediatrics or elderly always think of foreign bodies)

What procedure to do here in order to diagnose this (airway obstruction)?
broncoscopy

Endobronchial ultrasound guided lymph node aspirate: is a new broncoscopy and attached to it is an ultrasound and you can see the lymph nodes directly. Also you can insert a needle through the trachea into the lymph nodes. (you can diagnose the patient within 20 minutes and under local anesthesia instead of doing major surgery)



D) Bronchoscopy

- Suspected lung cancer
- Abnormal CXR
- Hemoptysis
- Unexplained cough
- Localized wheeze
- Positive sputum cytology
- Mediastinal lymph nodes
- Hemoptysis
- Refractory cough
- Unexplained pleural effusion
- Lung abscess
- Staging of lung cancer
- Obtain culture material
- Airway trauma
- Tracheoesophageal fistula
- diffuse lung disease

Bronchoscopy can be therapeutic

- Remove foreign bodies
- Remove abnormal endobronchial tissue
- difficult endotracheal tube intubation
- Endobronchial stent placement

D) Pulmonary function tests **(constitutes of 4 different modalities)**

- Spirometry (if you suspecting an airway disease…asthma. COPD or you want to know how bad is the disease.)
- Lung volumes (to diagnose restrictive lung disease)
- Diffusion capacity
- Respiratory muscle strength

if you diagnose patient with obstructing lung disease after doing spirometry. Next you do reversibility test to confirm it.

> Reversibility test is used to differentiate between reversible and irreversible lung disease. You give the patient a bronchodilator and then repeat the test again. If the respond is >12% then it is reversible.

SPIROMETRY CAN NOT DIAGNOSE RESTRICTIVE LUNG DISEASE. It can only suggest the presence of such disease. In order to diagnose them you need to do the lung volume.

Spirometry

- FVC (L) predicted >90%
- FEV1 (L) predicted >90%
- FEV1/FVC>75

→ diagnose obstructive lung disease and Suggest restrictive lung disease

FVC * FEV1 * FEV1/FVC:
If all low: diagnose obstructive lung disease
If each low but ratio is high: suggest restrictive, but still we can not rule out obstructive,, we do more tests.

Lung volumes

- TLC (L) >90% predicted
- RV (L) > 90% predicted

→ diagnose restrictive lung disease + air trapping

RV=Residual volume. If this is very high then this means patient is trapping air and he is not emptying it.

One patient can have both Restrictive AND Obstructive lung disease

Diffusing capacity (DL)

- Measure the ability of gases to diffuse from the alveoli into the pulmonary capillary blood

(Patient is usually given CO inhale because it is not present in the lungs nor blood so we measure the amount when we give it to the patient.)

- CO not normally present in lungs or blood
- More soluble in blood than lung tissues

Dlco:

If reduced DLco it reflect loss or damage to the gas exchanging surface of the lung:

- Emphysema
- Distinguish emphysema from chronic bronchitis or chronic asthma
- Interstitial lung disease
- Pulmonary vascular disease

Reduced DLco: means there is either destruction in alveoli (ex:emphysema) or if there is abnormality in alveolar capillary membrane (like in interstitial lung disease) or there is abnormality in the capillaries (ex:PE)
IT REFLECTS LOSS OF GASS EXCHANGE.
It can be used to differentiate between emphysema(alveolar destruction-low) and chronic bronchitis(no alveolar destruction-normal)

Respiratory muscle strength

- PImax (for diaphragm), Pemax (for mascular wall)
- Measured by pressure transducer at the mouth when subject make a maximal inspiratory effort from full expiration or maximal expiratory effort from full inspiration
- PI reflect inspiratory muscles (diaphragm)
- PE expiratory muscles including abdominal
- to diagnose → Motor neuron disease, Guillian Barre syndrome

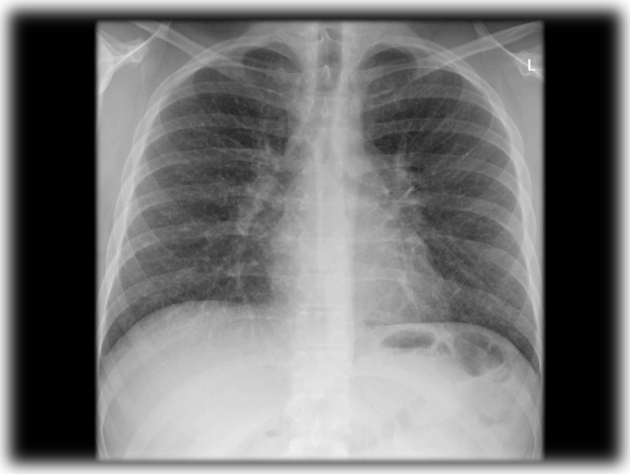
A common cause for muscle abnormalities is drug-induced myopathies. Corticosteroids when used chronically can cause muscle weakness.

Case (see figure) : patient presented with SOB and cough over the past 6 months. Respiratory examination revealed crackles bilaterally and scattered lymphadenopathy in the neck.
PFTs:
Spirometry:
FRC is low. FEV1 is low. Ratio is high. → this is suggestive of restrictive + still can not say this is obstructive. You need to do other tests.
Lung volume:
TLC is low → right away this is restrictive.
RV is high → obstructive
So patient has mixture of Obstructive and Restrictive lung disease.
Muscles:
Both are abnormal
DC:
Low

DIAGNOSIS

		Baseline	
Date and Time	03/02/2010	08:41	
SPIROMETRY	Pred	Pre	%Pred/P
FVC (L)	5.04	3.13	62.1
FEV 1 (L)	4.25	2.53	59.5
FEV 1 FVC		80.91	
MMEF 75/25 (L/s)	4.93	2.46	49.9
PEF (L/s)	9.73	7.88	81
FIF (50 (L/s)		4.09	
FEF 50 (L/s)	5.45	4.23	77.6
BODY PLETHYSMOGRAPH			
VC (L)	5.27	3.13	59.4
TLC (L)	6.9	4.51	65.4
ITGV (L)	3.25	3.58	110.2
ERV (L)	1.59	2.2	138.4
RV (L)	1.66	1.38	83.1
RV % TLC	24.49	30.58	124.9
PI MAX (kPa)	10.96	7.11	64.9
PE MAX (kPa)	14.51	11.55	79.6
DIFFUSING CAPACITY			
TLCO SB (mmol/min/kPa)	11.63	5.27	45.3
Hb (g/100ml)		16.2	
TLCOc SB (mmol/min/kPa)	11.63	5.06	43.5
KCO (mmol/min/kPa)	1.68	1.54	91.7
TLC-He (L)	6.75	3.42	50.7

What can causes restrictive, obstructive, abnormal muscles, and reduced dc?? Interstitial lung disease



(A sarcoidosis case present with):
- 50 yr old male with SOB and cough >3yrs
- Exam: clubbing and bilateral inspiratory crackles
- CXR: reticulation bilateral
- ABG: hypoxic respiratory failure
- PFT: restrictive defect with significant impairment in DLco

CXR: reticulonodular type of infiltrate bilaterally (which is seen in sarcoidosis or hypersensitive pneumoconiosis)

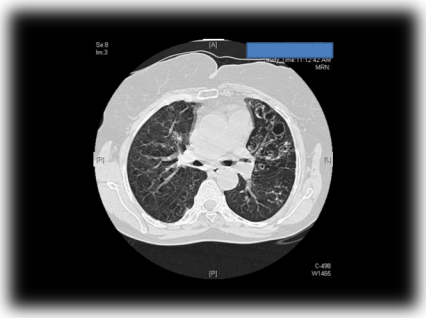
F) CT (4 different modalities)

1- CT
2- CT with contrast
3- HRCT → take very thin slices that give us detailed anatomy of lung parenchyma
4- CT angiography = spiral CT

The modality of choice for diagnosing interstitial lung disease or bronchiectasis is HRCT
The modality of choice for diagnosing PE is CT angiography or V/Q scan if contraindicated

HRCT
- Designed for detailed evaluation of interstitial structures of the lung
- Use narrow slice thickness (1-2 mm) compared with 5-10 mm for routine scans

HRCT
Principle indications
- Suspected interstitial lung disease
- Characterization of interstitial lung disease
- Characterization of solitary pulmonary nodules
- Diagnosis of bronchiectasis



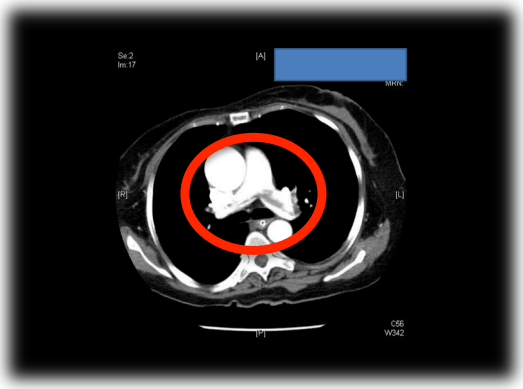
Patient with Pulmonary Embolism (PE) do not have Restrictive problems. The lungs are normal but the problem is in the circulation
However, we can have a combination of problems. ex: Interstitial lung disease with PE.

Case: 45 yrs old female with RT sided chest pain for 1 day
- ABG pH 7.32, PaCO2 28, PaO2 50, O2sat 88% • EKG sinus tachycardia
- CXR normal

most likely this is PE
so you do either CT angiography or V/Q scan

CT can be done in ICE patients (critically ill). Include a contrast so can not be used in case of renal failure, patient with very high risk of renal disease ex: diabetes or with patients allergic to contrast → in such cases v/q scan is used.

In healthy patients, whole pulmonary trunk should be White. We see a black area within the white opacity, which indicates a saddle pulmonary embolism, a clot occupying the trunk bilaterally.



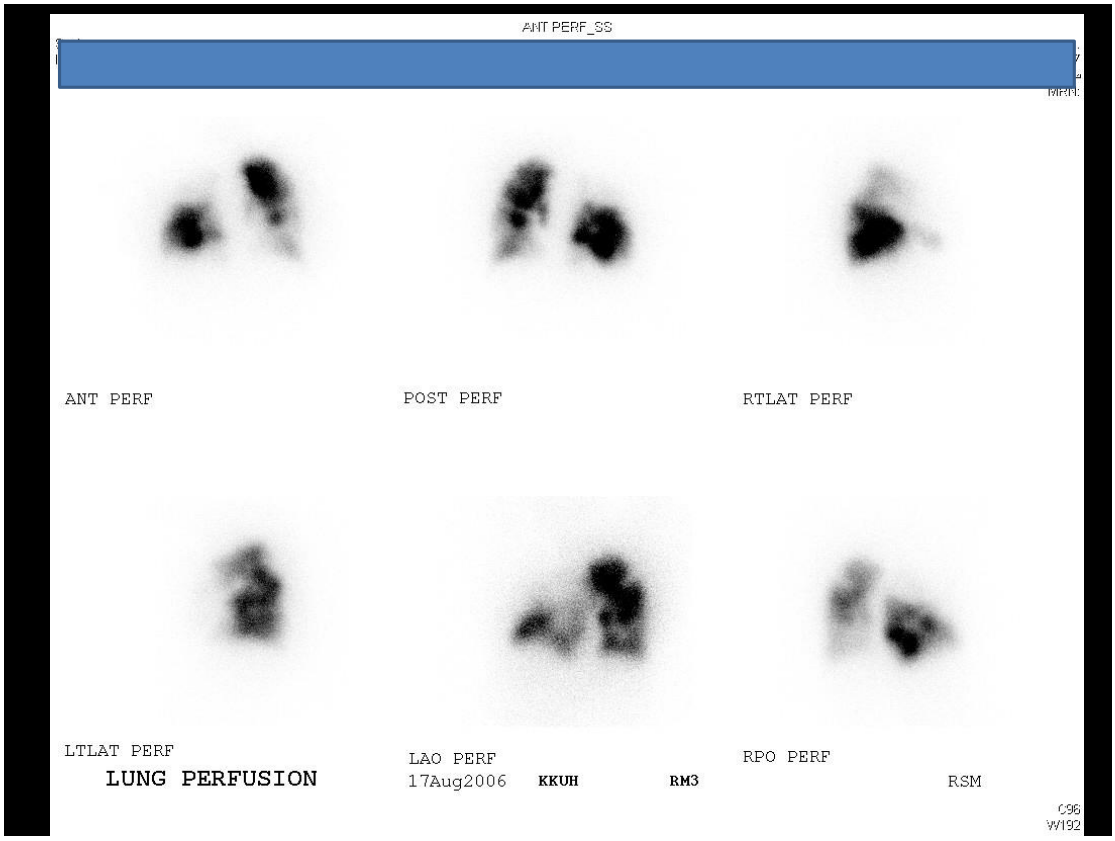
CT Angiography
• Image data are acquired continuously as the tube and detector rotate within the gantry and the patient moves continuously through the gantry
Advantages
• Critically ill patients
• Children
• Less volume of intravenous contrast
• Permits greater processing of the raw data

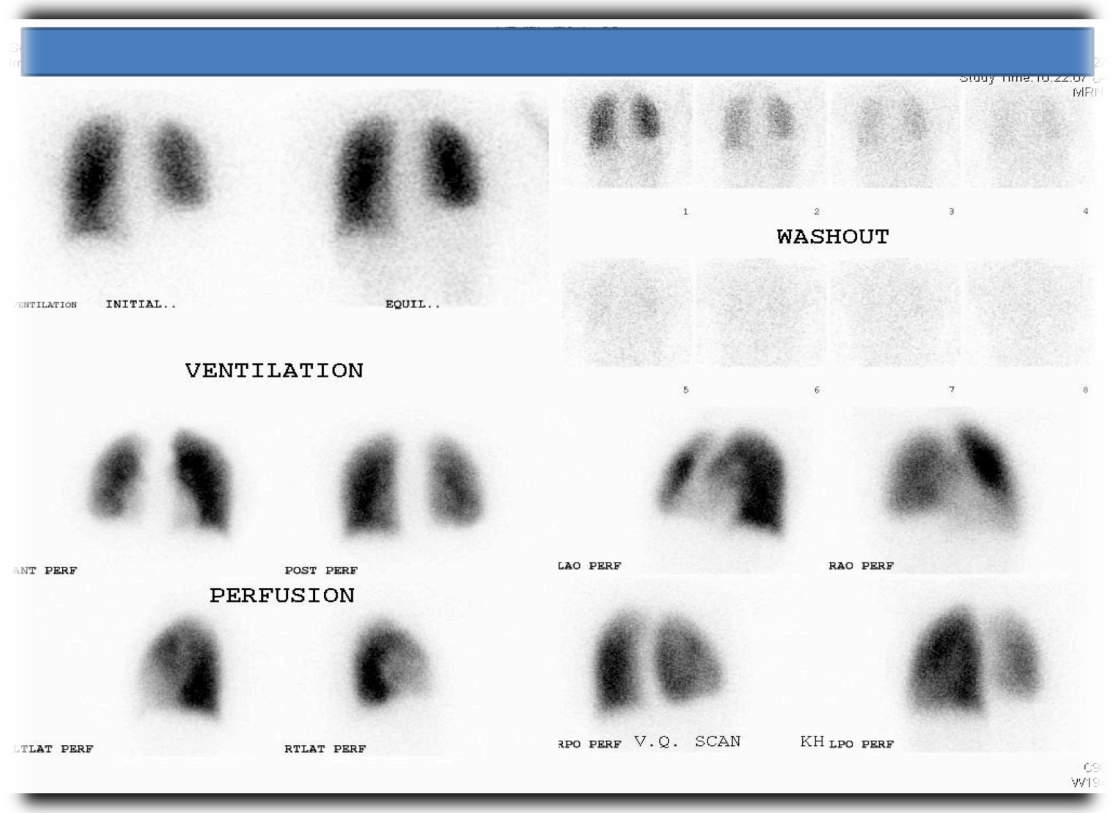
C) Lung Scans: V/Q

• Technetium (Tc) 99 m radionuclide is tagged to macroaggregated albumin to make small radioactive particles
• When Tc decays, it emits a gamma ray detected by the nuclear medicine gamma camera: a nuclear medicine image is formed by detection of many gamma rays

Lung scan: normal perfusion Q
• When injected via periphral venous site, the first capillaries encountered are the pulmonary capillaries
• If perfusion is present at the capillary level of the lungs, nuclear medicine perfusion image demonstrate activity in the periphery of the lungs

Lung scan: perfusion defect Q
If there is an obstructing vascular lesion in the pulmonary arterial circulation
→
blocked perfusion to the distal capillary level
→
nuclear medicine perfusion image demonstrate no activity in the periphery of the lungs


ANT PERF_SS
ANT PERF
POST PERF
RTLAT PERF
LTLAT PERF
LUNG PERFUSION
LAO PERF
17Aug2006 KKUH RM3
RPO PERF
RSM


WASHOUT
INITIAL..
EQUIL..
VENTILATION
POST PERF
PERFUSION
RTLAT PERF
LAO PERF
RAO PERF
V.Q. SCAN
LPO PERF

Summery:

Pulmonary Diagnostic Procedures

A) Thoracentesis (to examine fluid if you suspect pleural effusion)
B) Chest tube (to drain fluid or air)
C) Pleural biopsy (to diagnose granulomatous diseases and cancer)
D) Bronchoscopy (for airways and lymph nodes)
E) Pulmonary function tests (to differentiate between obstructive and restrictive lung diseases)
F) Computed tomography (The modality of choice for diagnosing interstitial lung disease or bronchiectasis is HRCT + The modality of choice for diagnosing PE is CT angiography)
C) Lung Scans: V/Q (for PE when you cannot use CT angiography)