急重症與心血管影像判讀

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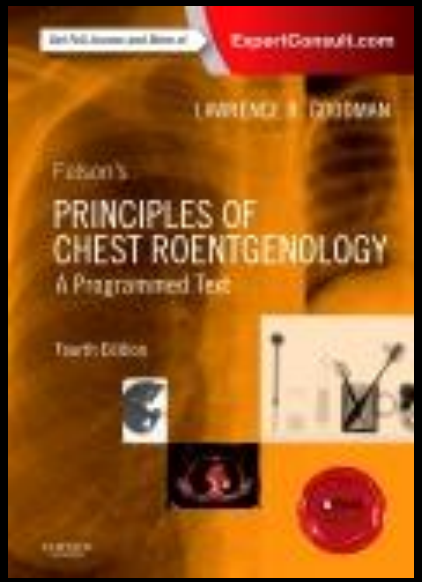
急重症醫學研究所
111年5月1日

推薦必讀參考書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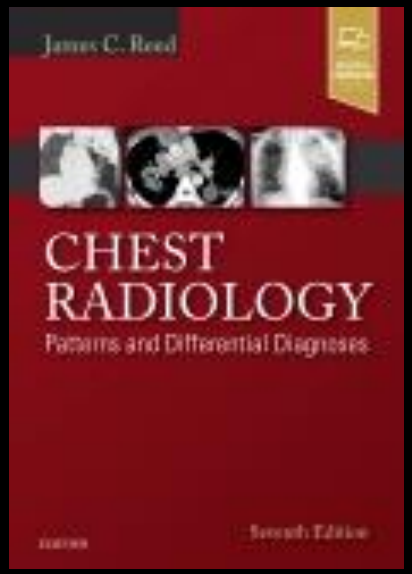
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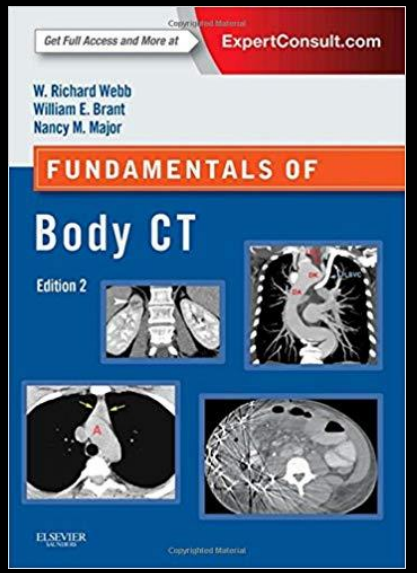
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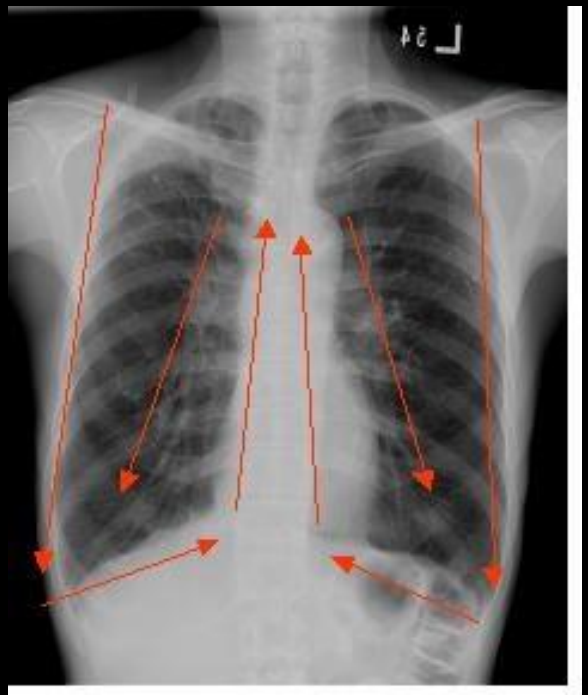
系統性的判讀

蕭光明主任游泳姿勢順序

1. 胸廓及其外軟組織
2. 橫膈及其下軟組織
3. 縱膈
4. 大氣道
5. 肺門
6. 肺區 (肺裂、肺紋及支氣管分支)



Felson判讀順序

1. 橫膈 及其下軟組織
2. 胸廓 及其外軟組織
3. 縱膈
4. 大氣道
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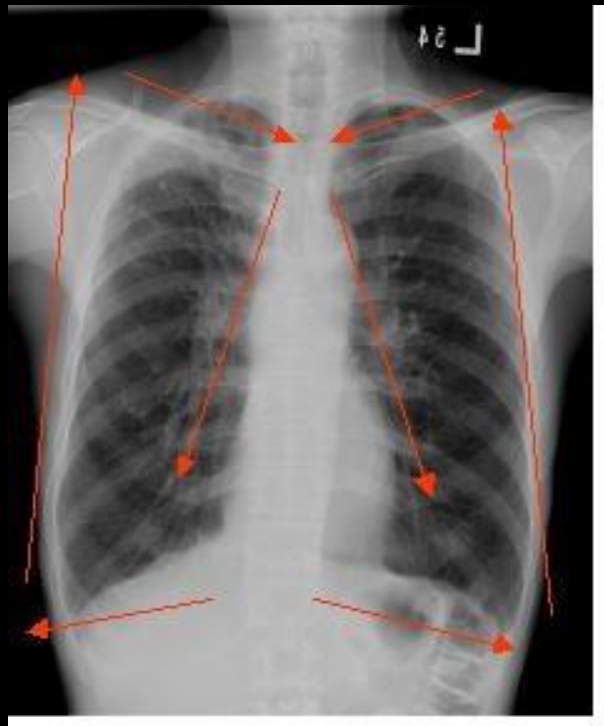
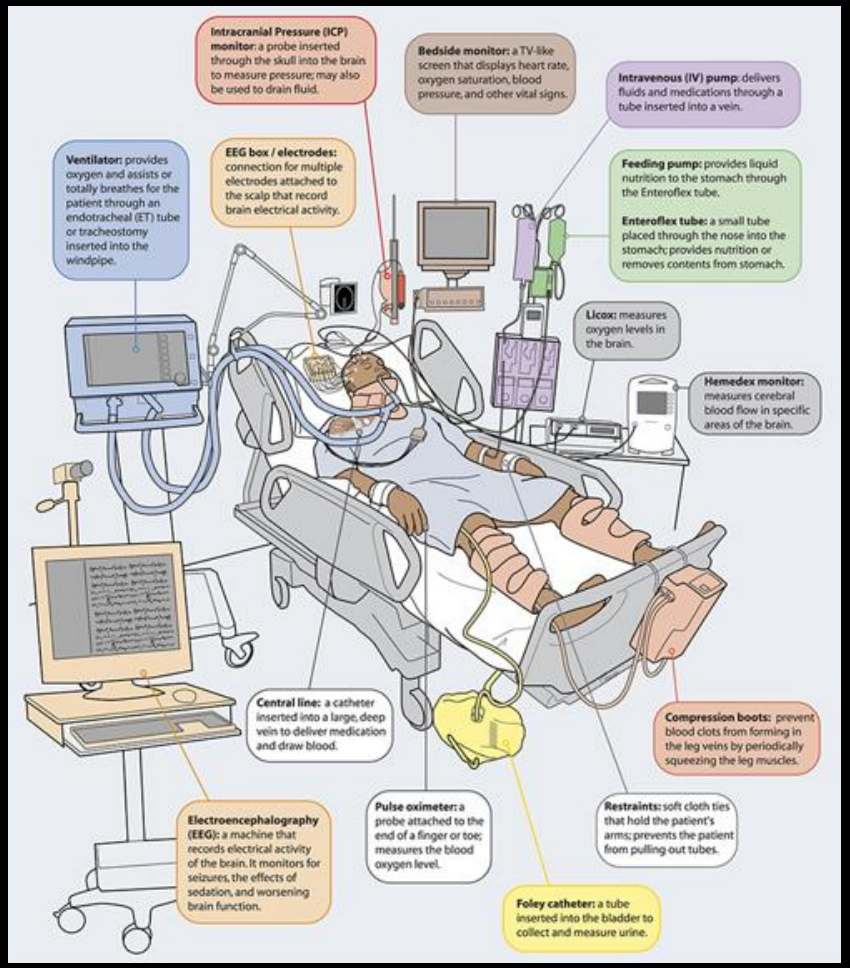


這是重症胸部X光?


Intracranial Pressure (ICP) monitor: a probe inserted through the skull into the brain to measure pressure; may also be used to drain fluid.
Bedside monitor: a TV-like screen that displays heart rate, oxygen saturation, blood pressure, and other vital signs.
Intravenous (IV) pump: delivers fluids and medications through a tube inserted into a vein.
Ventilator: provides oxygen and assists or totally breathes for the patient through an endotracheal (ET) tube or tracheostomy inserted into the windpipe.
EEG box / electrodes: connection for multiple electrodes attached to the scalp that record brain electrical activity.
Feeding pump: provides liquid nutrition to the stomach through the Enteroflex tube.
Enteroflex tube: a small tube placed through the nose into the stomach; provides nutrition or removes contents from stomach.
Licox: measures oxygen levels in the brain.
Hemedex monitor: measures cerebral blood flow in specific areas of the brain.
Central line: a catheter inserted into a large, deep vein to deliver medication and draw blood.
Compression boots: prevent blood clots from forming in the leg veins by periodically squeezing the leg muscles.
Electroencephalography (EEG): a machine that records electrical activity of the brain. It monitors for seizures, the effects of sedation, and worsening brain function.
Pulse oximeter: a probe attached to the end of a finger or toe; measures the blood oxygen level.
Restraints: soft cloth ties that hold the patient's arms; prevents the patient from pulling out tubes.
Foley catheter: a tube inserted into the bladder to collect and measure urine.


L11

Daily chest X ray in ICU ?
點名照?

拍片部位	攝像日期	攝像時間
CHEST AP VIEW- PORTABLE	2021/10/27	02:16:13
CHEST AP VIEW- PORTABLE	2021/10/26	02:07:06
CHEST AP VIEW- PORTABLE	2021/10/25	01:50:32
CHEST AP VIEW- PORTABLE	2021/10/24	02:11:15
CHEST AP VIEW- PORTABLE	2021/10/23	15:37:22
CHEST AP VIEW- PORTABLE	2021/10/23	02:04:39
Bronchoscopic ultraso...	2021/10/22	15:13:56
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CHEST AP VIEW- PORTABLE	2021/10/21	02:32:14
CHEST AP VIEW- PORTABLE	2021/10/20	02:30:11
CHEST AP VIEW- PORTABLE	2021/10/19	02:15:11
CHEST AP VIEW- PORTABLE	2021/10/18	02:10:09
CHEST AP VIEW- PORTABLE	2021/10/17	02:28:45
CHEST AP VIEW- PORTABLE	2021/10/16	01:39:12
CHEST AP VIEW- PORTABLE	2021/10/15	02:19:22
CHEST AP VIEW- PORTABLE	2021/10/14	02:24:47
CHEST AP VIEW- PORTABLE	2021/10/13	02:24:17
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CHEST AP VIEW- PORTABLE	2021/10/09	02:33:05
CHEST AP VIEW- PORTABLE	2021/10/08	02:39:20
CHEST AP VIEW- PORTABLE	2021/10/07	02:31:56

Restrictive or routine chest X ray?

Study	Restrictive Events	Restrictive Total	Routine Events	Routine Total	Weight	Risk Ratio [95% CI]
Primary analysis: Trials						
Clec'h et al, 2008	27	81	27	84	22.3%	1.04 [0.67, 1.61]
Hejblum et al, 2009	98	306	94	305	77.7%	1.04 [0.82, 1.31]
Patients	**125**	**387**	**121**	**389**	**100.0%**	**1.04 [0.84, 1.28]**
Overall effect: p=0.72; heterogeneity: I^2=0%						
Sensitivity Analysis: Trials and observational studies						
Graat et al, 2007	62	622	94	754	31.8%	0.80 [0.59, 1.08]
Clec'h et al, 2008	27	81	27	84	15.2%	1.04 [0.67, 1.61]
Hejblum et al, 2009	98	306	94	305	53.0%	1.04 [0.82, 1.31]
Patients	**187**	**1009**	**215**	**1143**	**100.0%**	**0.96 [0.81, 1.13]**
Overall effect: p=0.60; heterogeneity: I^2=0%						

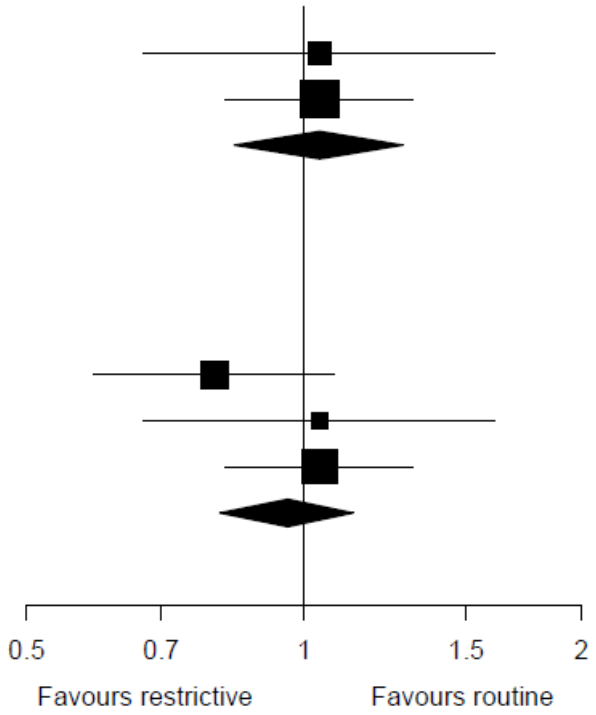


Figure 2 Effect of a restrictive versus routine chest x-ray strategy on intensive care unit mortality among trials (primary analysis) and trials and observational studies (sensitivity analysis). The number of events and sample size of Hejblum *et al.* [13] have been adjusted for clustering (see Methods for details). Weight is the relative contribution of each study to the overall estimate of treatment effect on a log scale using a random effects model.

Critical Care 2012, 16:R68

Restrictive or routine chest X ray?

Study	Restrictive Events	Restrictive Total	Routine Events	Routine Total	Weight	Risk Ratio [95% CI]
Primary analysis: trials						
Krivopal et al, 2003	12	51	11	43	25.9%	0.92 [0.45, 1.87]
Clec'h et al, 2008	28	81	29	84	74.1%	1.00 [0.66, 1.52]
Total	**40**	**132**	**40**	**127**	**100.0%**	**0.98 [0.68, 1.41]**
Overall effect: p=0.91; heterogeneity: I^2=0%						
Sensitivity analysis: trials and observational studies						
Leong et al, 2000	3	100	2	100	0.4%	1.50 [0.26, 8.79]
Krinsley et al, 2003	256	1267	265	1297	55.5%	0.99 [0.85, 1.15]
Krivopal et al, 2003	12	51	11	43	2.6%	0.92 [0.45, 1.87]
Graat et al, 2007	104	622	132	754	23.8%	0.96 [0.76, 1.21]
Hendrikse et al, 2007	38	250	79	486	10.3%	0.94 [0.66, 1.33]
Clec'h et al, 2008	28	81	29	84	7.4%	1.00 [0.66, 1.52]
Total	**441**	**2371**	**518**	**2764**	**100.0%**	**0.98 [0.87, 1.09]**
Overall effect: p=0.68; heterogeneity: I^2=0%						

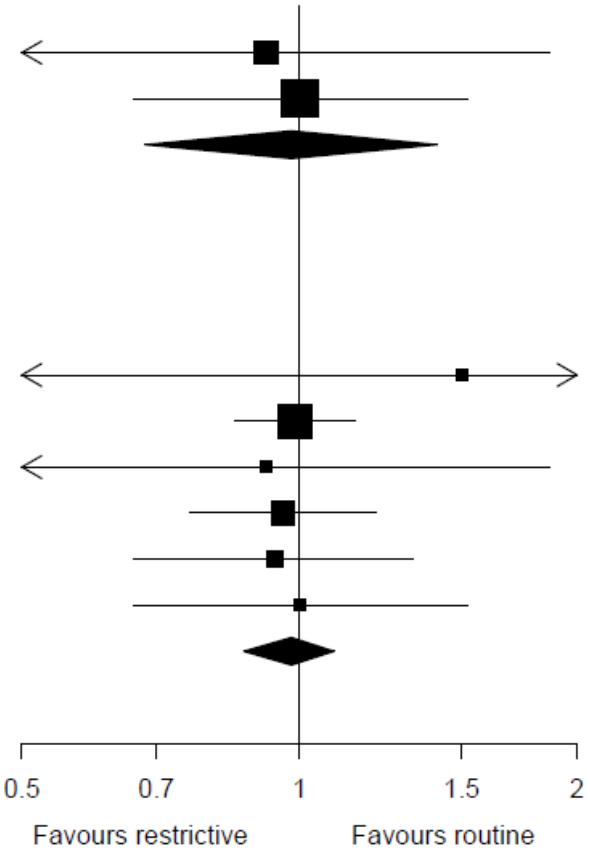


Figure 3 Effect of a restrictive versus routine chest x-ray strategy on hospital mortality among trials (primary analysis) and trials and observational studies (sensitivity analysis). Weight is the relative contribution of each study to the overall estimate of treatment effect on a log scale using a random effects model.

Critical Care 2012, 16:R68

ACR appropriateness criteria 2021

Usually appropriate

- Admission or transfer to intensive care unit
- Intensive care unit patient with clinically worsening condition
- Intensive care unit patient following support device placement

May be appropriate (Disagreement)

- Stable intensive care unit patient. No change in clinical status
- Intensive care unit patient. Post chest tube or mediastinal tube removal

J Am Coll Radiol. 2021 May;18(5S):S62-S72.

Interpreting the portable chest radiograph

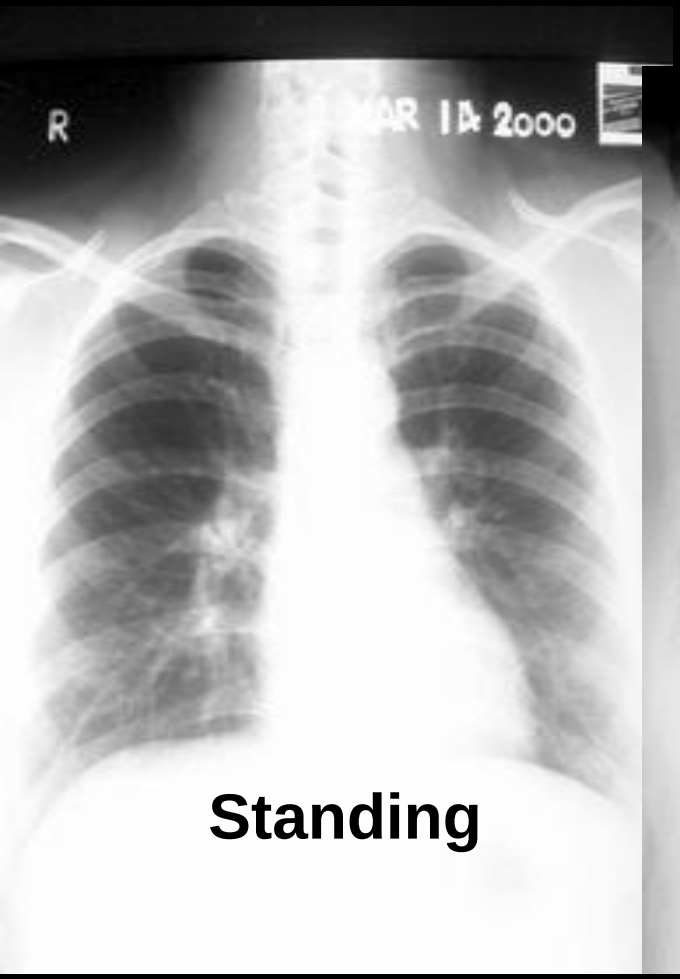
- Assess the technical quality of the study
- Evaluate the location of all catheters, tubes, and support devices
- Assess the cardiovascular status of the patient
- Check for abnormal parenchymal opacities
- Search for evidence of barotrauma
- Look for pleural effusions
- Compare with the prior studies; does the patient look the same, better, or worse?

Crit Care Clin 23 (2007) 539–573

Limitations of portable X ray

- Inconsistent X-ray technique
- Magnification of cardiac silhouette
- Poor visualization of mediastinal structures, lung parenchyma and effusion

Effects of body position on X ray



Standing

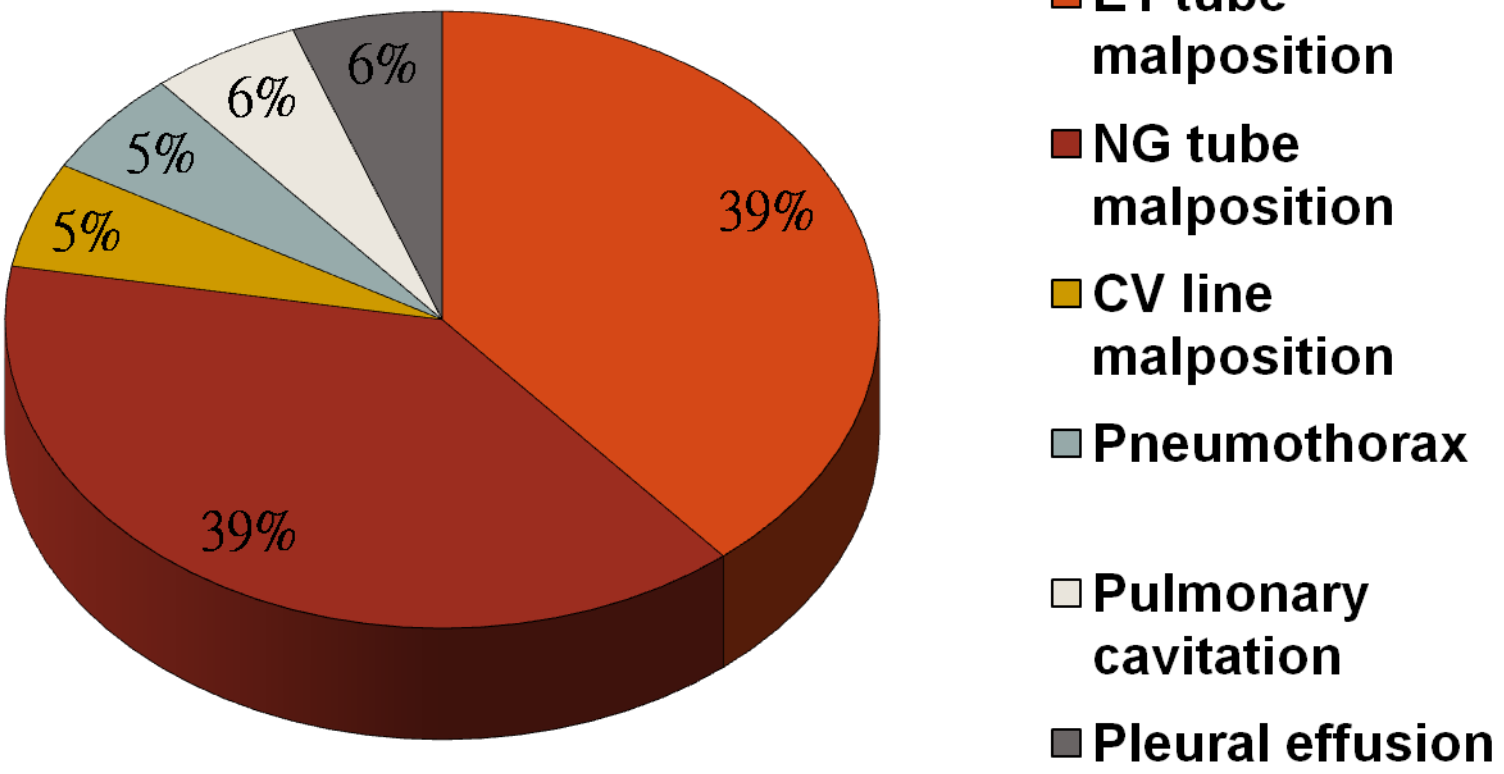
Sitting

Supine

Rules for better portable X ray

- Consistent patient's position (supine)
- Focus-film distance: at least 50 inches, constant
- Exposure: 72-100 kVp, < 0.1 sec, at peak inspiration
- All external devices removed

Major Findings by CXR but not by clinical assessment



(Hall JB CCM 1991;19:689)

Endotracheal tube placement

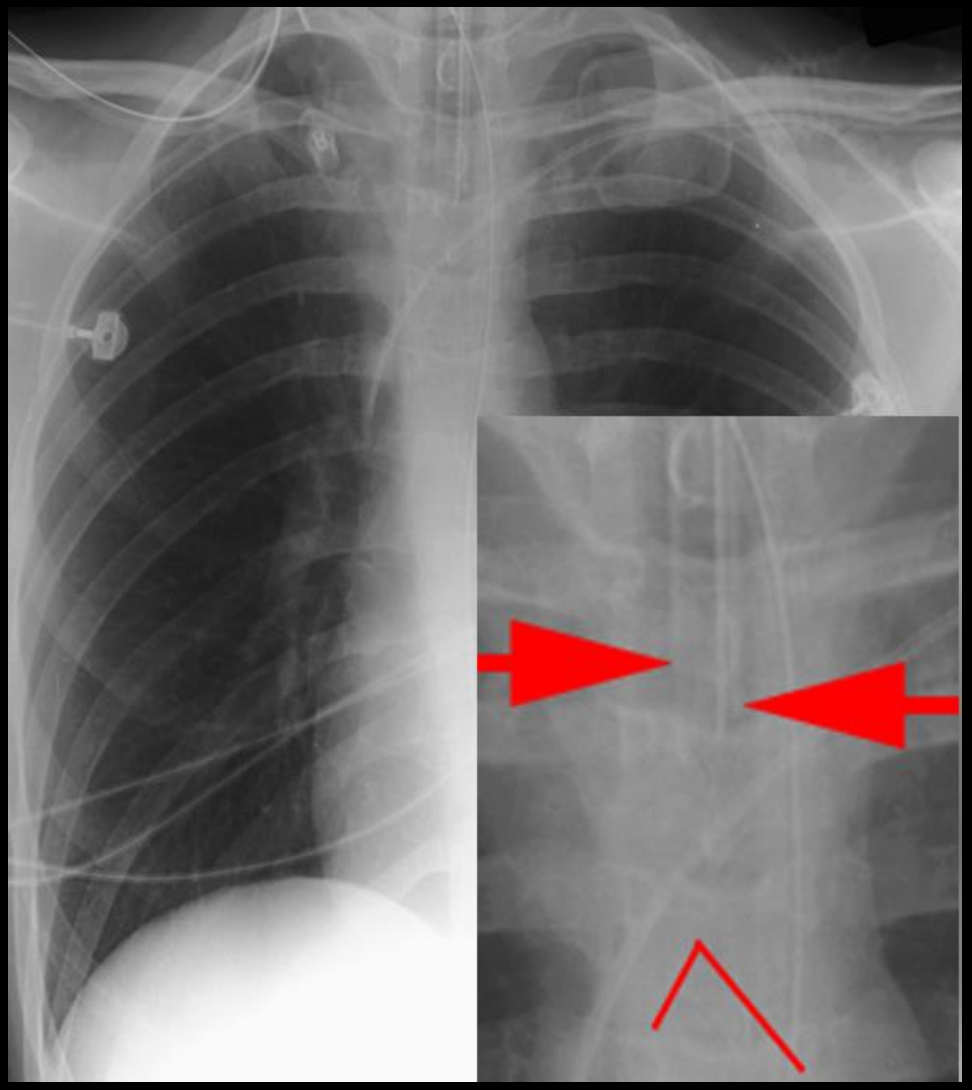
- Tip at 3 to 5 cm above carina or at T3-T4 level or between clavicle
- Cuff diameter < 2.5 cm or cuff diameter /tr lumen ratio < 1.5

Complications

- Too high or too low

(10-15%)

- Esophageal intubation
- Tracheal rupture
- Cuff related injury



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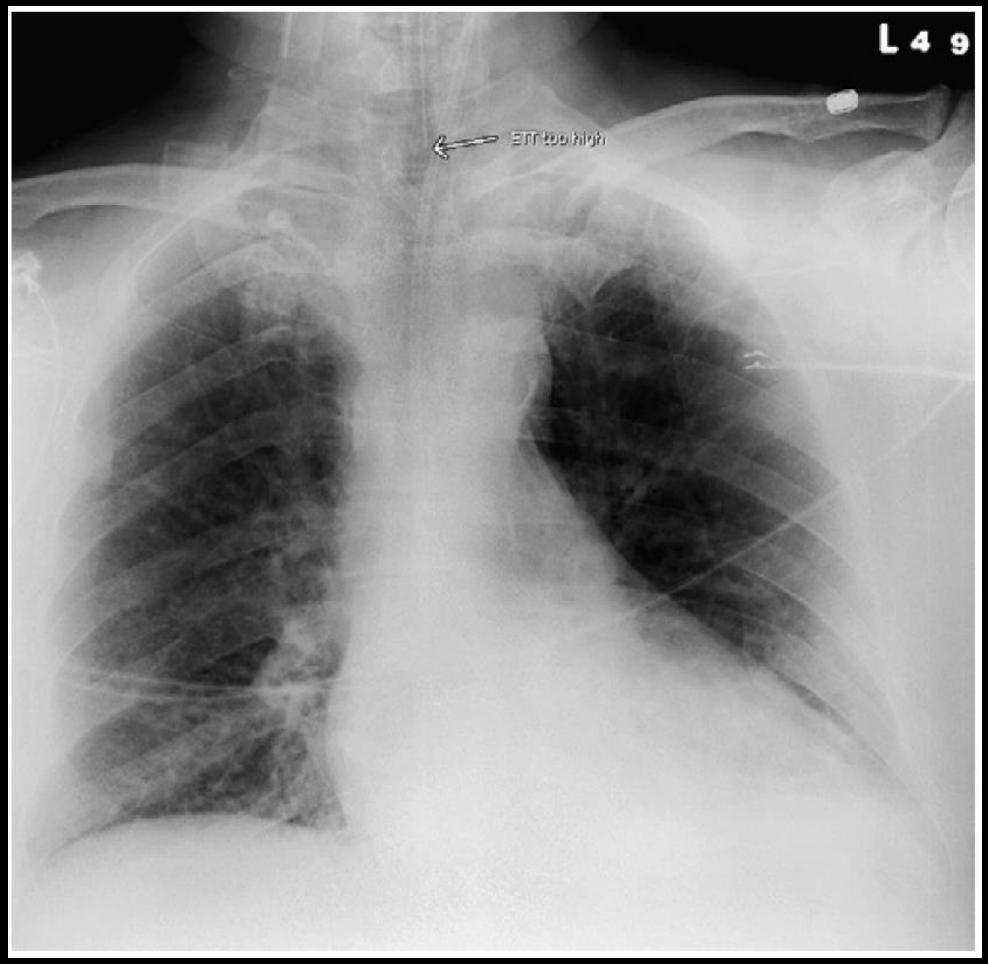
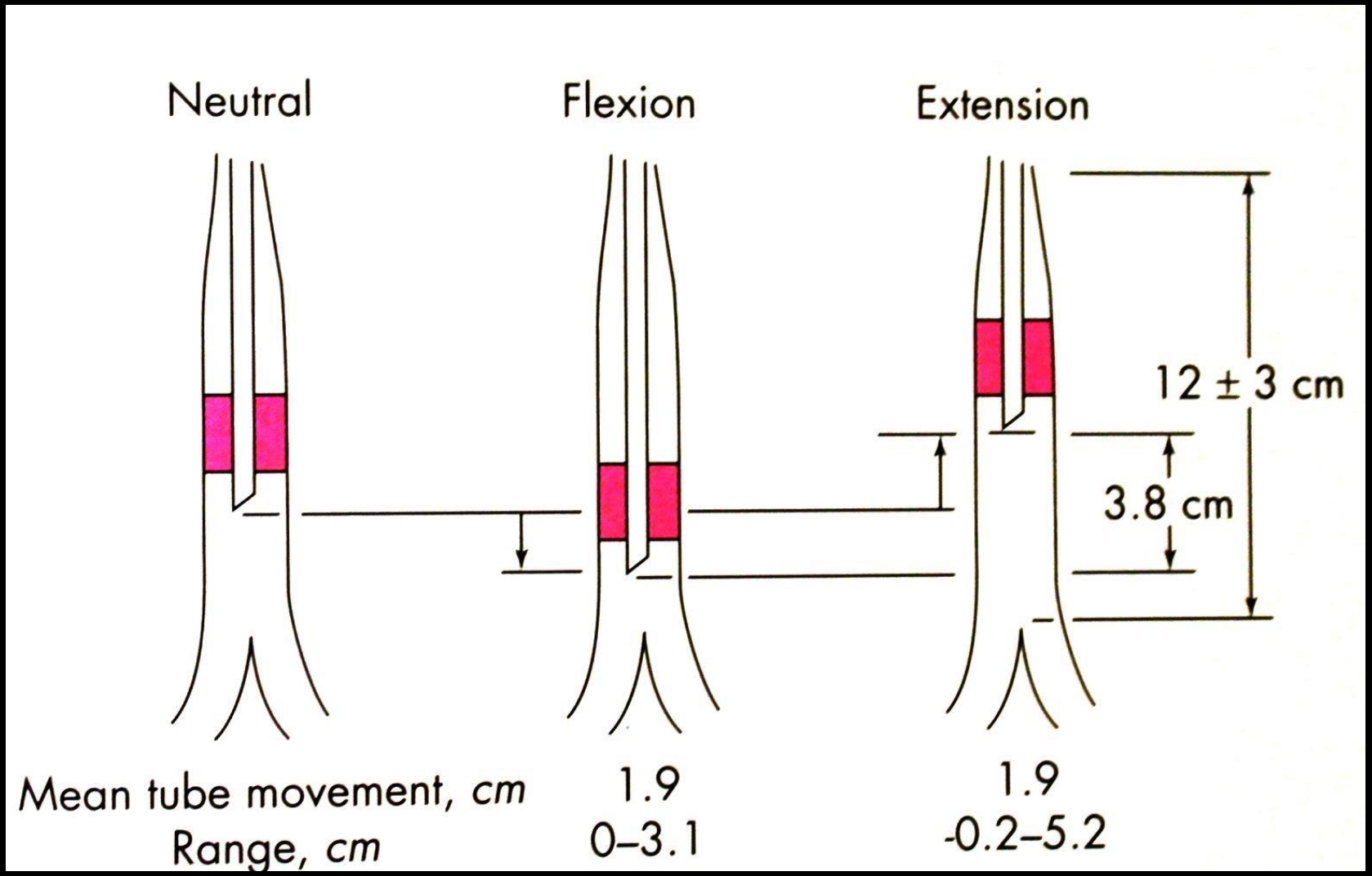
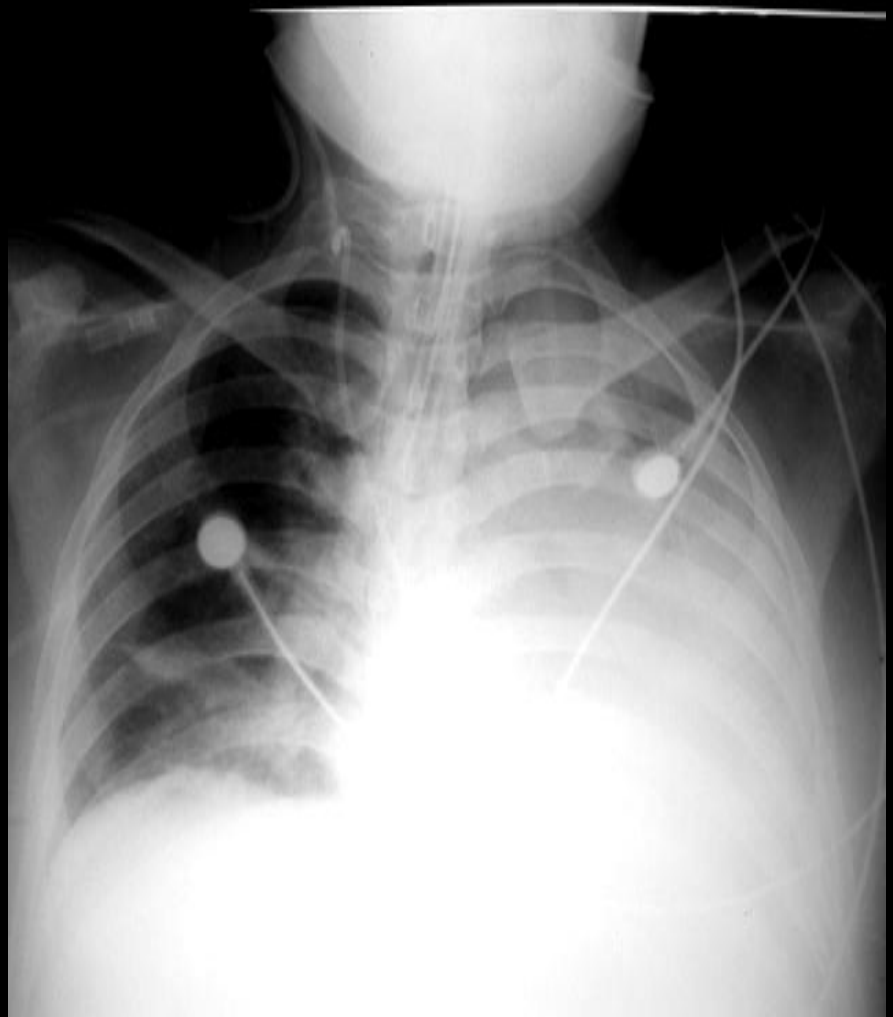


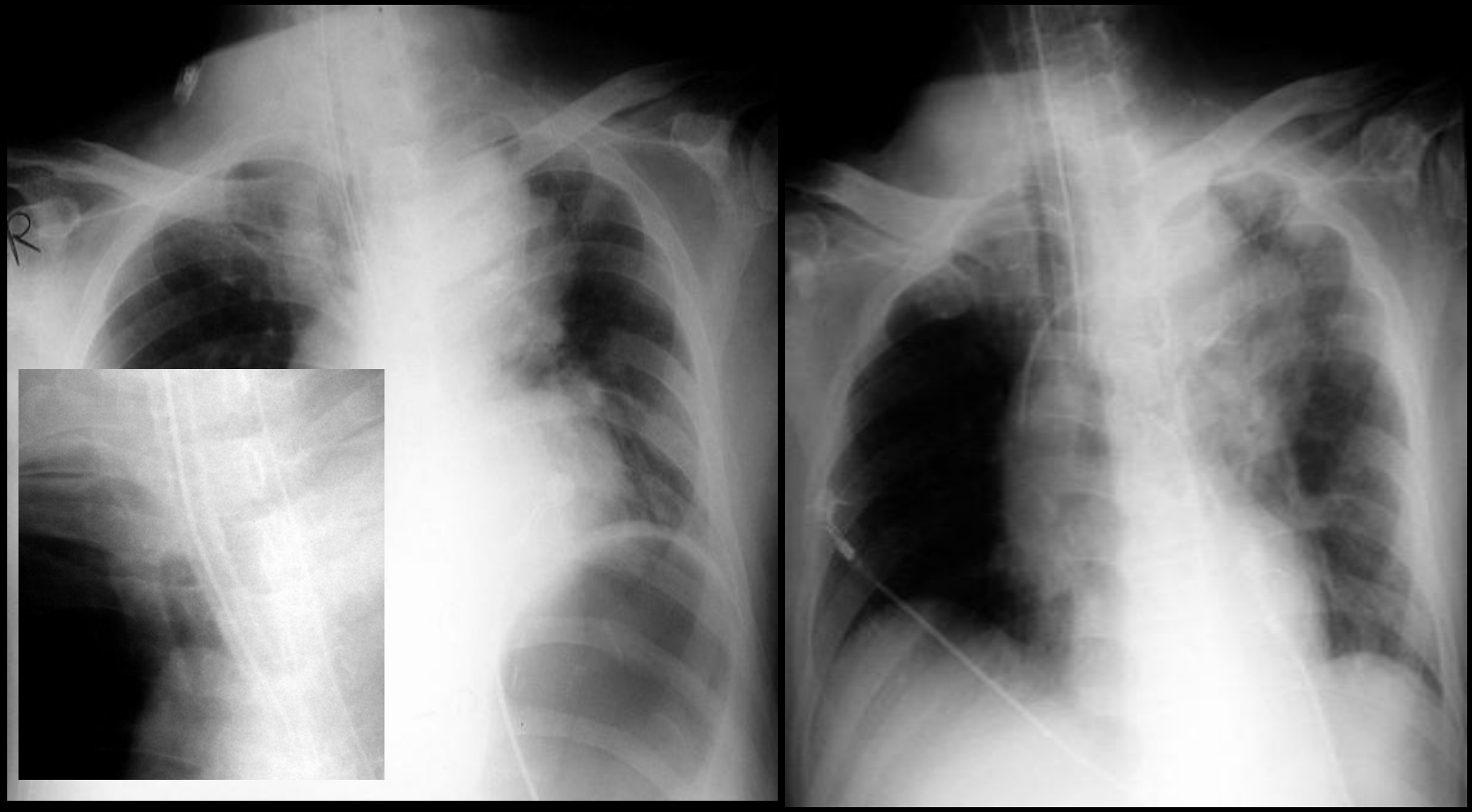
Endotracheal tube movement



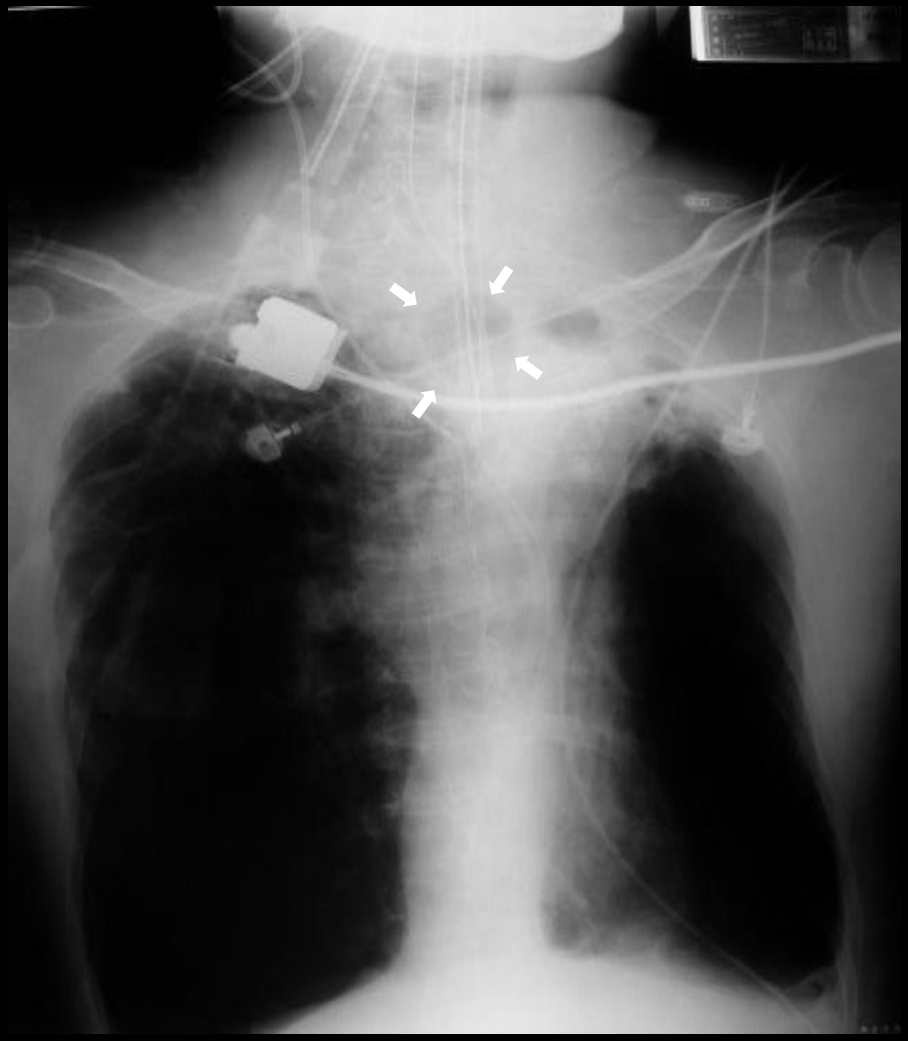
One lung intubation

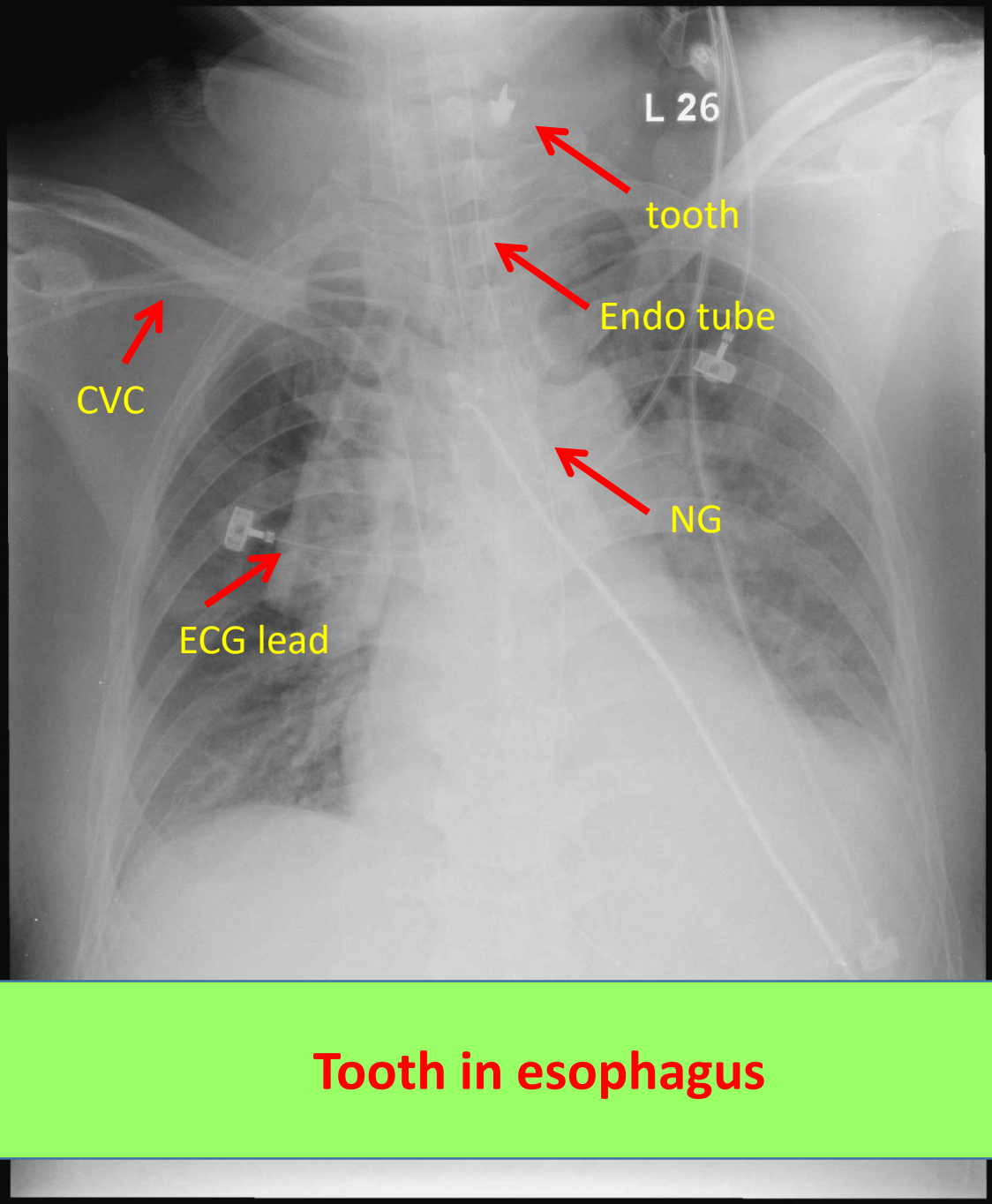


Esophageal intubation



Cuff overdistention

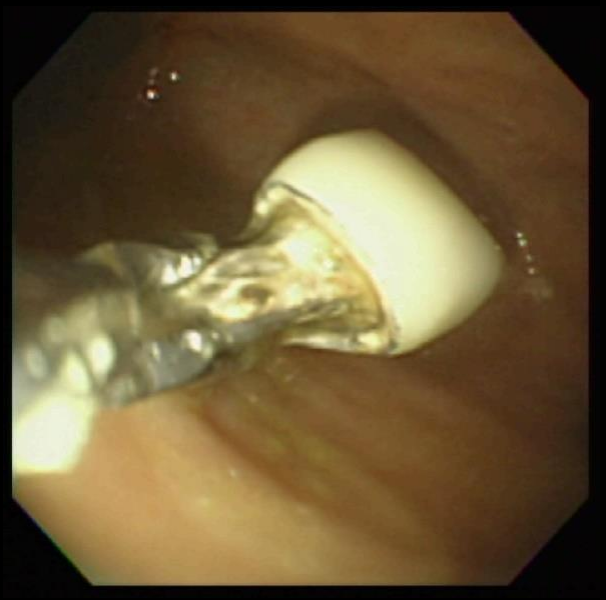


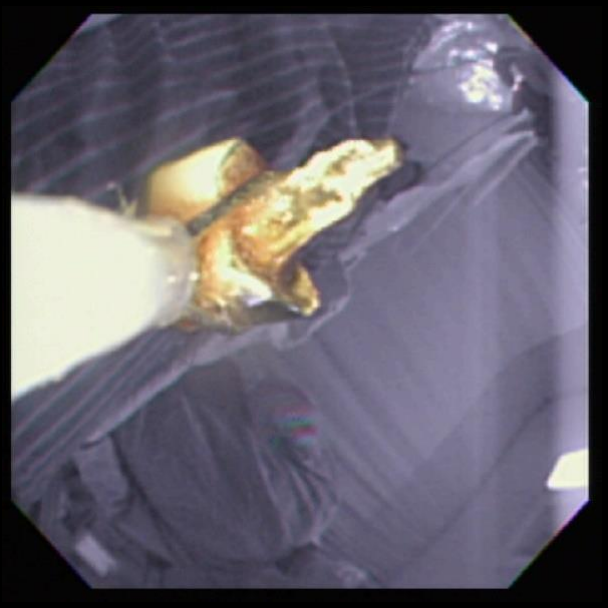


55-year-old male
Traumatic brain injury
post-operation

Tooth in esophagus

UGIPES





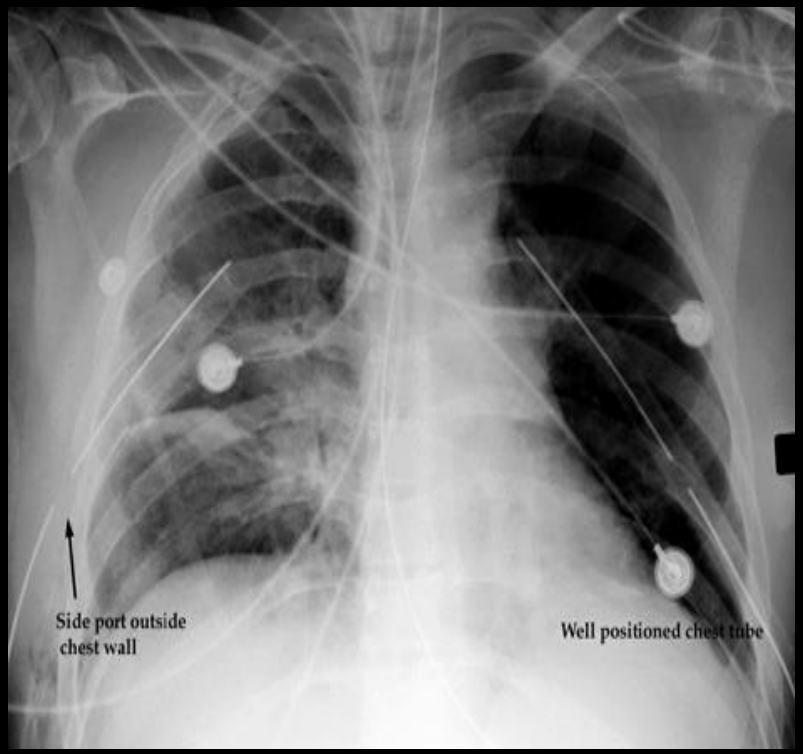
An artificial tooth was seen at esophagus and dropped to the stomach, fundus. We used basket and the tooth was removed succesfully.

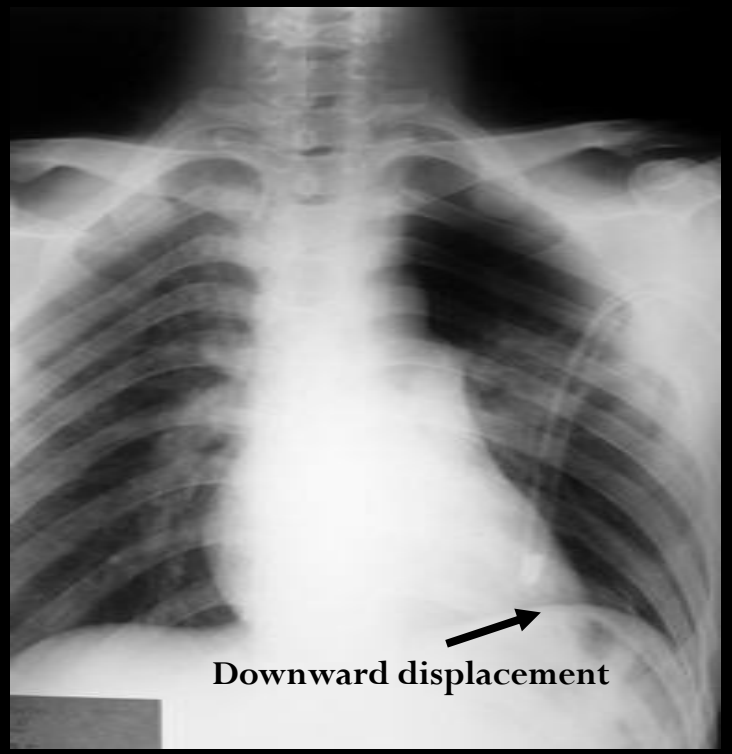
Chest tube

- Straight or gently bending upward or downward

Malposition

- In interlobar fissure
- Injury lung, liver or spleen





Chest tube malposition

NG tube

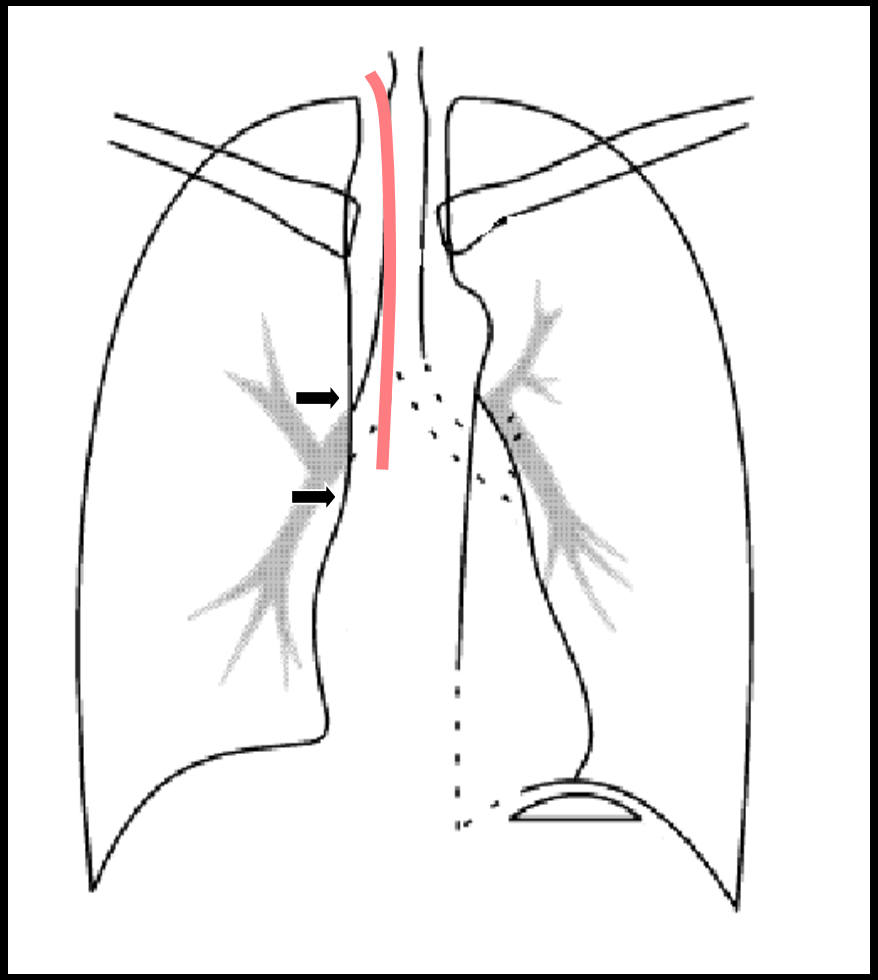
- ~ 1% incidence of malposition, such as pharynx, esophagus, airway and pleura

Central venous catheter

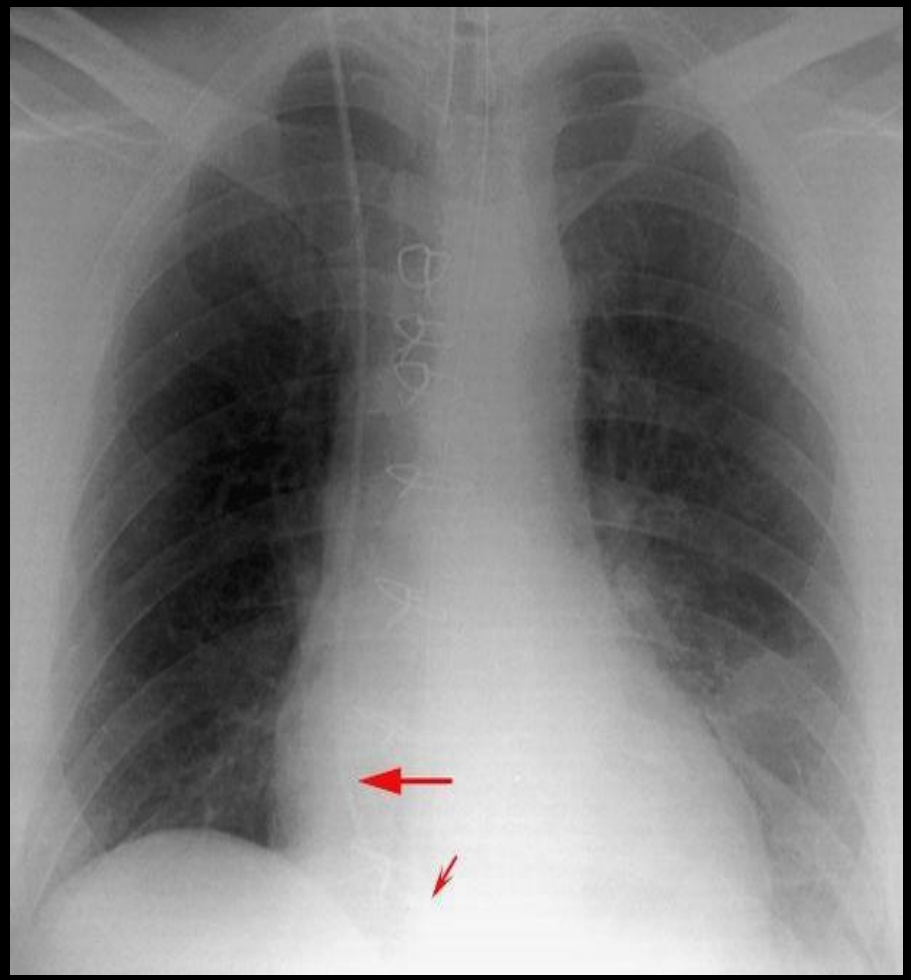
- Tip beyond the venous valves, in intrathoracic cavity
- Tip between right tracheobronchial angle and superior heart border

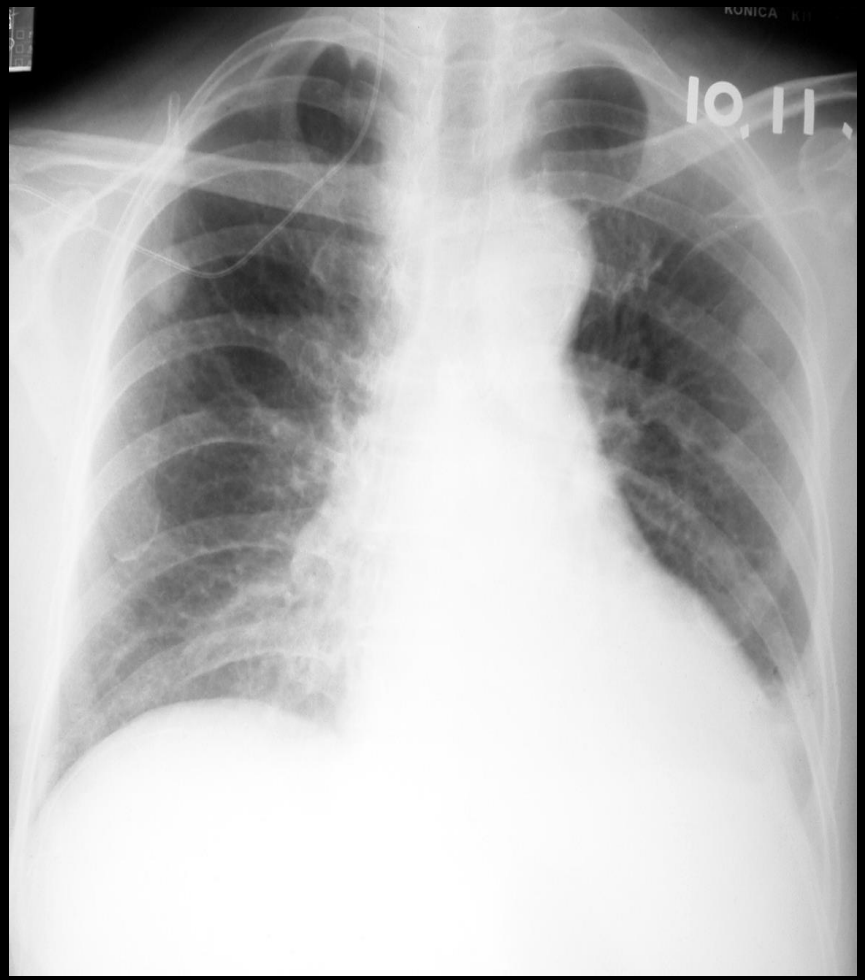
Complications:

- Malposition
- Coiled or kinking
- Pneumothorax
- Vessel perforation

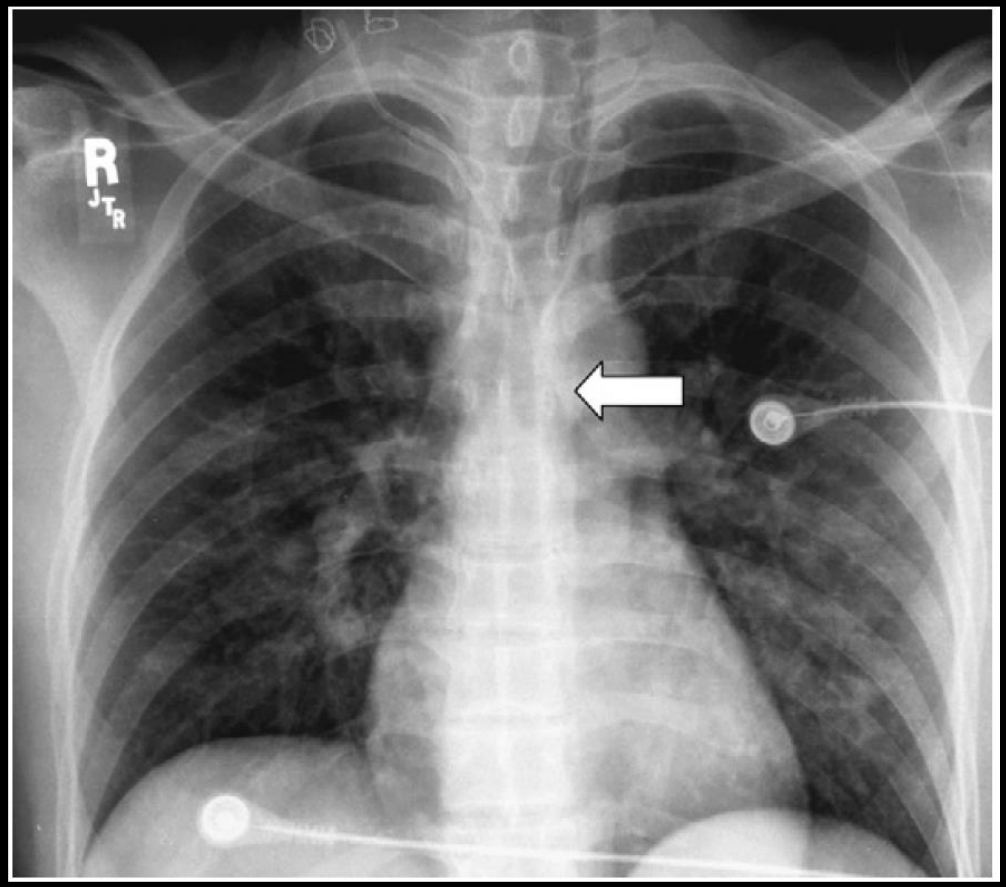


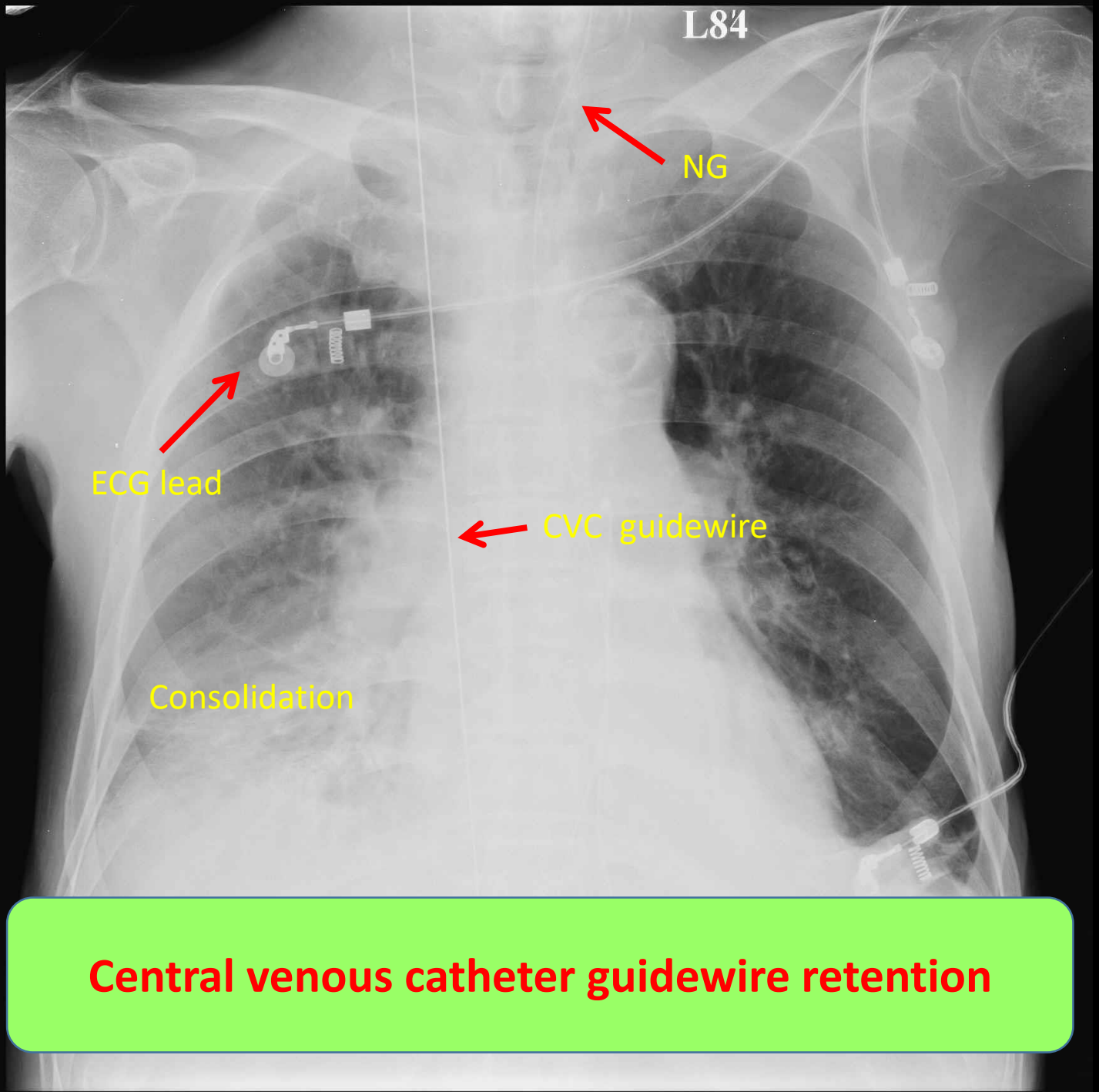
Central venous catheter malposition





Central venous catheter malposition





87 y/o male
Hypotension post fluid resuscitation

Central venous catheter guidewire retention

Angiography

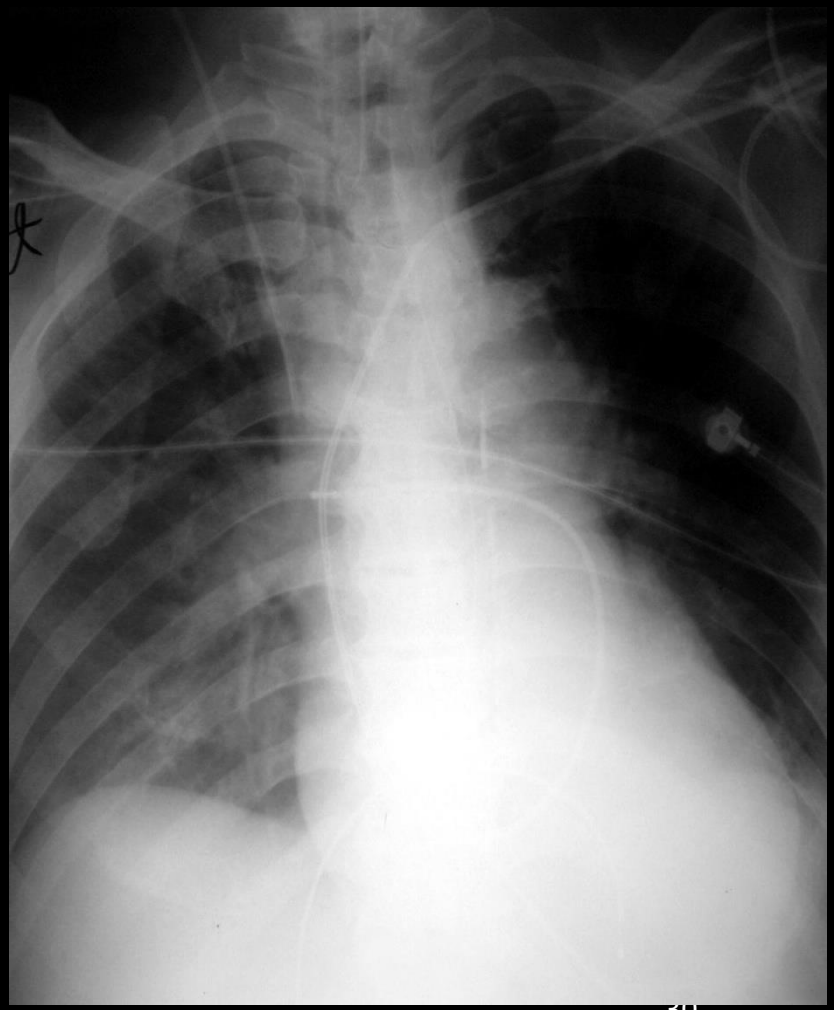
Snare is inserted into right femoral vein, grasping the J-end of the guidewire.

Pulmonary artery catheter

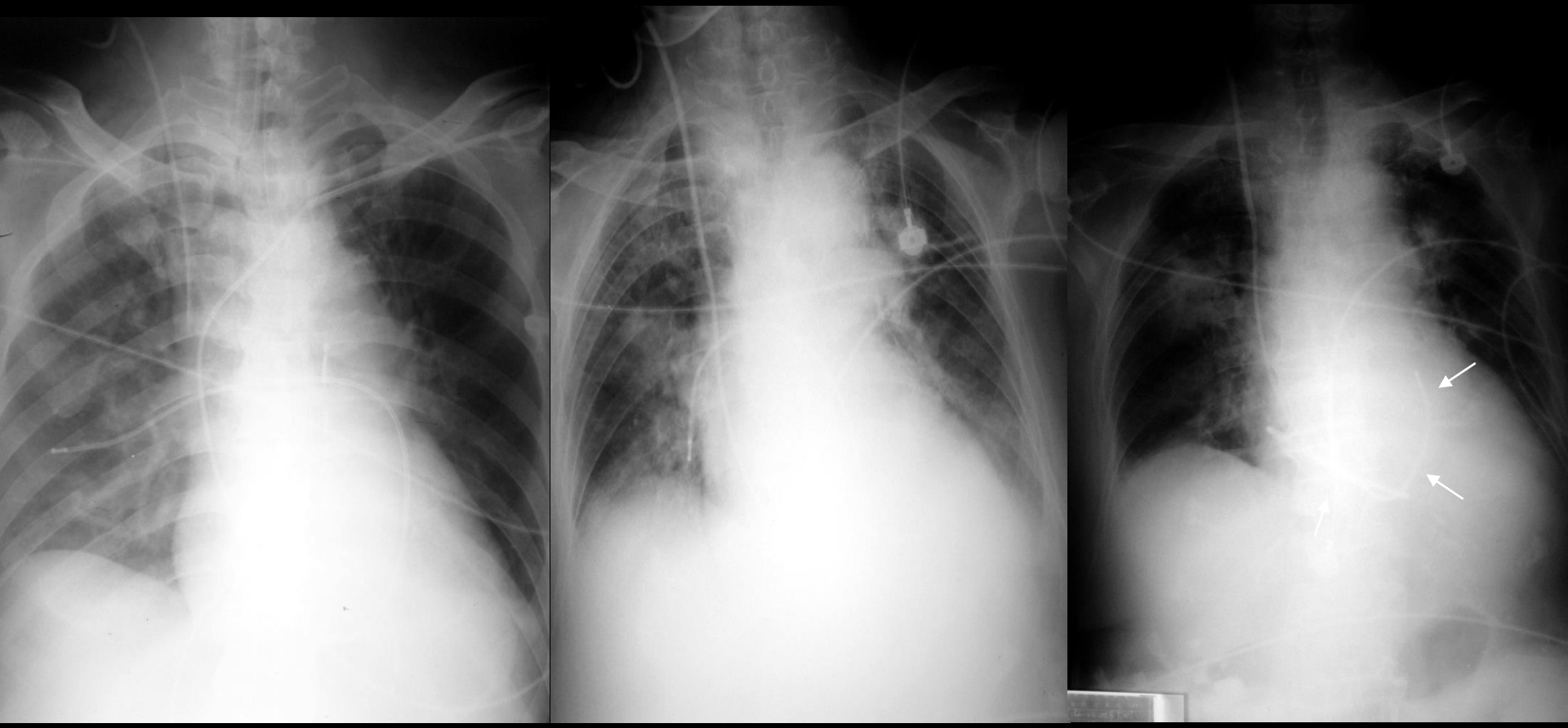
- Tip in the interlobar pul artery: <2 cm lateral to hilum

Complications:

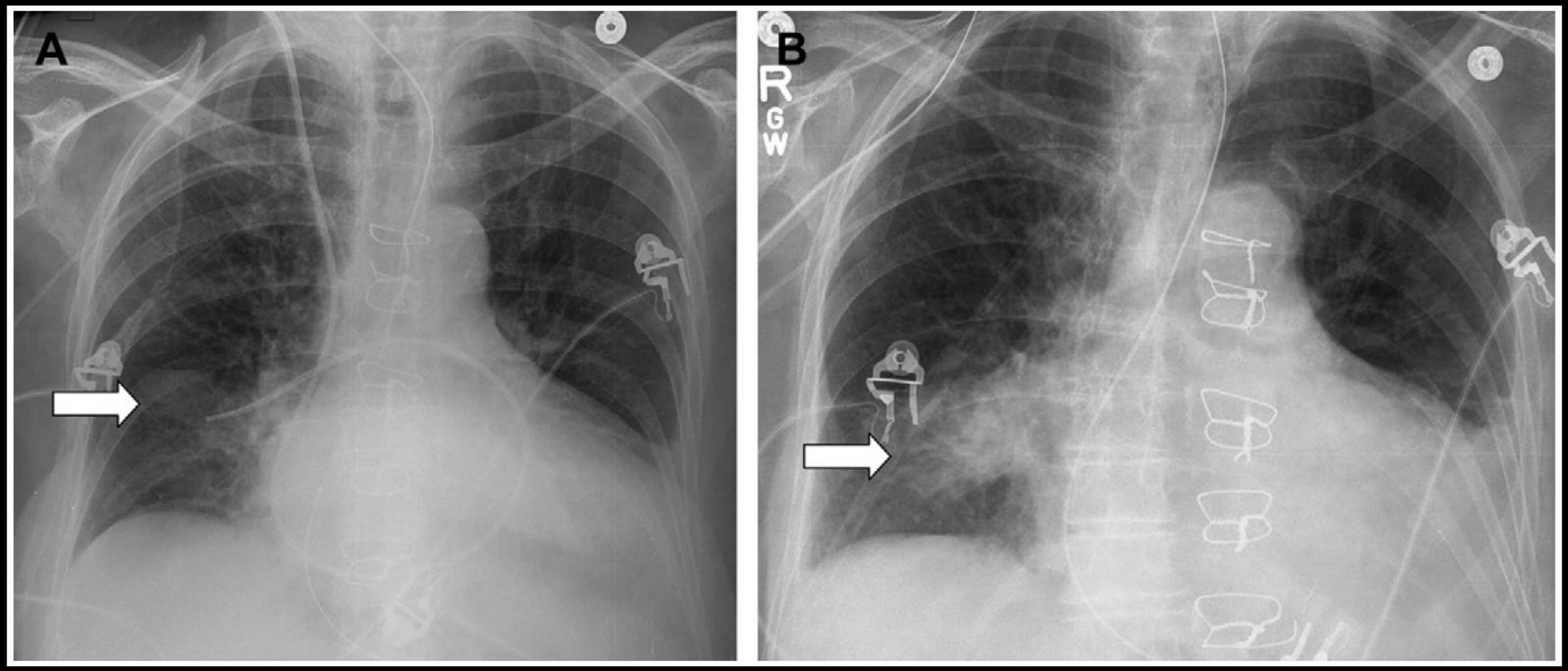
- Malposition: too proximal or too distal (24%)
- Arrhythmia, cardiac damage
- Pulmonary hemorrhage, infarction



Malpositioned PA catheter

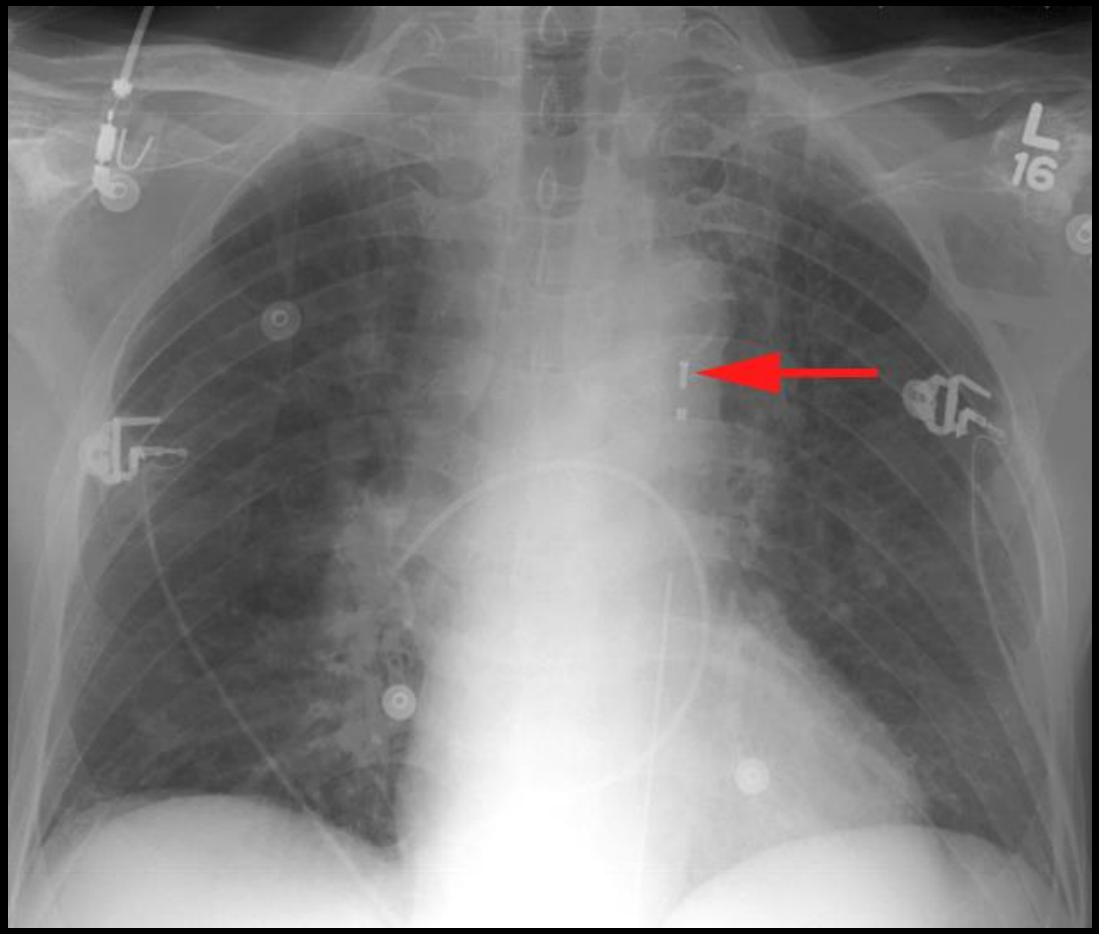


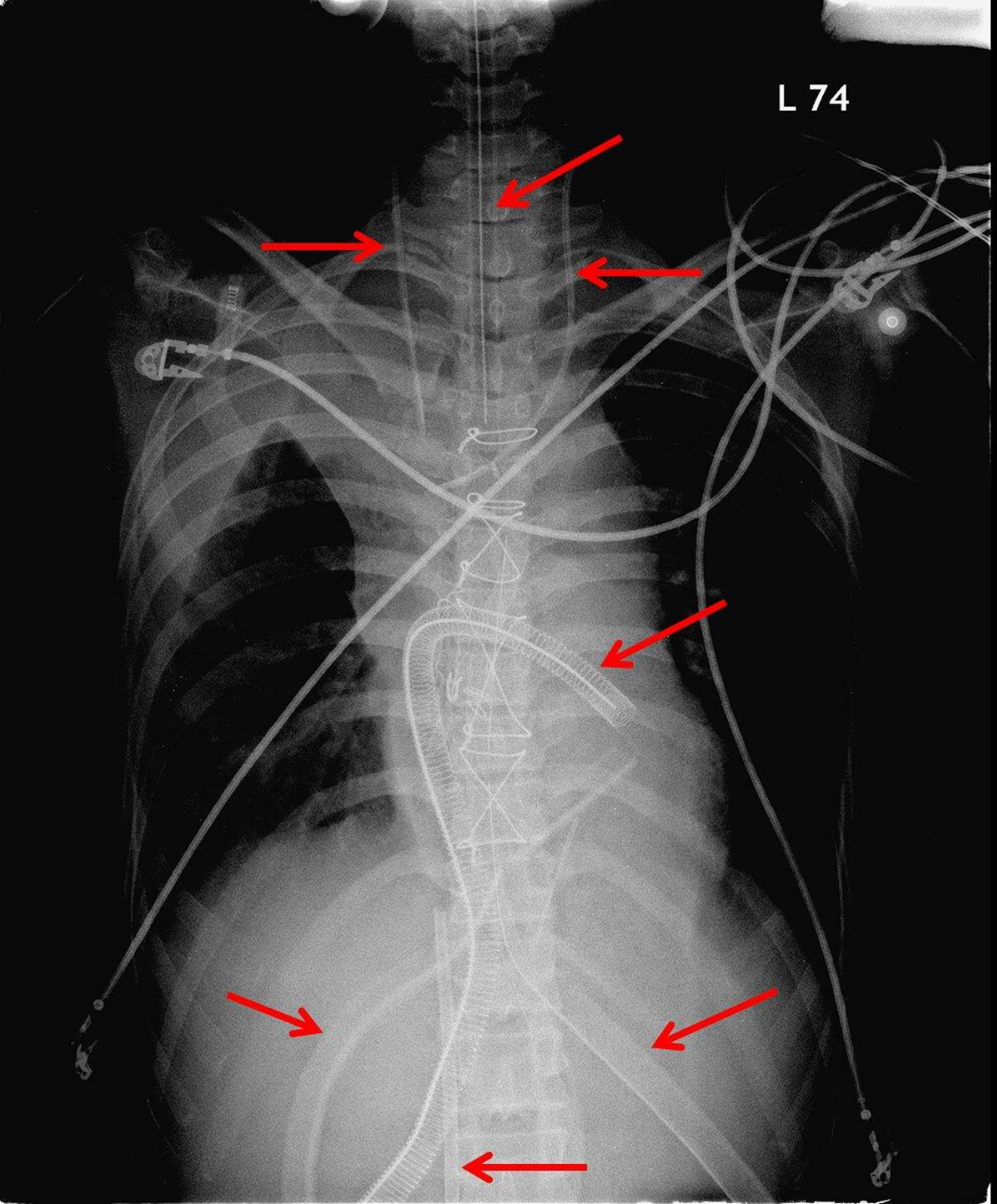
Malpositioned PA catheter



Intraaortic balloon pump

- Tip in descending aorta
- Distal to the origin of left subclavian artery
- Inflated balloon above sup mesenteric and renal artery

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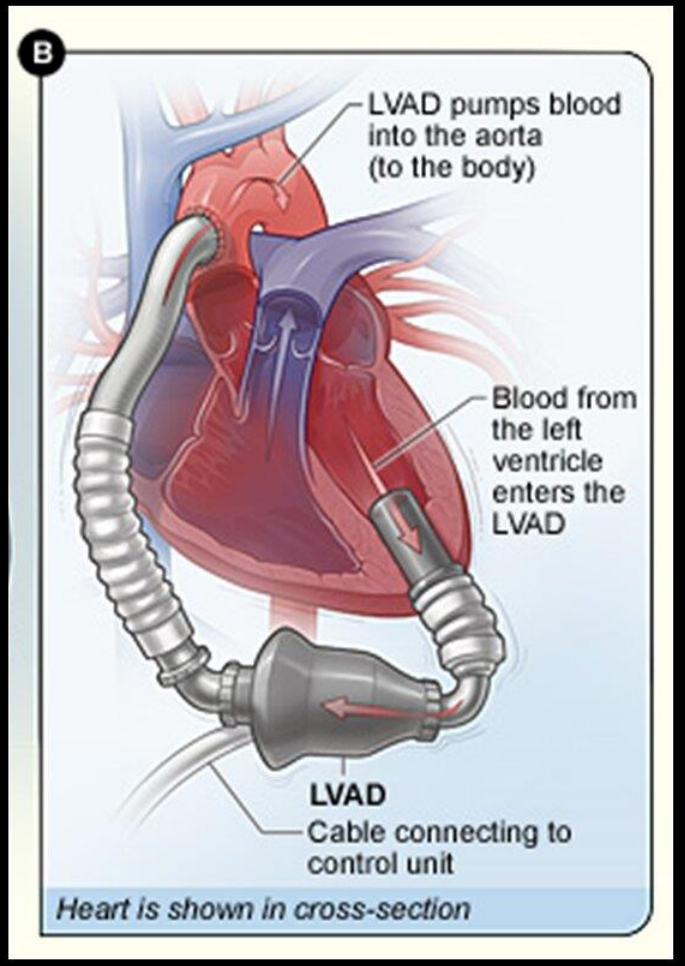
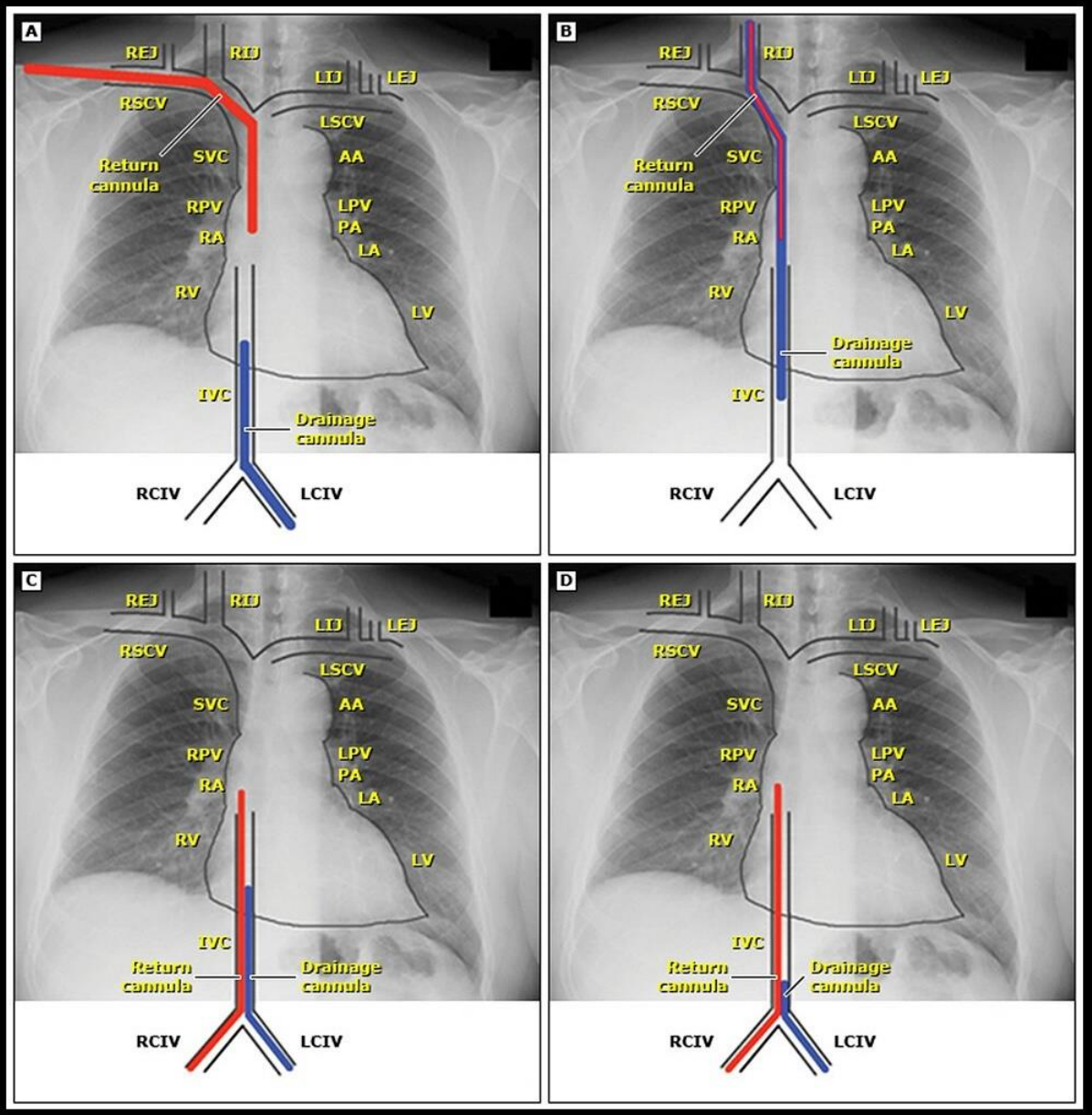
LVAD


B
LVAD pumps blood into the aorta (to the body)
Blood from the left ventricle enters the LVAD
LVAD
Cable connecting to control unit
Heart is shown in cross-section

ECMO


A
REJ
RIJ
LIJ
LEJ
RSCV
LSCV
Return cannula
SVC
AA
RPV
LPV
PA
RA
LA
RV
LV
IVC
Drainage cannula
RCIV
LCIV
B
REJ
RIJ
LIJ
LEJ
RSCV
LSCV
Return cannula
SVC
AA
RPV
LPV
PA
RA
LA
RV
LV
Drainage cannula
IVC
RCIV
LCIV
C
REJ
RIJ
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RSCV
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IVC
Return cannula
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RSCV
LSCV
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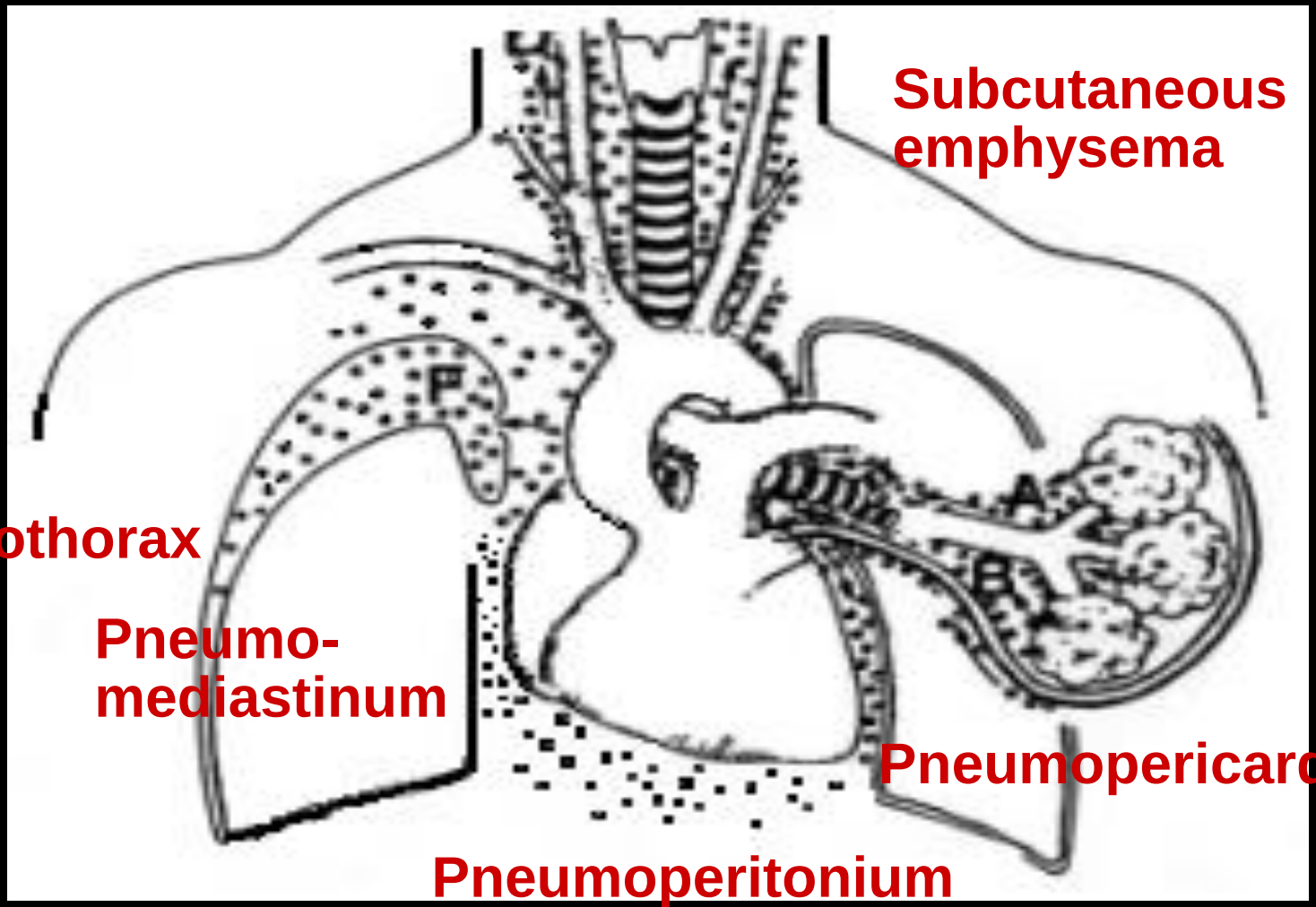
IVC
Return cannula
Drainage cannula
RCIV
LCIV

Extra-alveolar gas

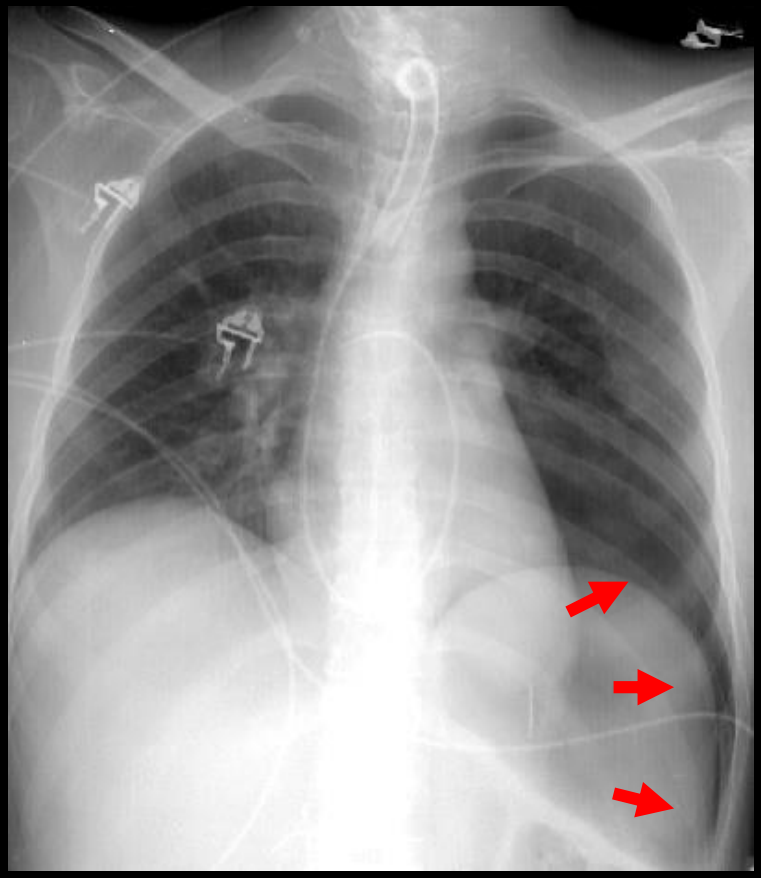


Pneumothorax on supine film

- Easily missed on supine films (32%)

Features:

- Increased radiolucency at lung bases
- Sharp, elongated costophrenic/ cardiophrenic sulcus (deep sulcus)
- Depression of hemidiaphragm
- Flattening of heart border



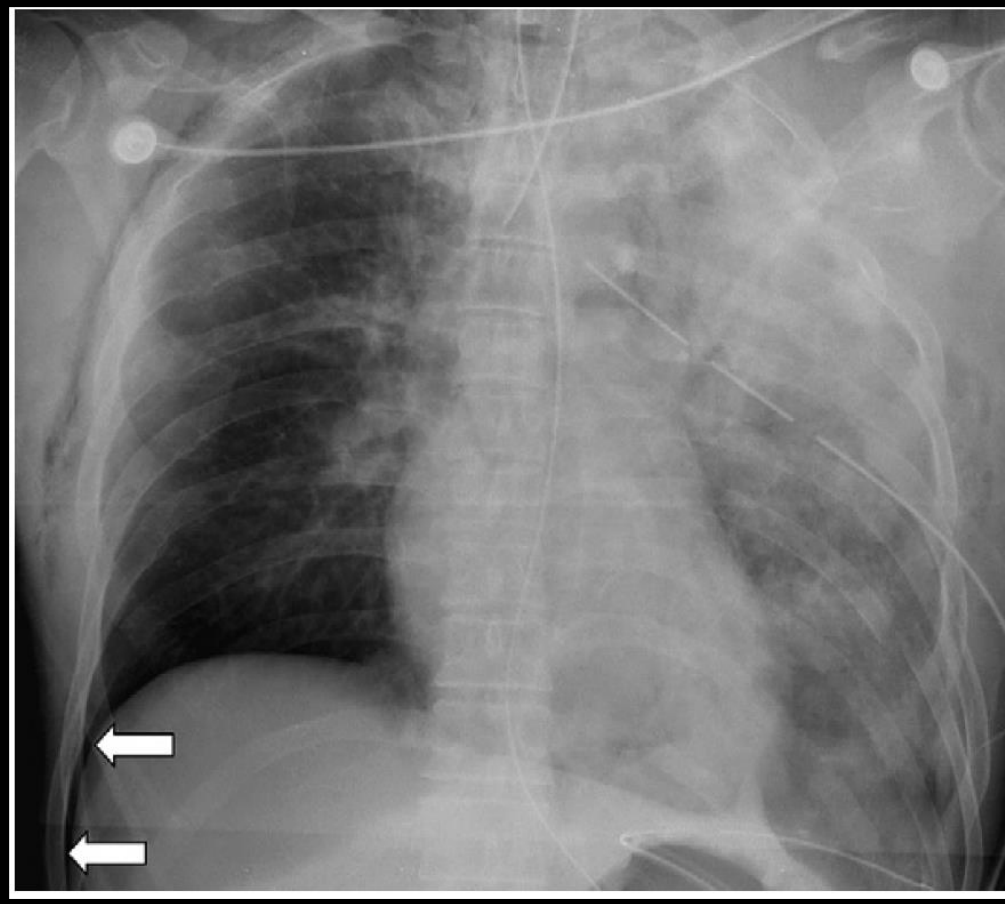
Deep sulcus sign

Pneumothorax on supine film

- Easily missed on supine films (32%)

Features:

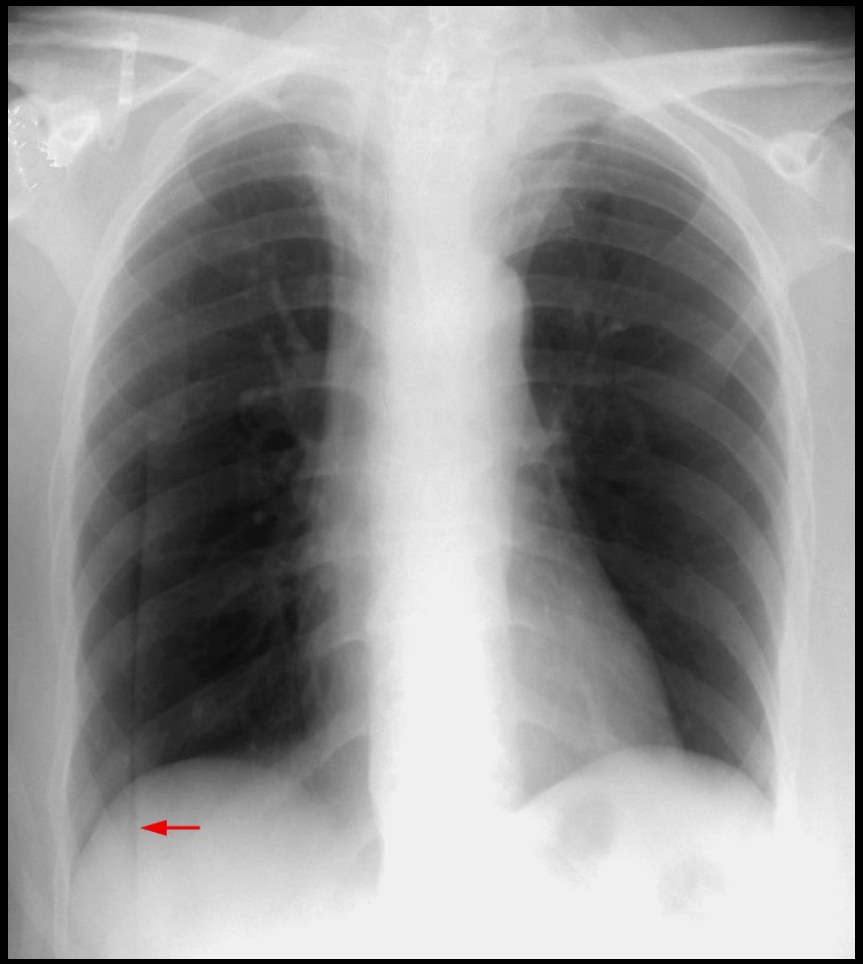
- Increased radiolucency at lung bases
- Sharp, elongated costophrenic/ cardiophrenic sulcus (deep sulcus)
- Depression of hemidiaphragm
- Flattening of heart border



Deep sulcus sign

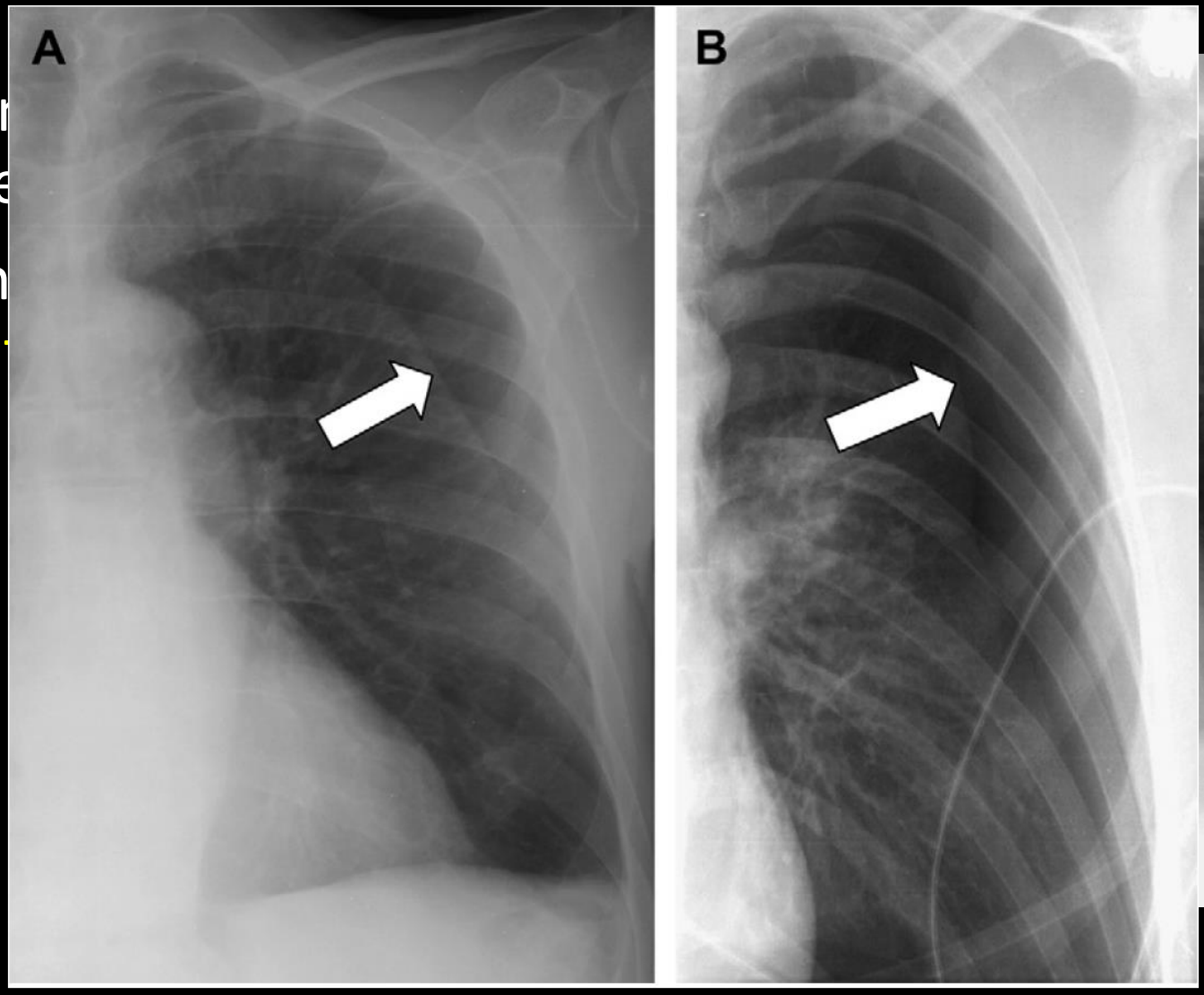
Skin folds mimicking pneumothorax

- Lung markings beyond the thin line
- Line may extend outside of the chest



Skin folds mimicking pneumothorax

- Lu
  the
- Lin
  ou

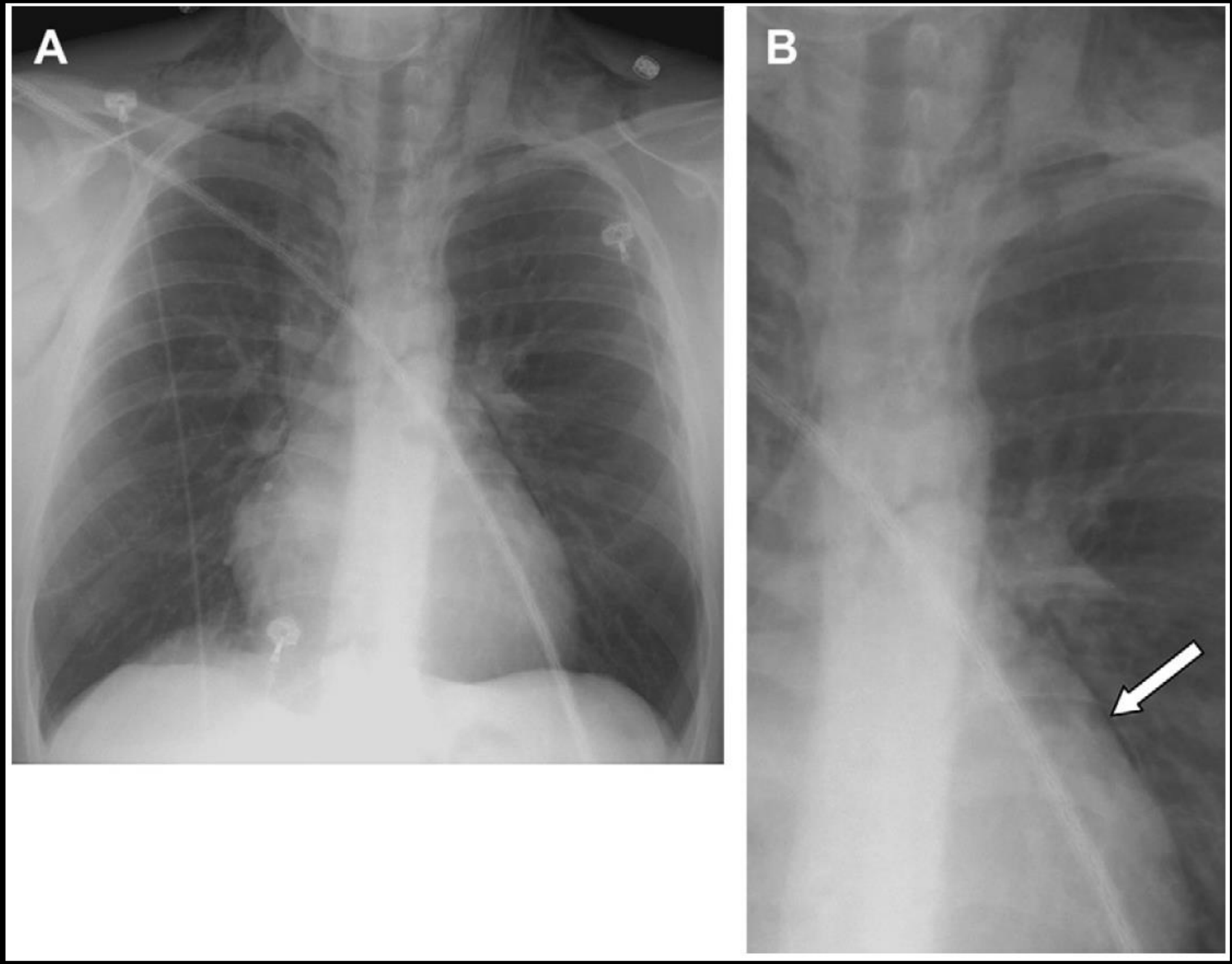


Pneumomediastinum

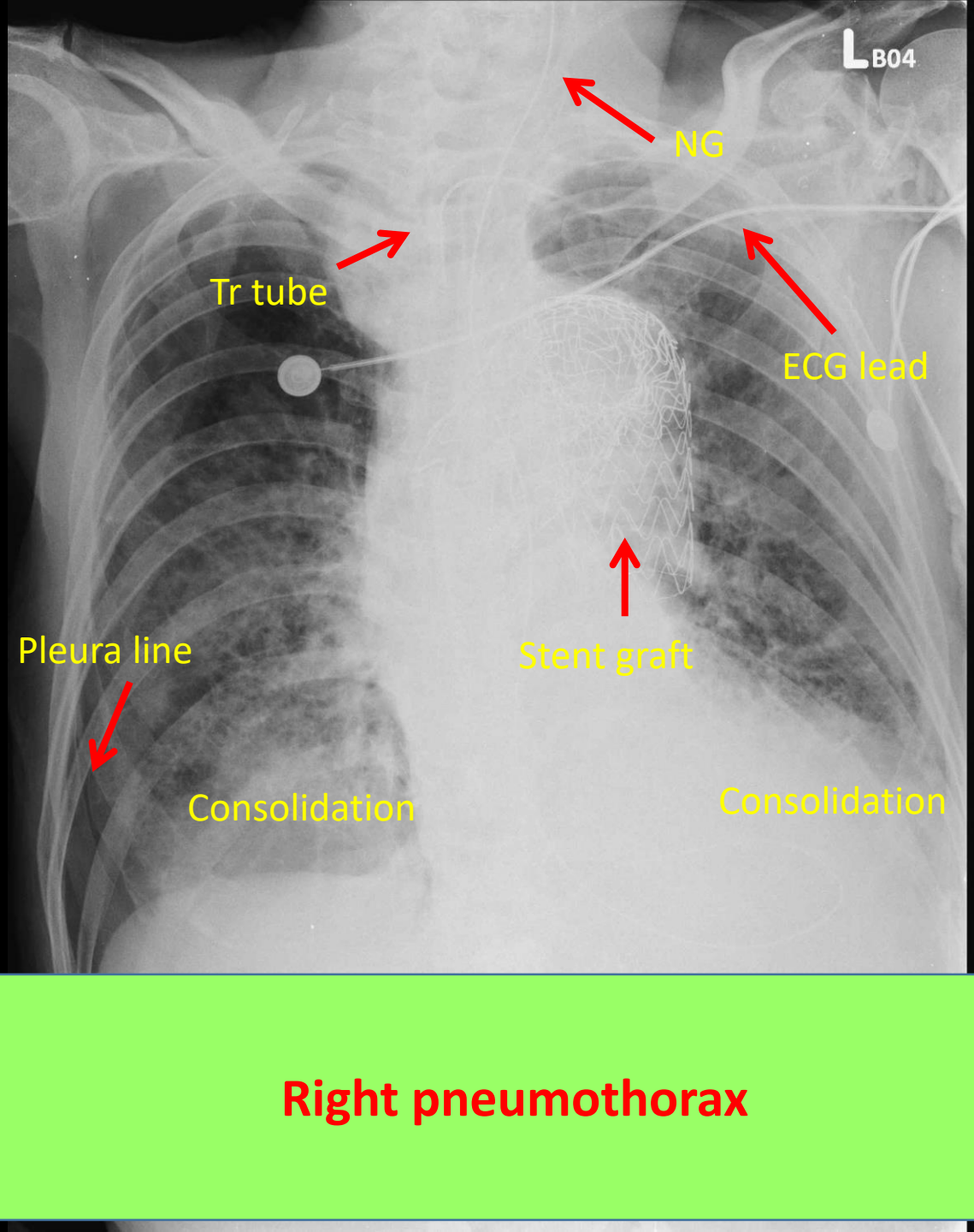
- Gas within the mediastinum can result from 5 sites: Lung (most common), mediastinal airway, esophagus, neck, and abdominal cavity.

Plain film findings:

- Lucent streaks of gas outlining the mediastinal structures
- Continuous diaphragm sign: when gas interposed between the heart and diaphragm, it permits identification of the central portion of diaphragm.


A
B

Pneumopericardium



85 y/o male
Increased oxygen demand since yesterday

Right pneumothorax


2021/09/21
21:46:44
L
B01

Pleural effusion on supine film

- Most dependent part of pleural cavity on supine: posterior basilar space and apex

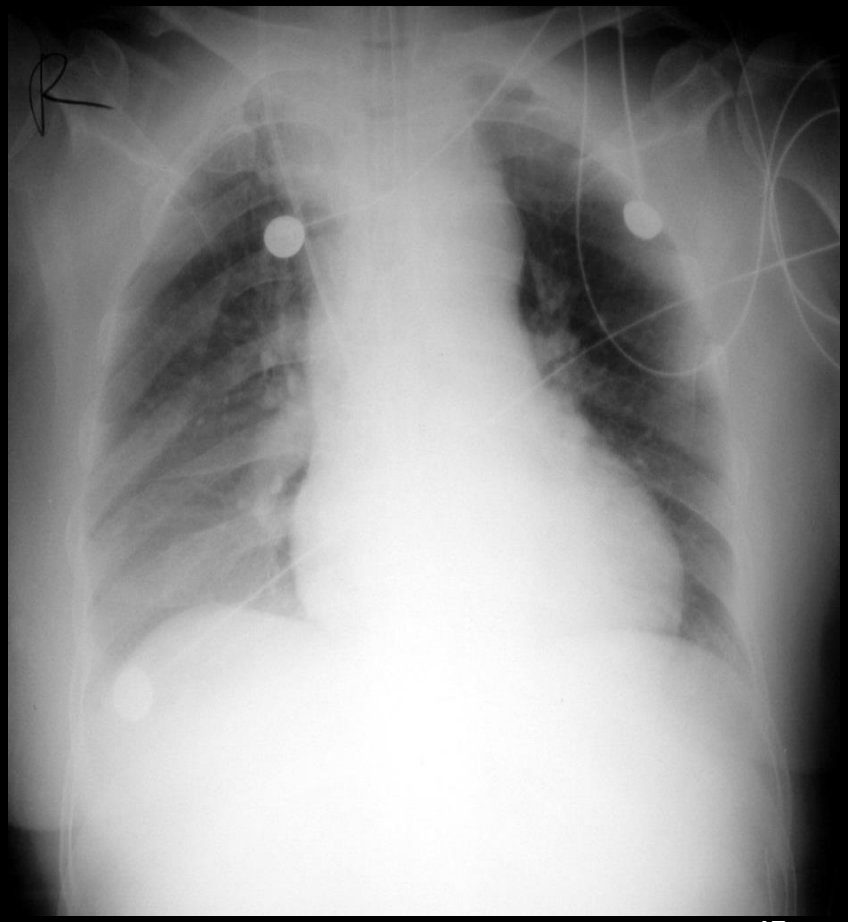
Features:

- absence of air-bronchogram
- blunted costophrenic angle
- loss of hemidiaphragm silhouette
- apical cap
- Bronchovascular markings not lost

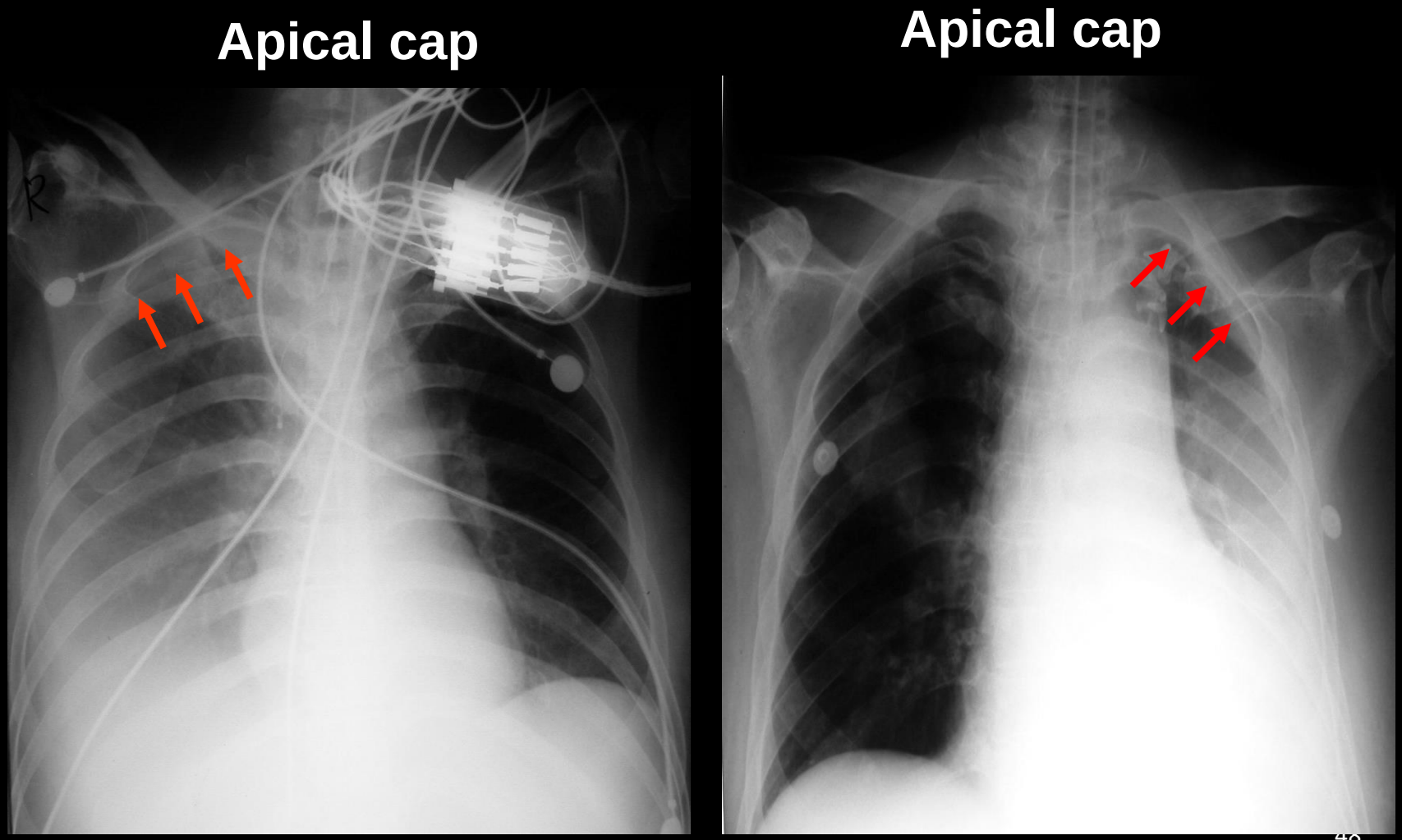
Pleural effusion on supine film

Upright film

Supine film



Pleural effusion on supine film



Atelectasis

- Most common cause of pulmonary opacities in the ICU
- Incidence: LLL(66%), RLL(22%), RUL(11%)
- Complete lung collapse to relatively normal-appearing: acute mucus plugging
- Features: rapid coming/going, lobar/segmental distribution, volume loss

Common patterns of atelectasis

- Uneven distribution
- Centrally located confluent alveolar infiltrates
- Confluent alveolar infiltrates with sparing of the peripheral lung tissues

Atelectasis

Day 1

Day 2

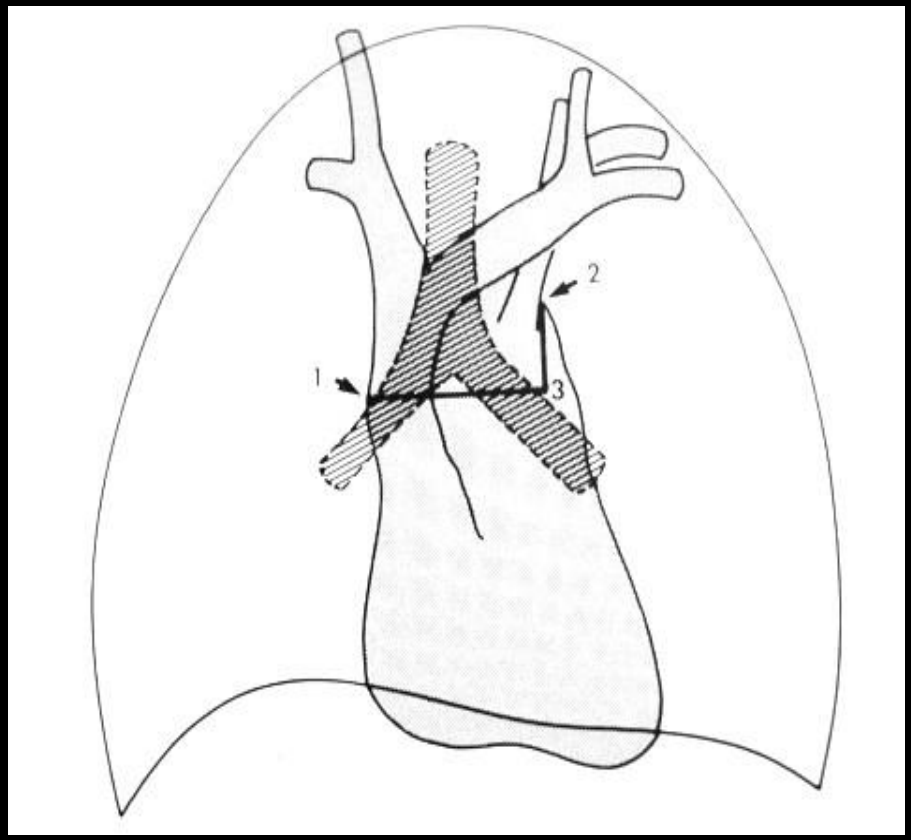
Day 5

Pulmonary edema differentials

Characters	Cardiogenic/ Fluid overload	Noncardiogenic
Cardiac size	Enlarged	Usually normal
VPW	Normal/Enlarged	Normal/Small
P. Blood flow	Cephalad	Caudad/Balanced
Kerley's B	Common	Uncommon
Peribrochial cuffing	Common	Uncommon
Air bronchogram	Uncommon	Common
Lung edema	Even/Perihilar	Patchy/Peripheral
Pleural effusion	Common, moderate-large	Uncommon, small

Vascular pedicle width

- Point 1 is where SVC crosses RMB
- Point 2 is where subclavian a arises from the aorta
- VPW = point 1 to 3
- Normal <48mm, CHF >62mm in PA view



Vascular pedicle width

Increase (>7cm)

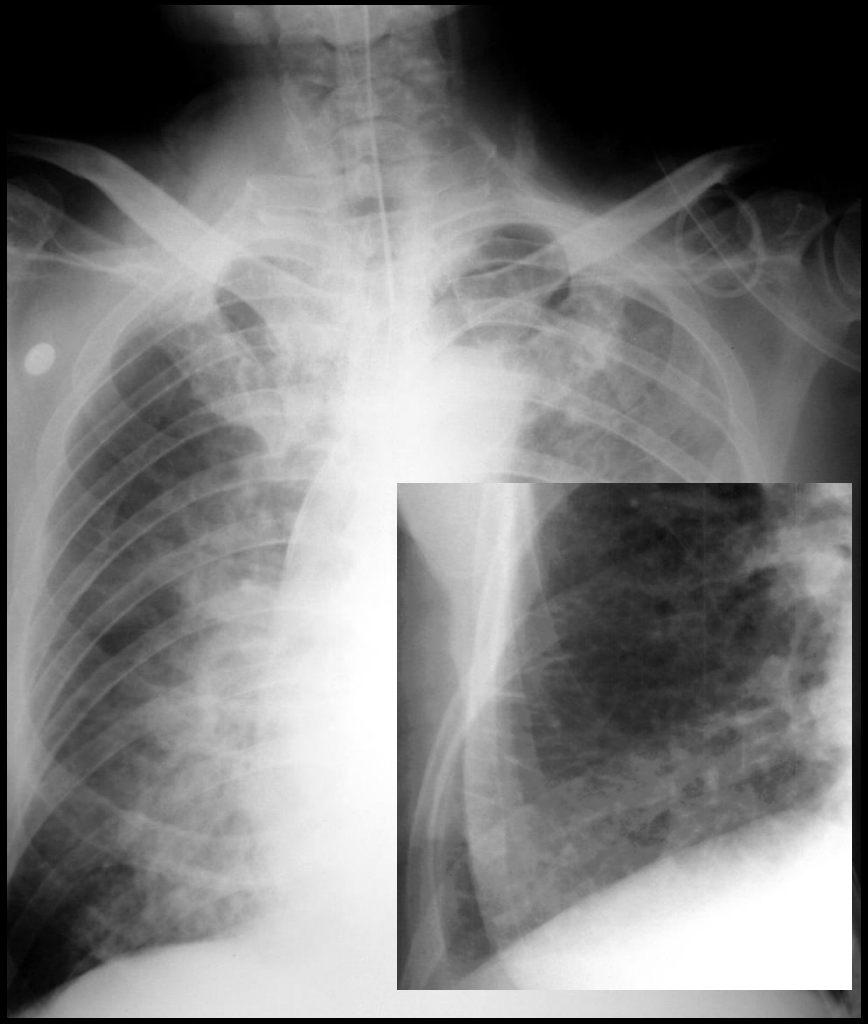
- Volume overload
- High right heart pressure
- Supine position

Decrease (<3cm)

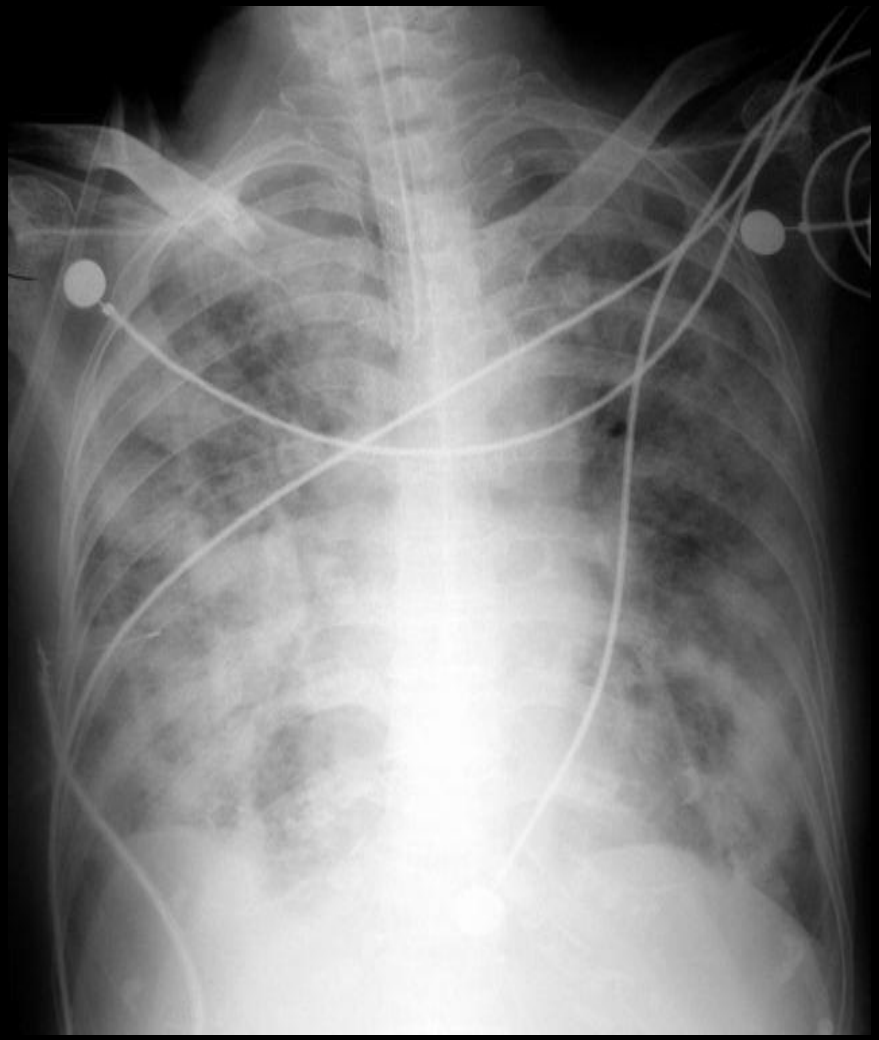
- Hypovolemia
- High level of positive ventilatory pressure

Acute pulmonary edema

Cardiac edema



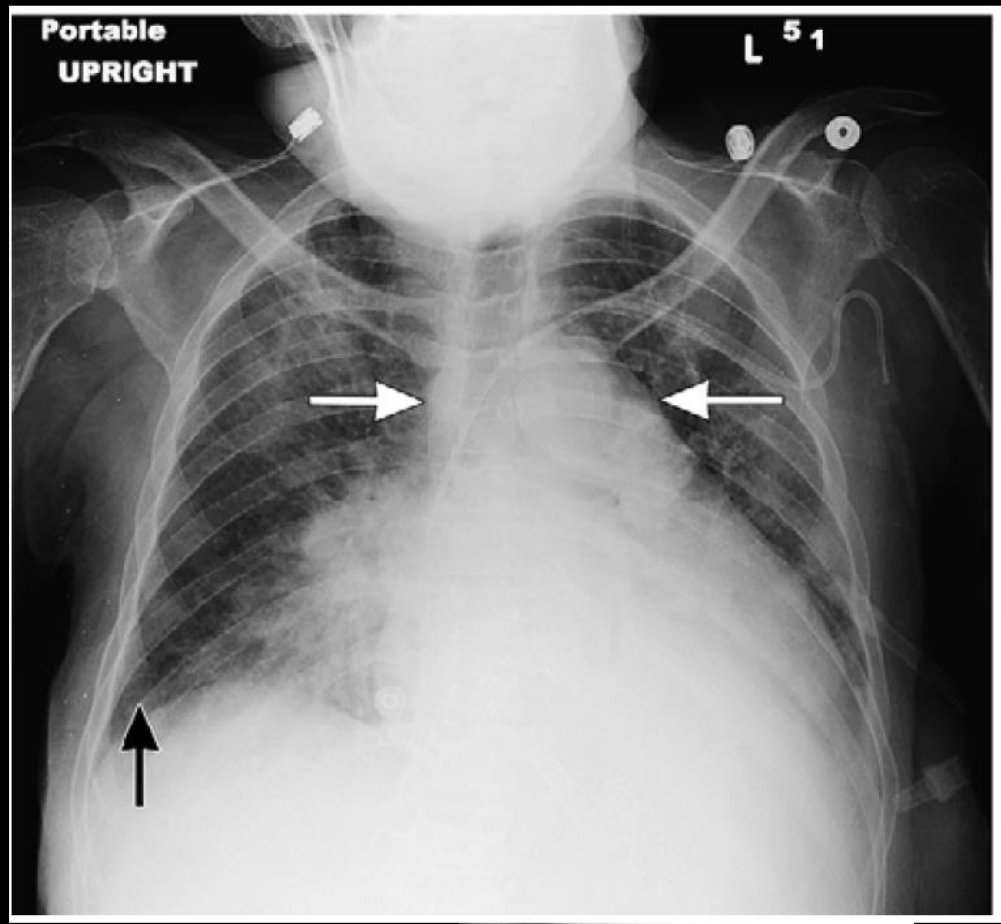
Noncardiac edema

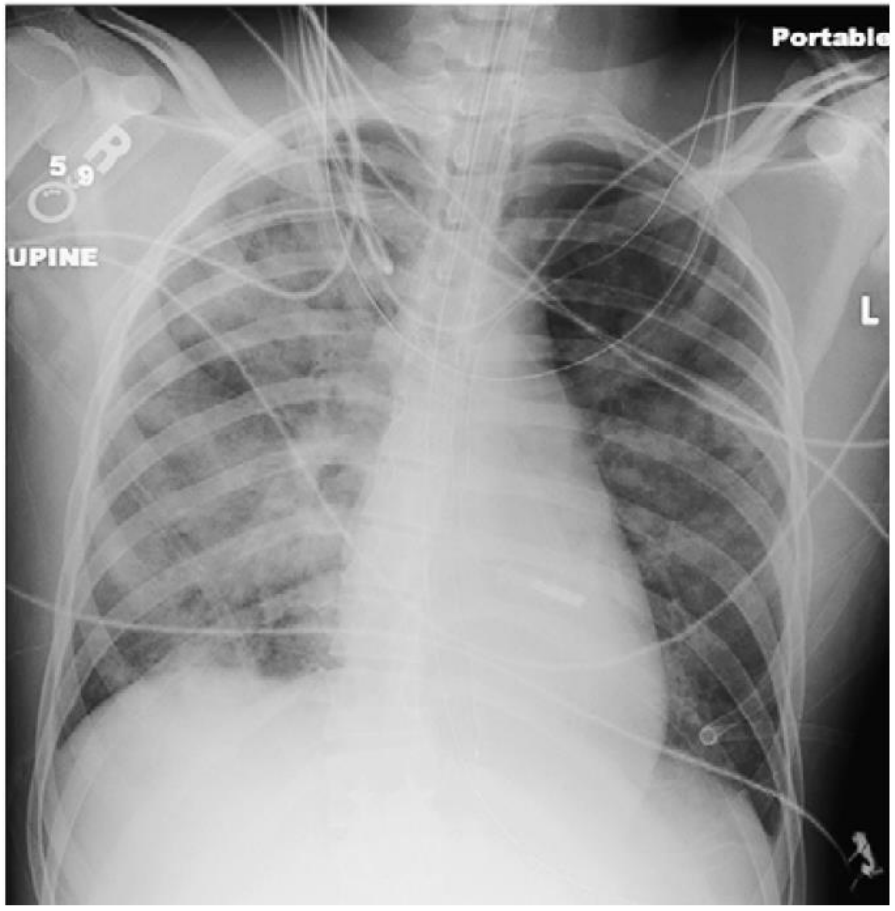


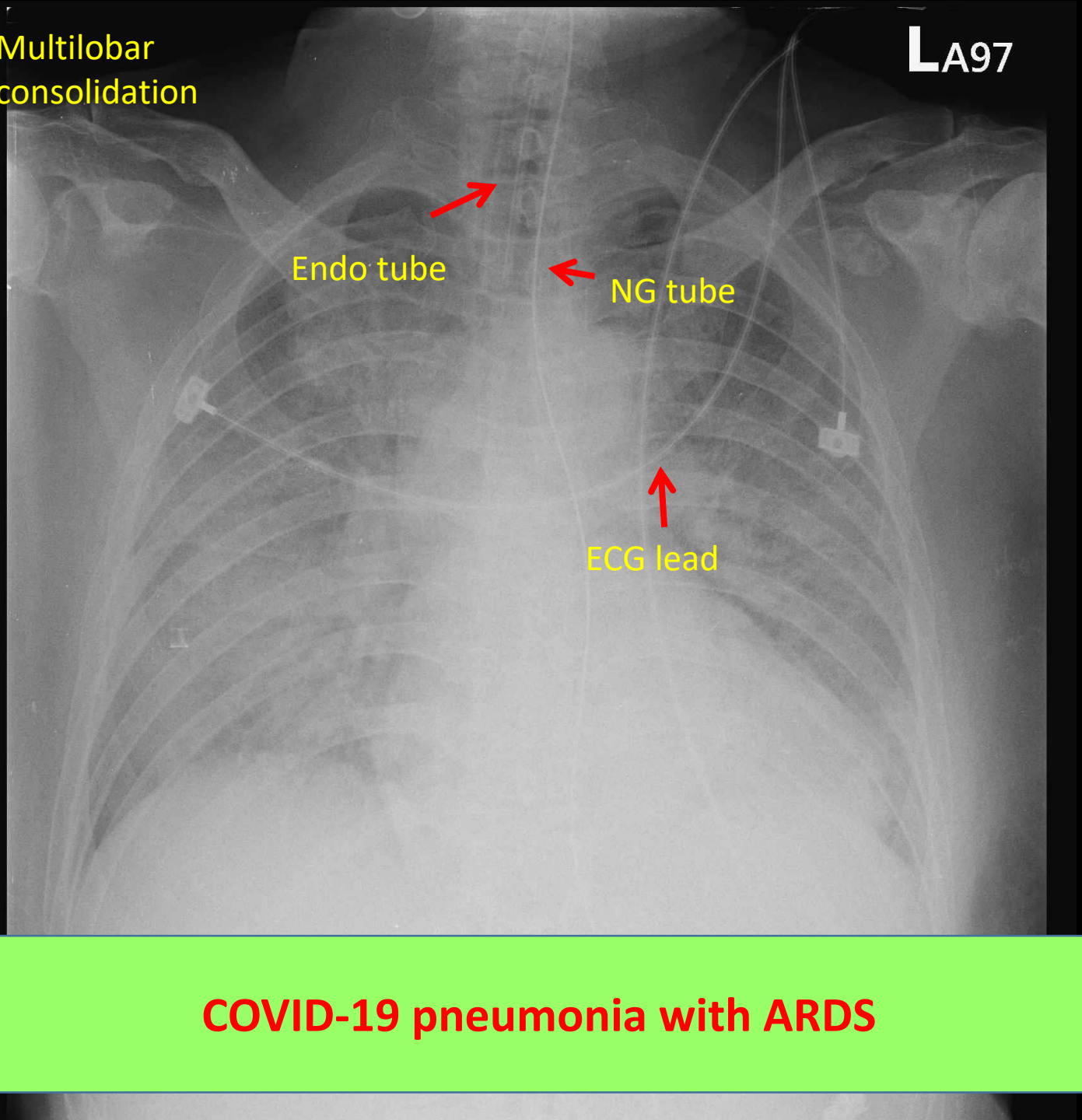
Acute pulmonary edema

Cardiac edema

Noncardiac edema



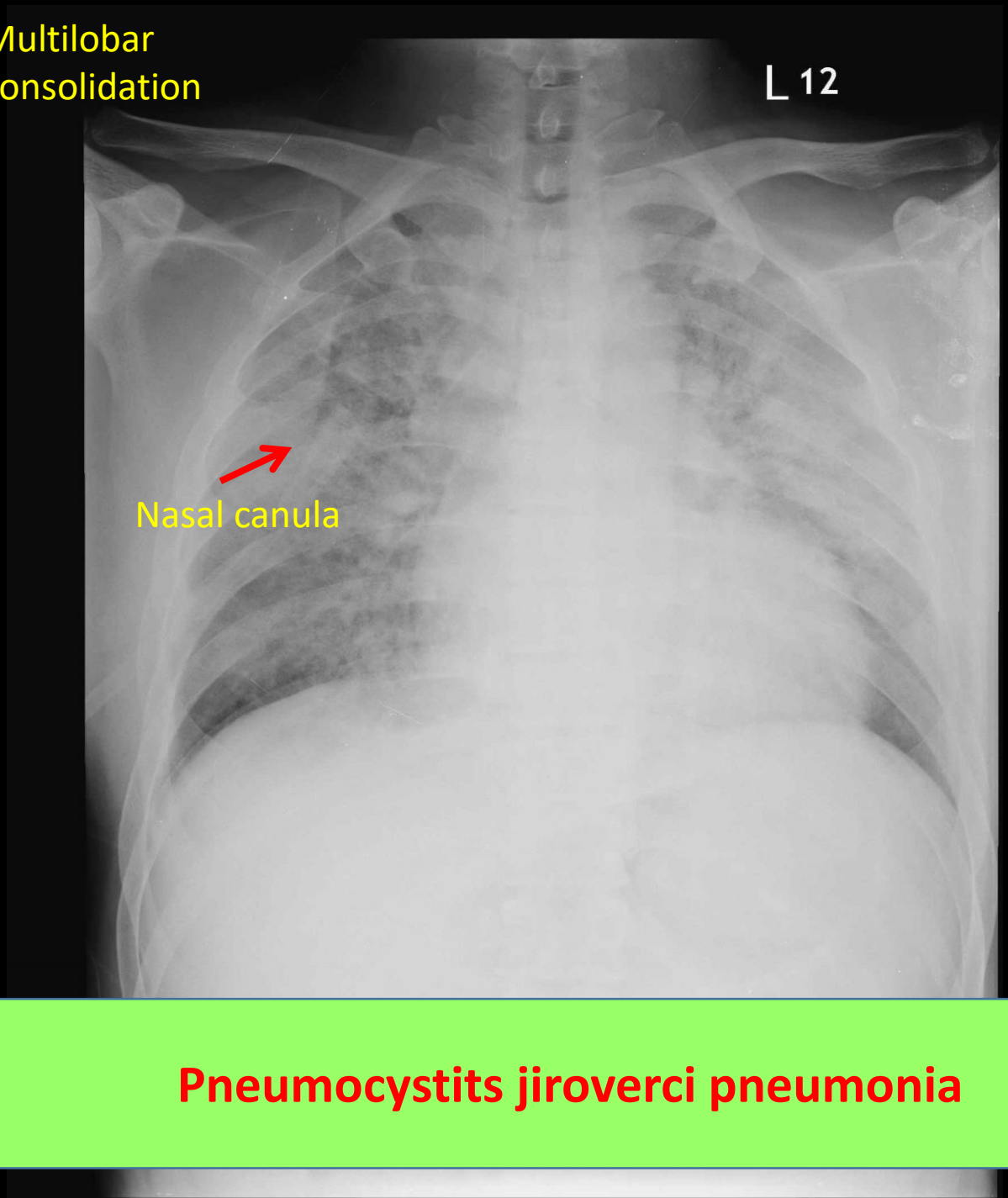




75 y/o female
Dyspnea for 1 day

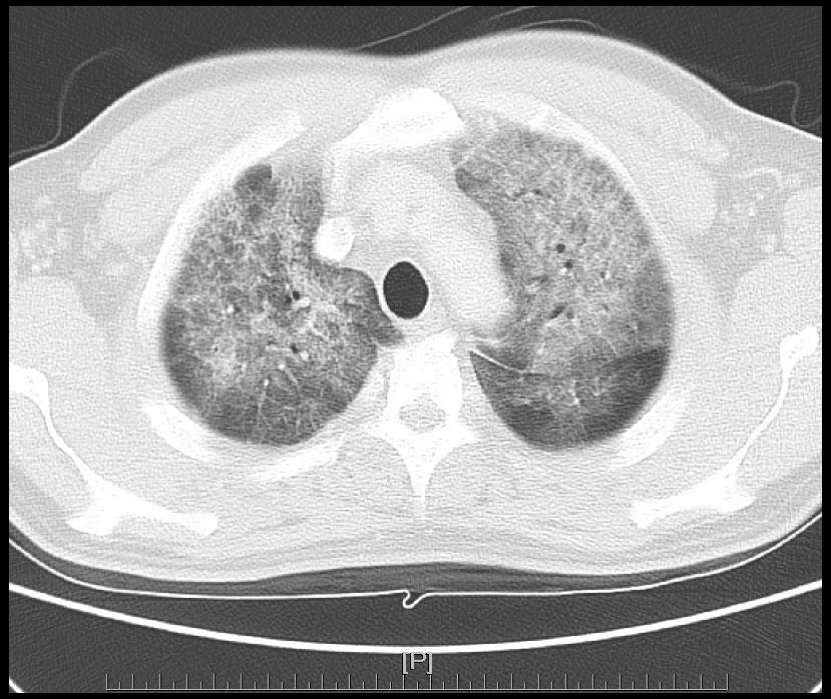
COVID-19 pneumonia with ARDS

Multilobar consolidation



41 y/o male
Fever off and on and severe dry cough for days

Pneumocystits jiroverci pneumonia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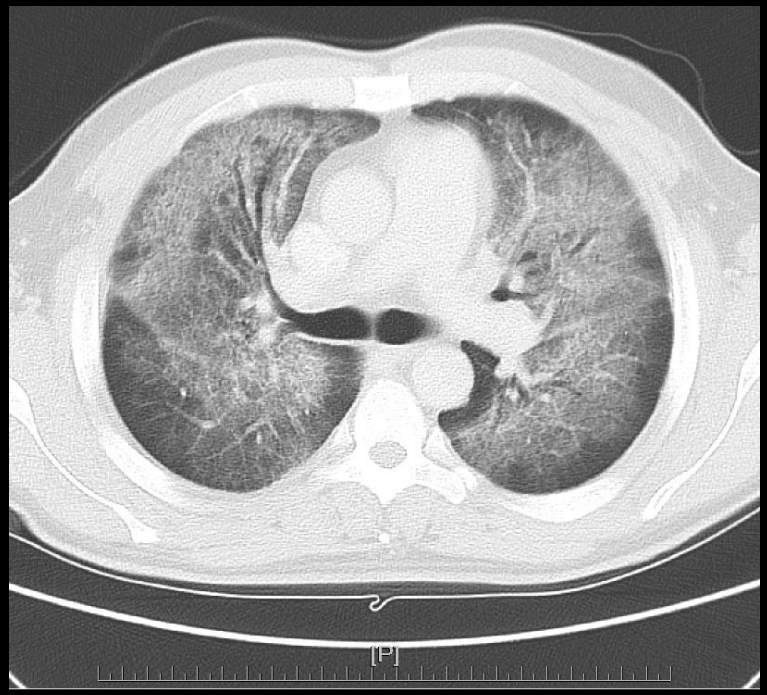
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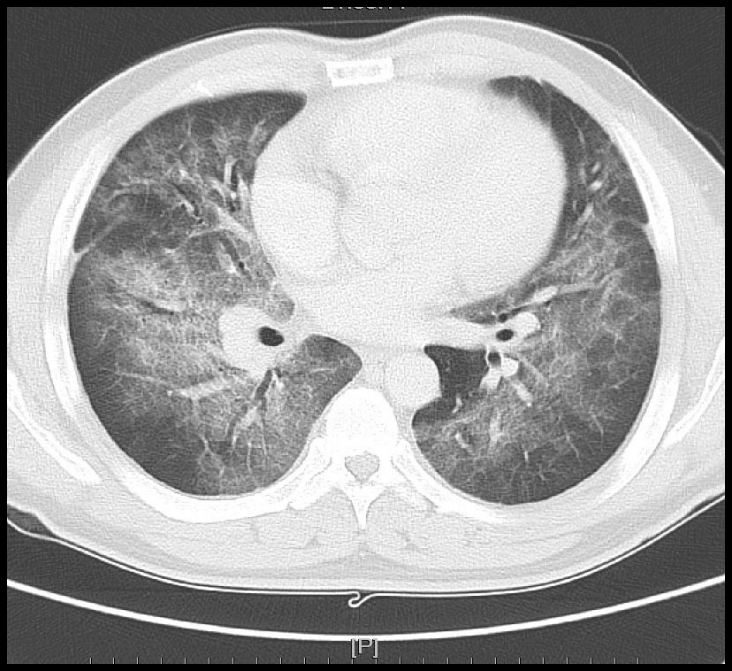
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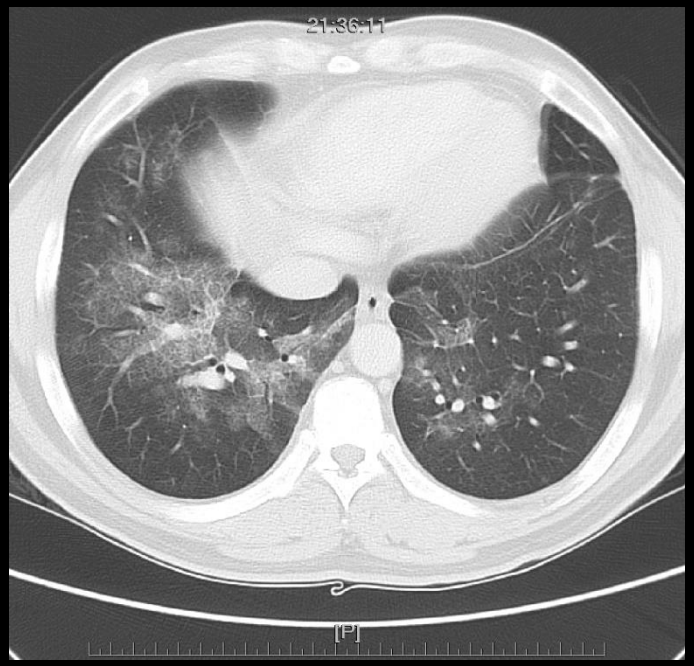
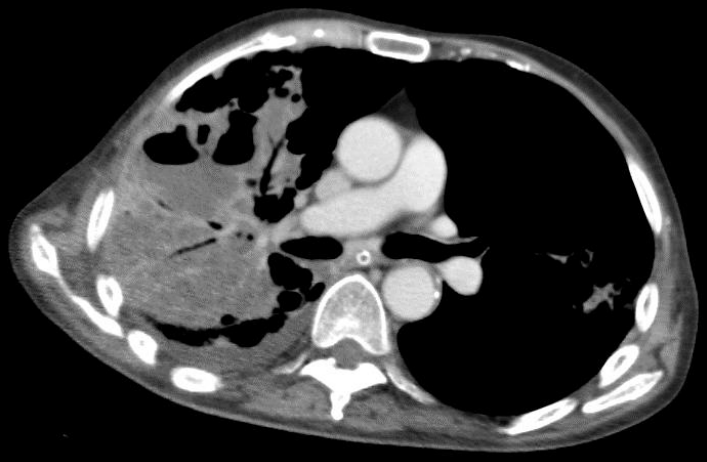
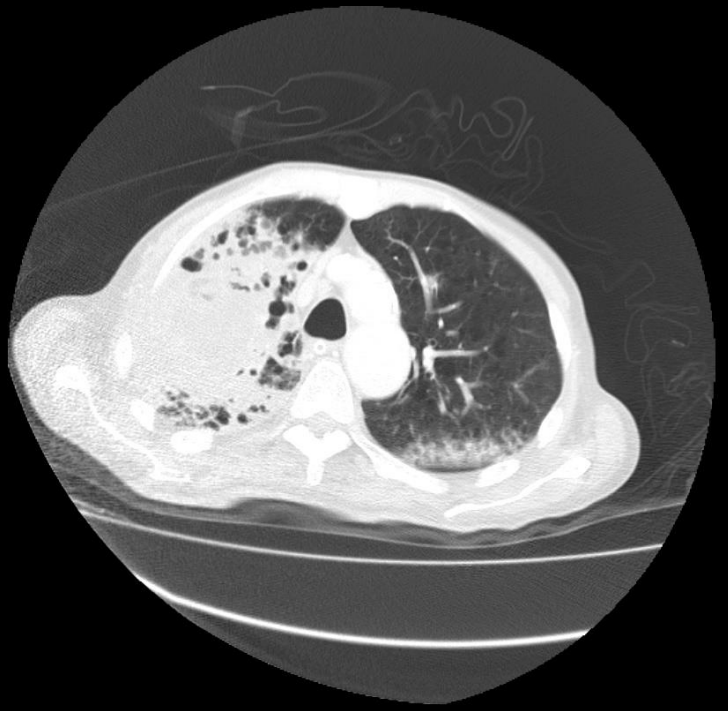

21:36:11
[P]

Pneumonia

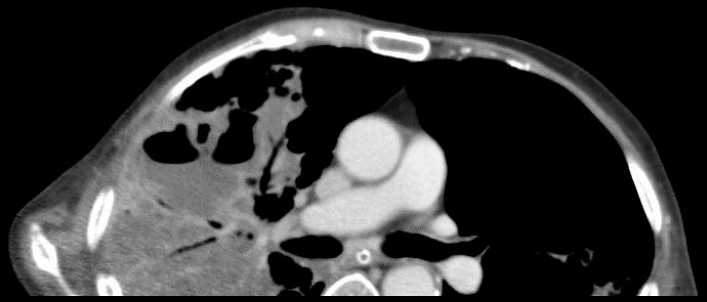
- Localized alveolar infiltrate(s) presented initially in the peripheral lung tissue; air-bronchogram and air-alveologram
- Rapid expansion of the alveolar infiltrates to the neighboring lung tissue
- Confluent alveolar infiltrates followed
- Retrocardiac and retrodiaphragmatic infiltrates difficult to appreciate
- Improved more slowly

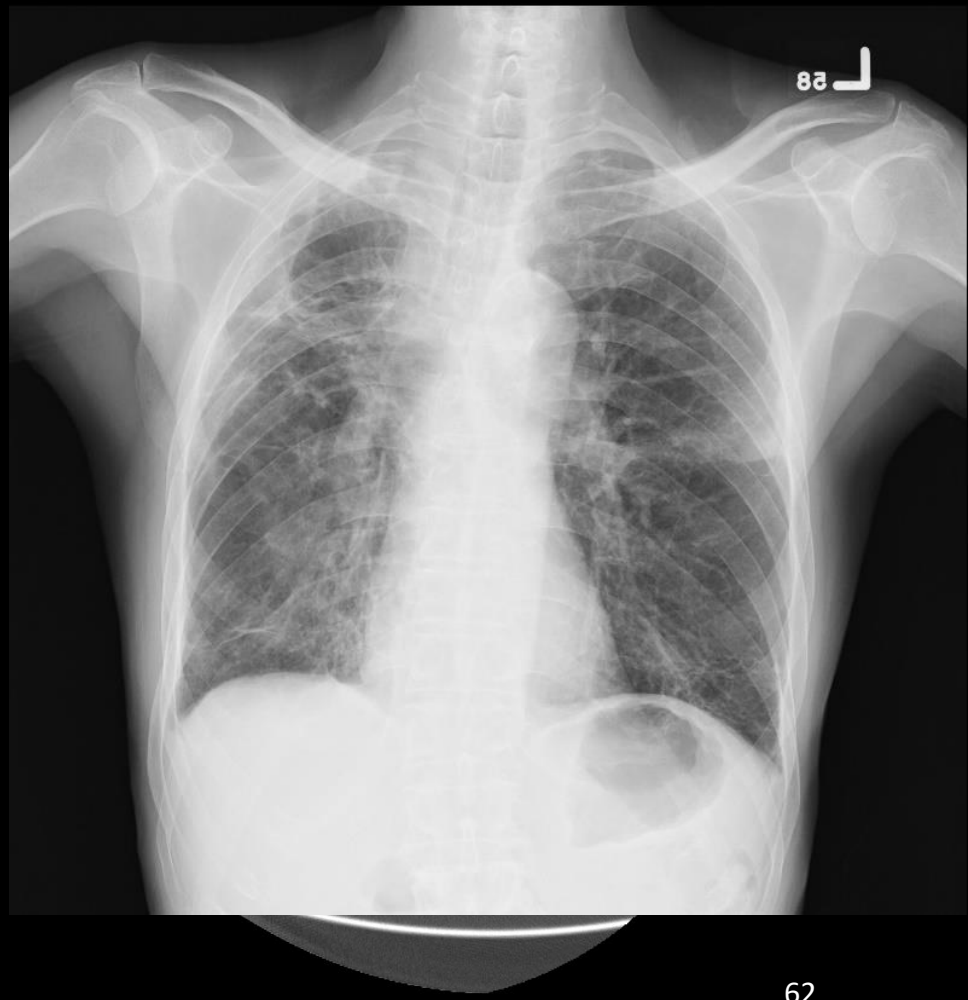
Pneumonia



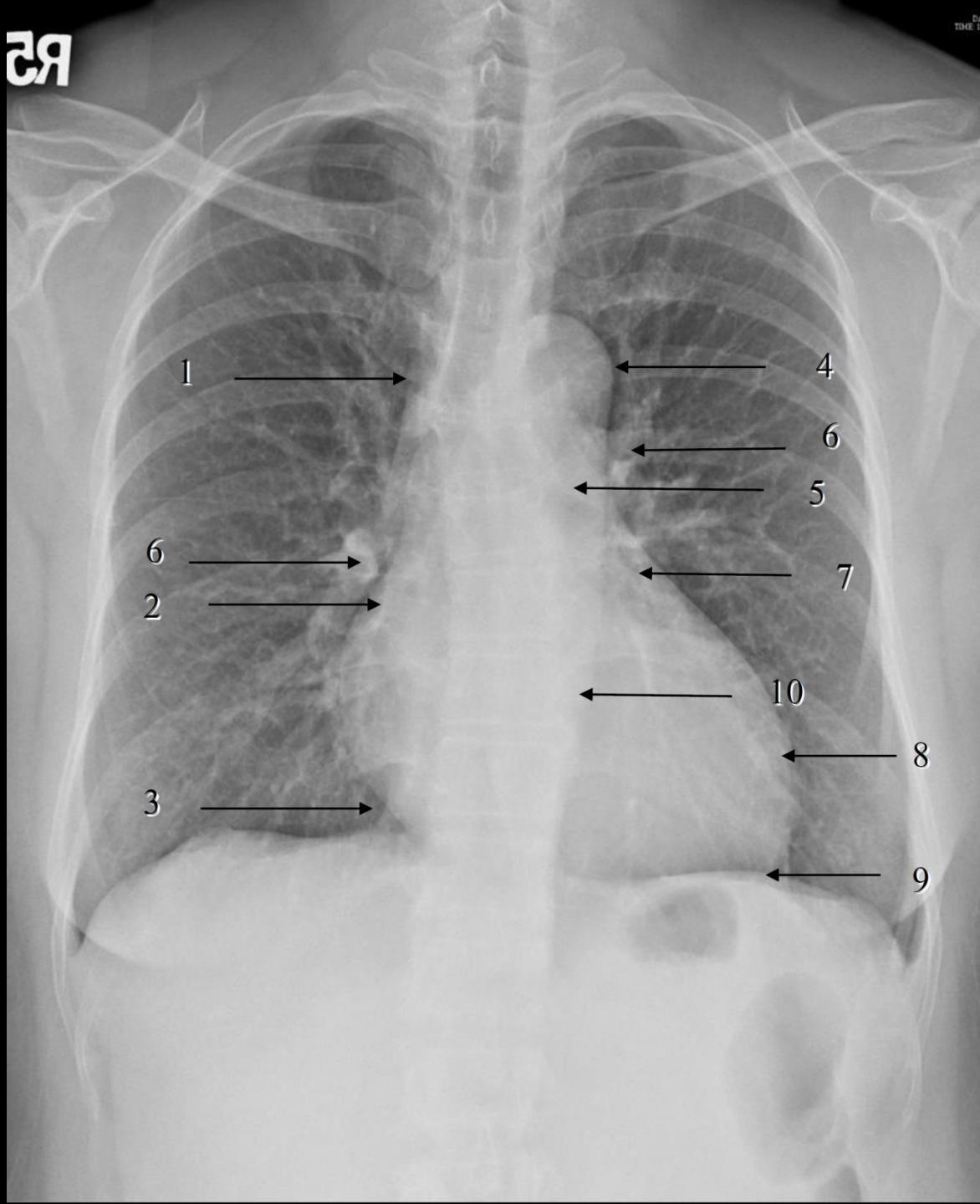


Pneumonia

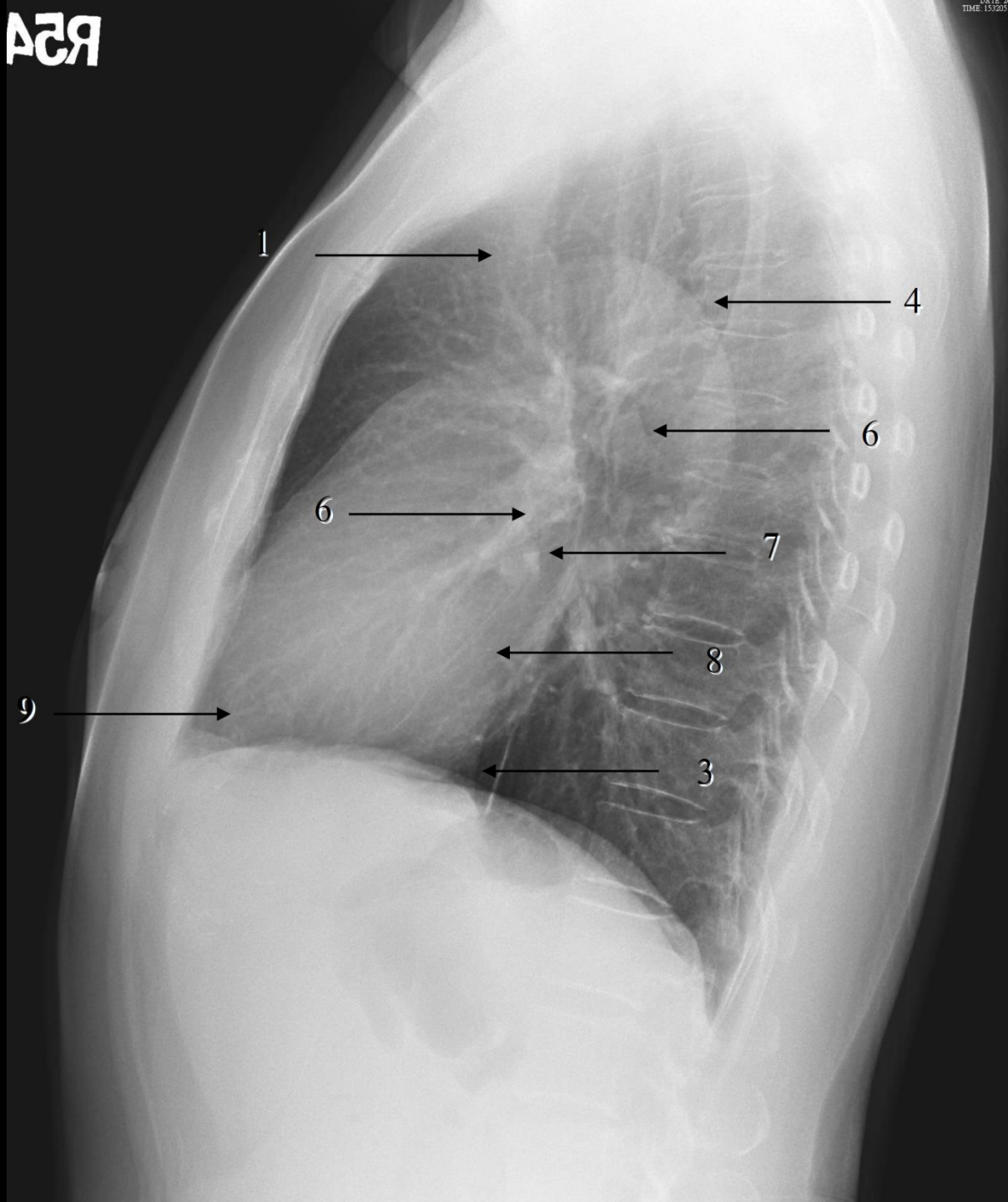


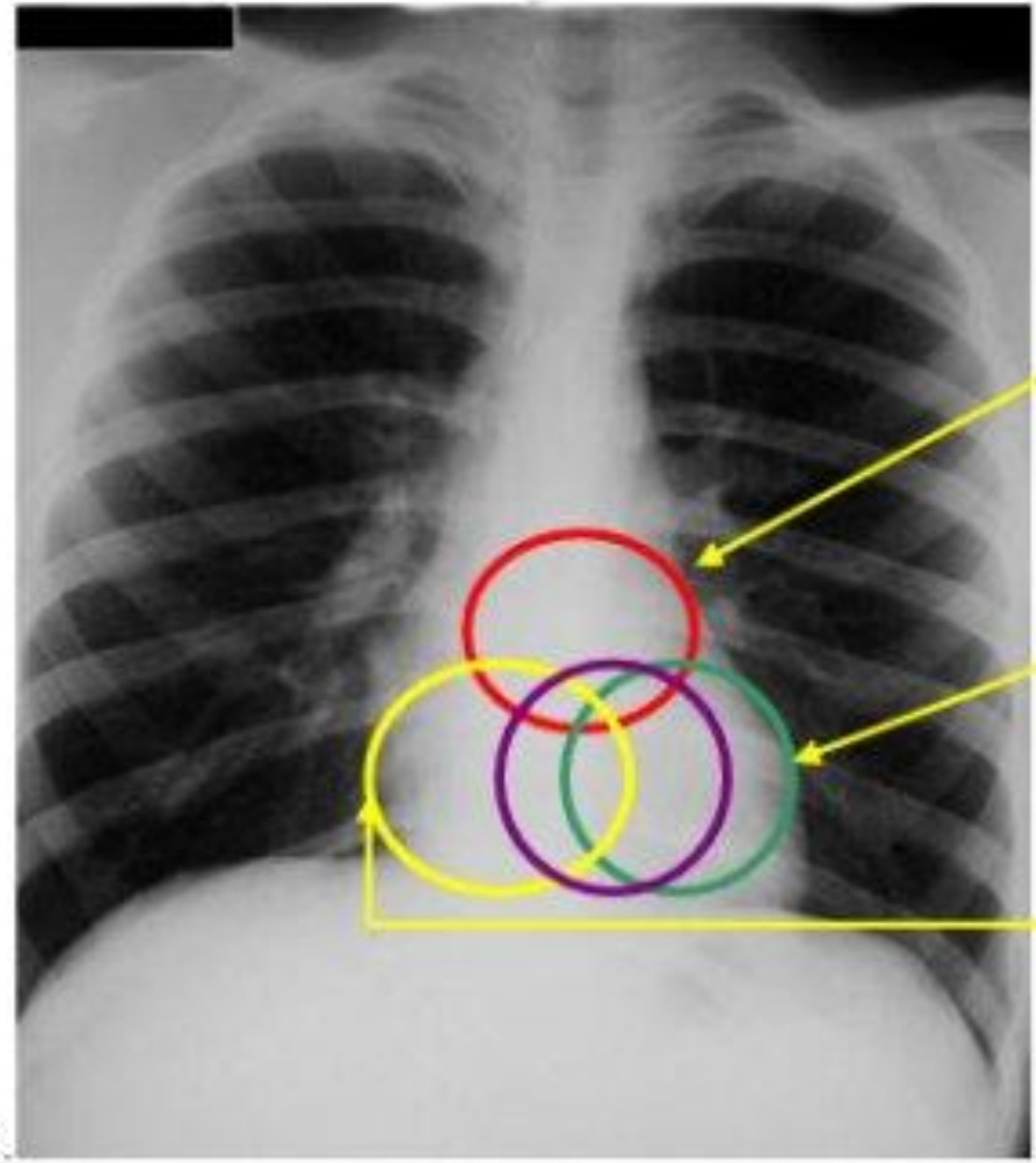


1. SVC
2. RA
3. IVC
4. Aortic arch
5. Pulmonary trunk
6. Pulmonary arteries
7. Auricle, LA
8. LV
9. Left cardiophrenic angle
10. Descending aorta



1. SVC
3. IVC
4. Aortic arch
6. Pulmonary arteries
7. LA
8. LV
9. Cardiac apex





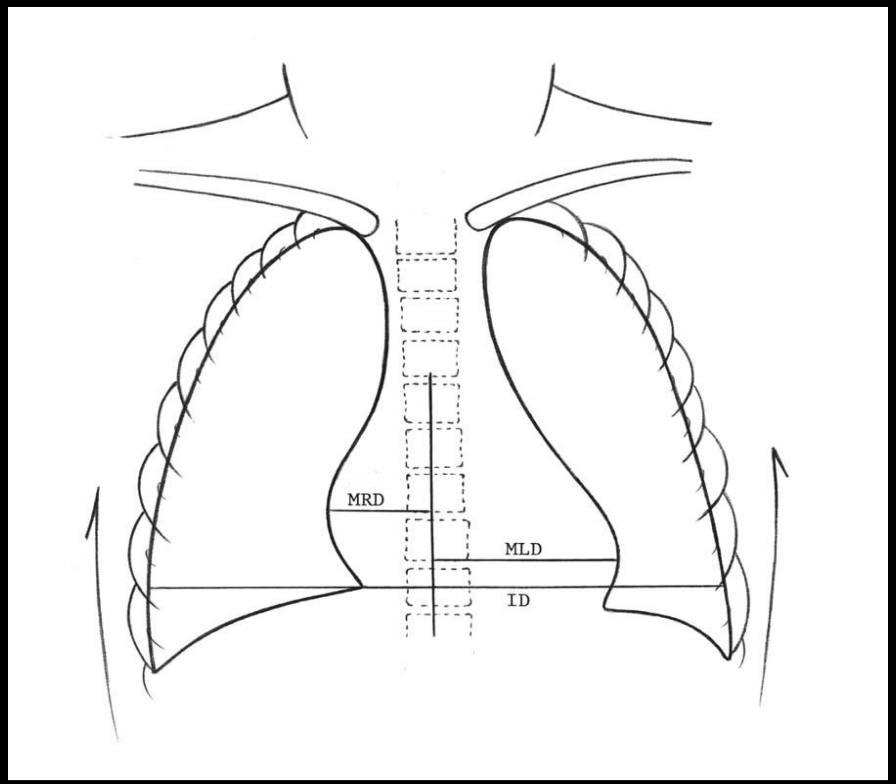
Left Atrium – only the left appendage is visible - Lies under the carina

Left ventricle – Forms the left lateral edge of the heart shadow

Right atrium – forms the right heart margin

Right ventricle – no margins visible on the frontal view

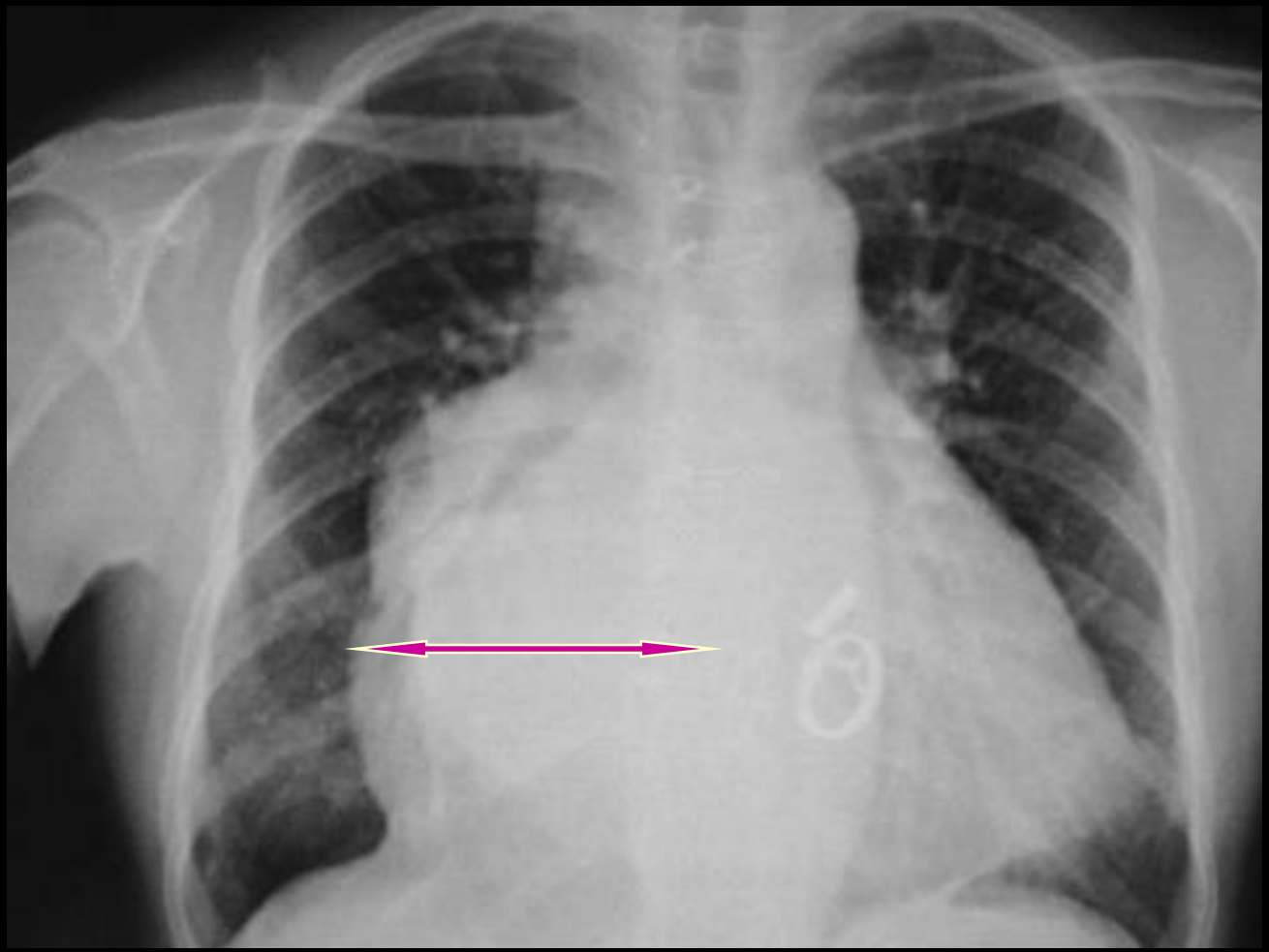
Cardiothoracic Index 正常成人< 0.5



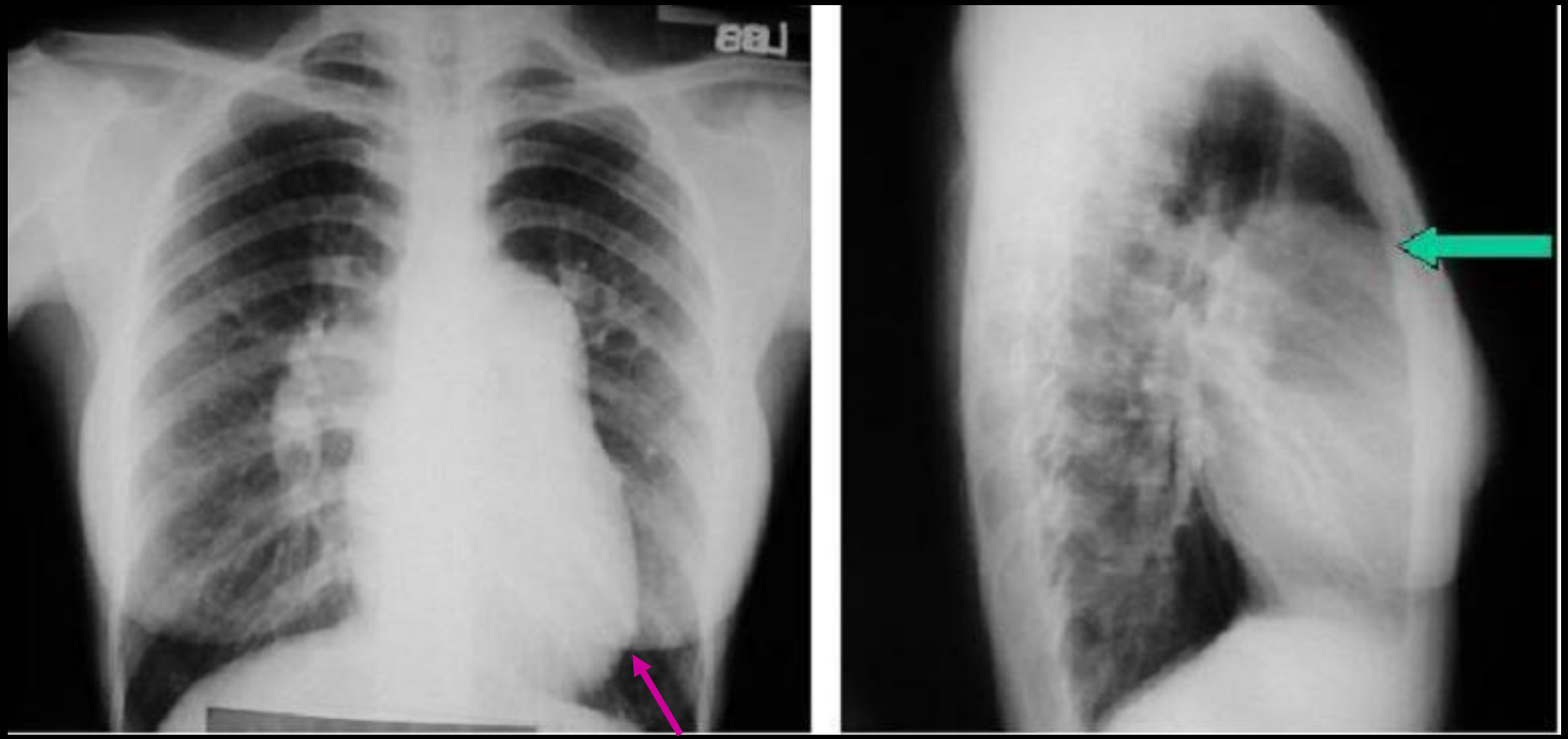
- ID = internal diameter of chest at level of right hemidiaphragm
- MRD = greatest perpendicular diameter from midline to right heart border
- MLD = greatest perpendicular diameter from midline to left heart border
- CT index = (MRD + MLD)/ID

Right atrial enlargement

Lateral bulging of right heart border (on PA view)

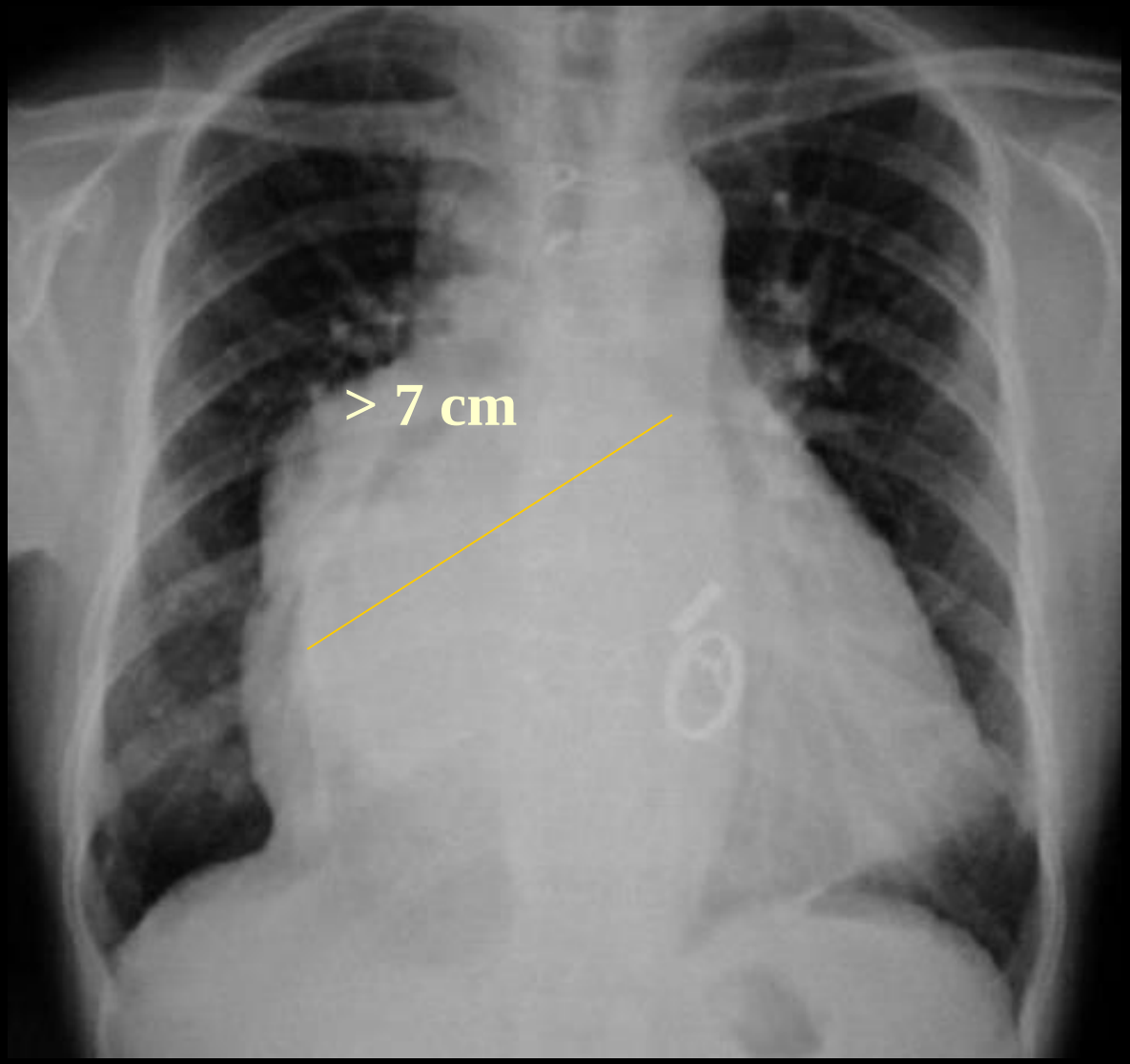


Right ventricular hypertrophy



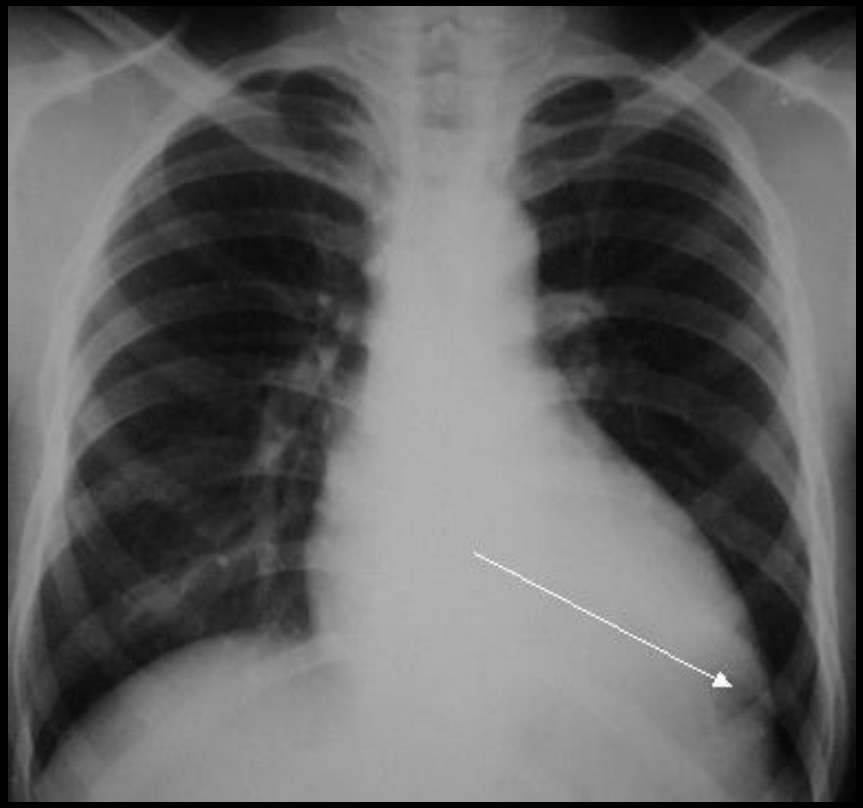
- Cardiac apex up and left
- Fullness of sternum to upper half heart border

Left atrial enlargement



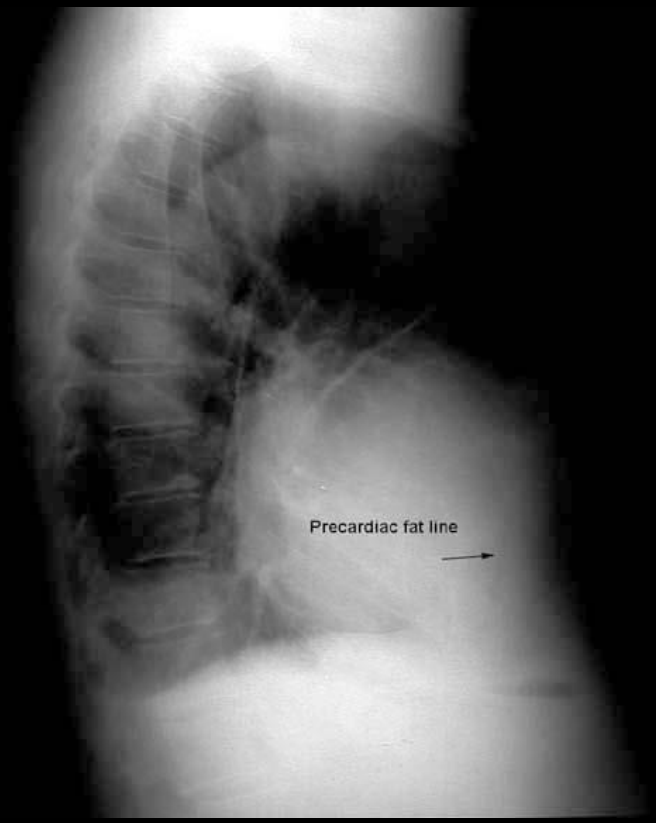
1. Double contour of Rt heart border
2. Mid-Double contour-LMB>7 cm
3. Carina Angle>80’
4. Loss of left cardiac waist

Left ventricular hypertrophy



- Caridac apex 變圓
- 往左、下、後凸
- 與橫膈成鈍角

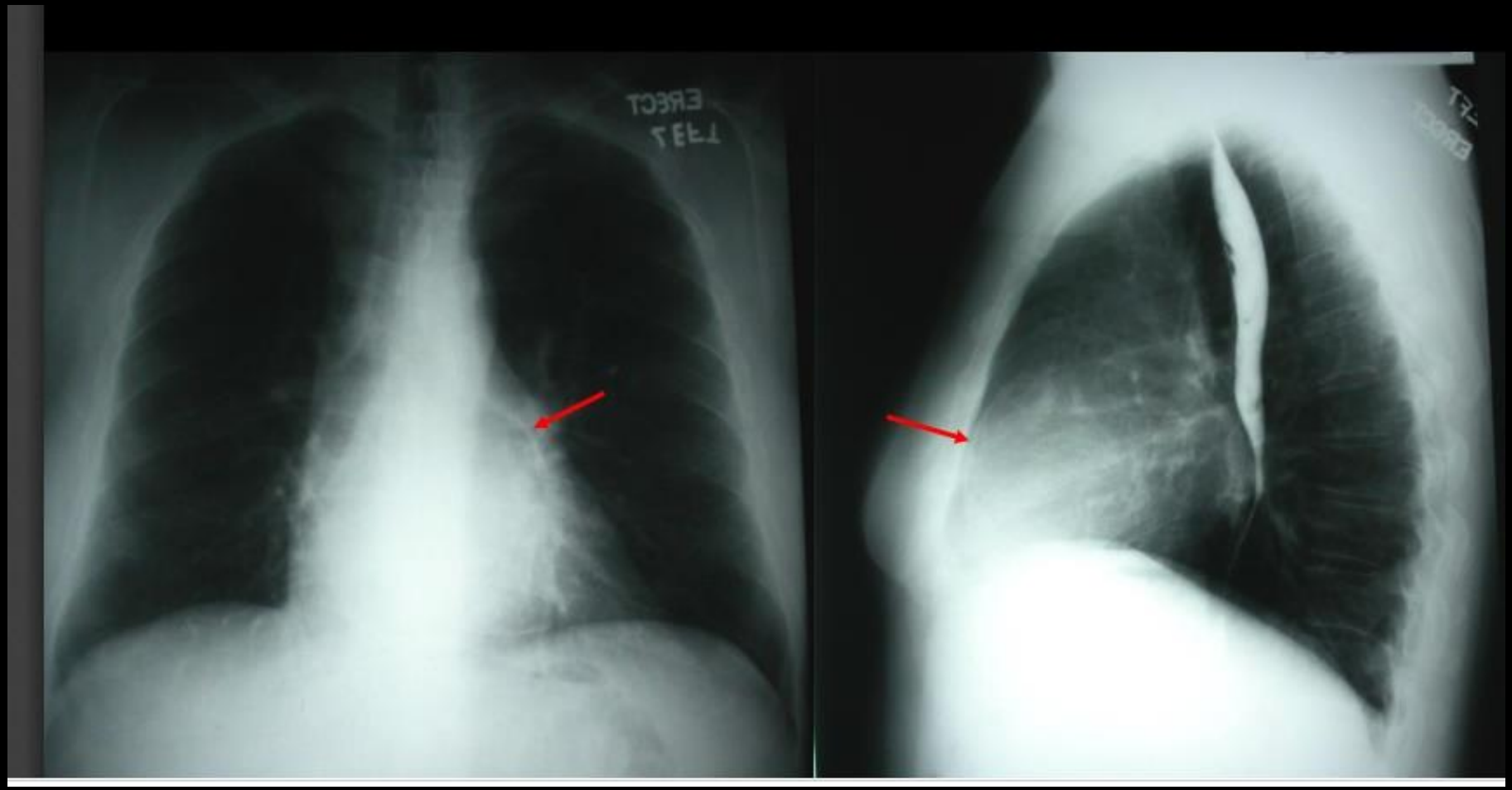
Pericardial Effusion



- Enlarged "cardiac" density
- Water bottle appearance
- Pulmonary oligemia
- Precardic fat line in lateral view below

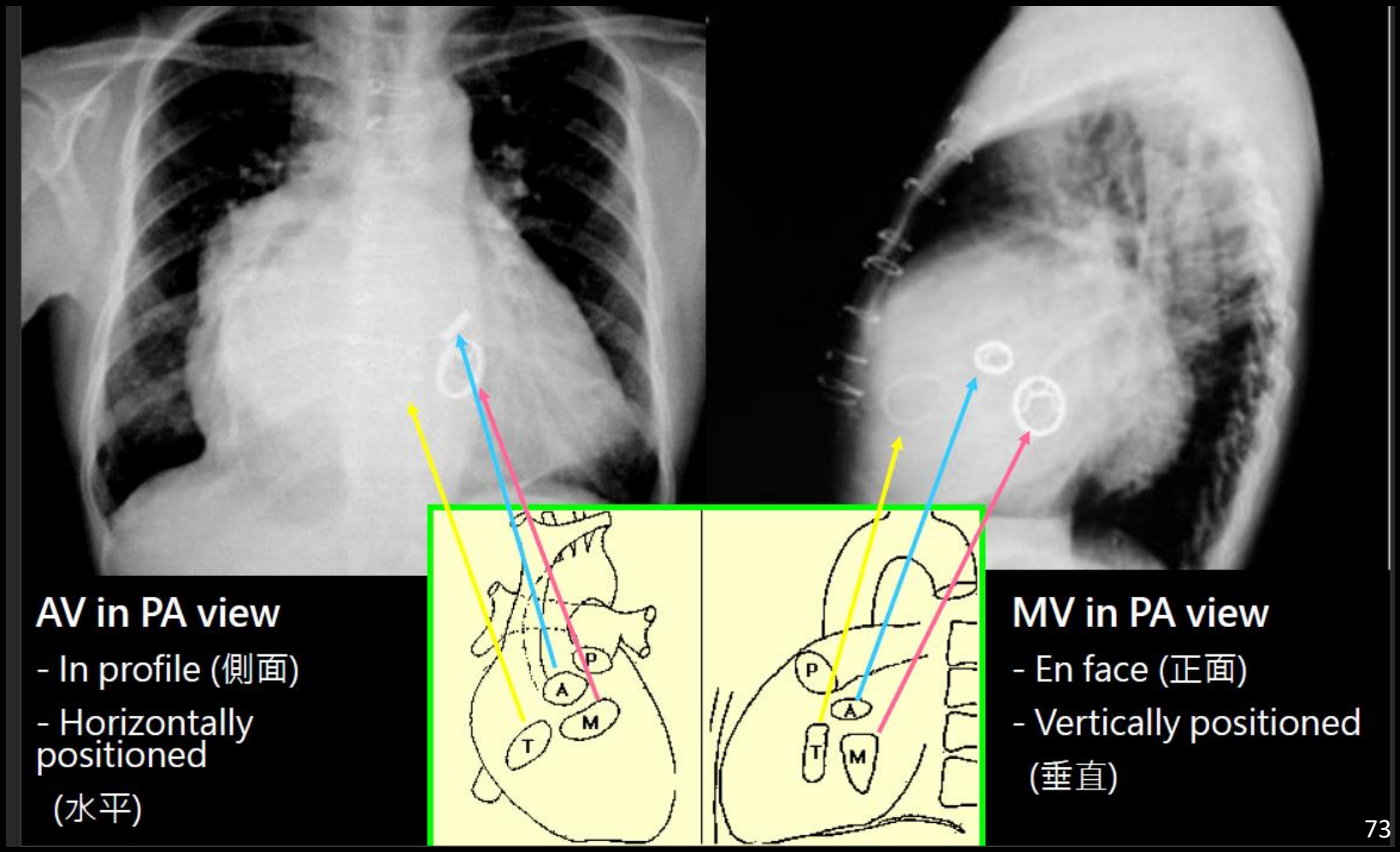
- Obliteration of retrosternal space on Lat view - a**n anterior pericardial stripe > 2 mm**

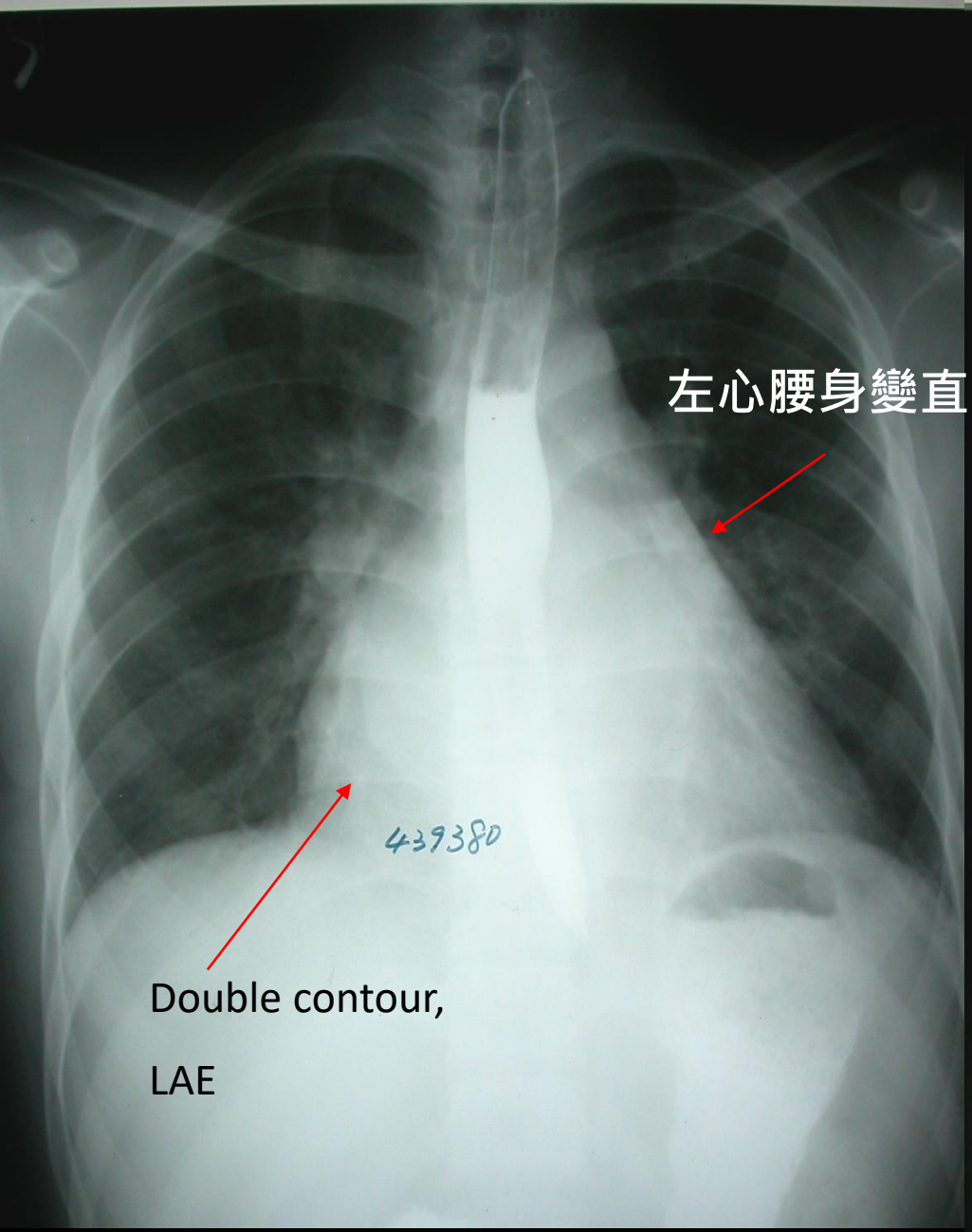
Constrictive pericarditis

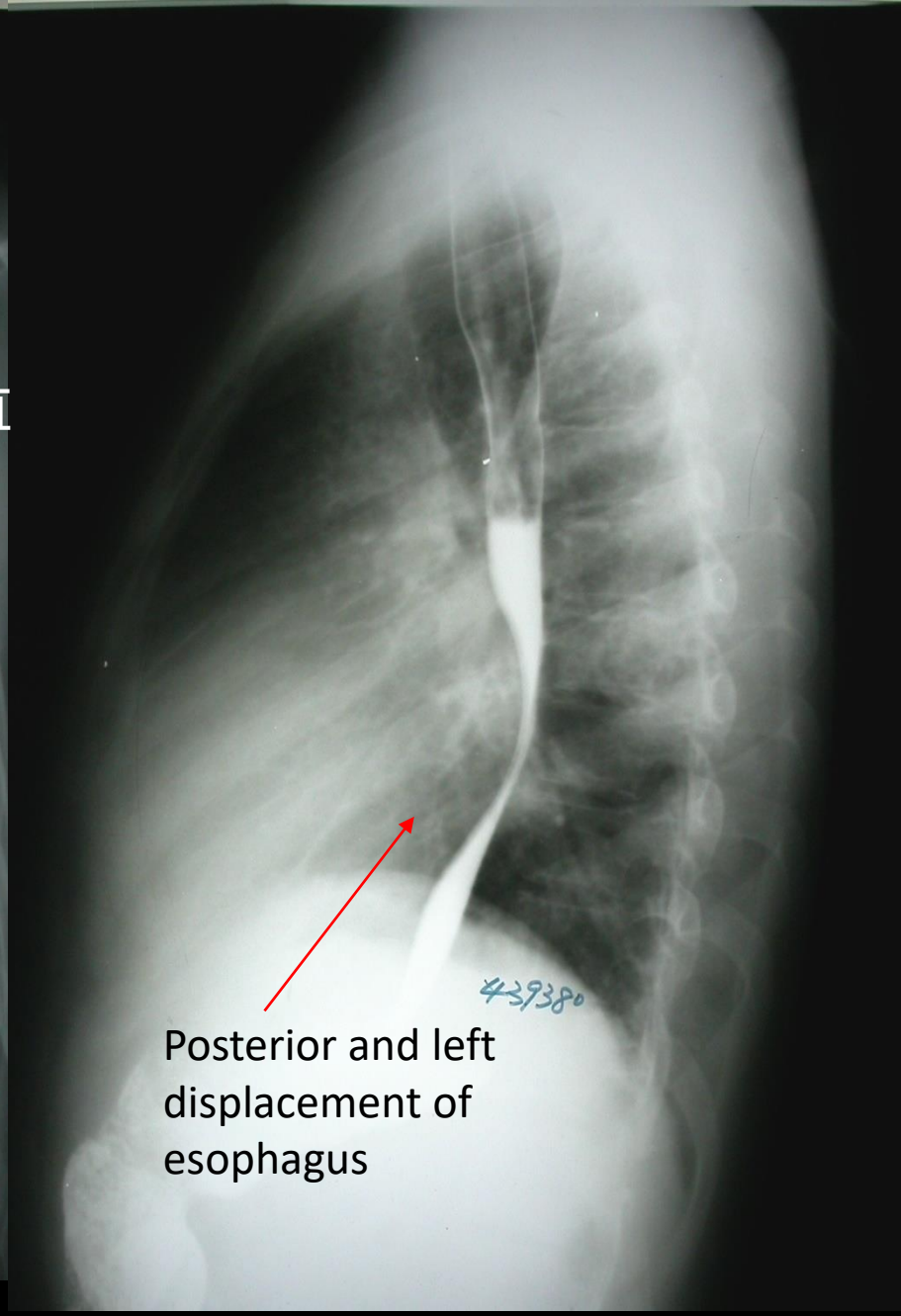


50% patients with pericardial calcification

RHD s/p MV, AV replacement, s/p TV annuloplasty

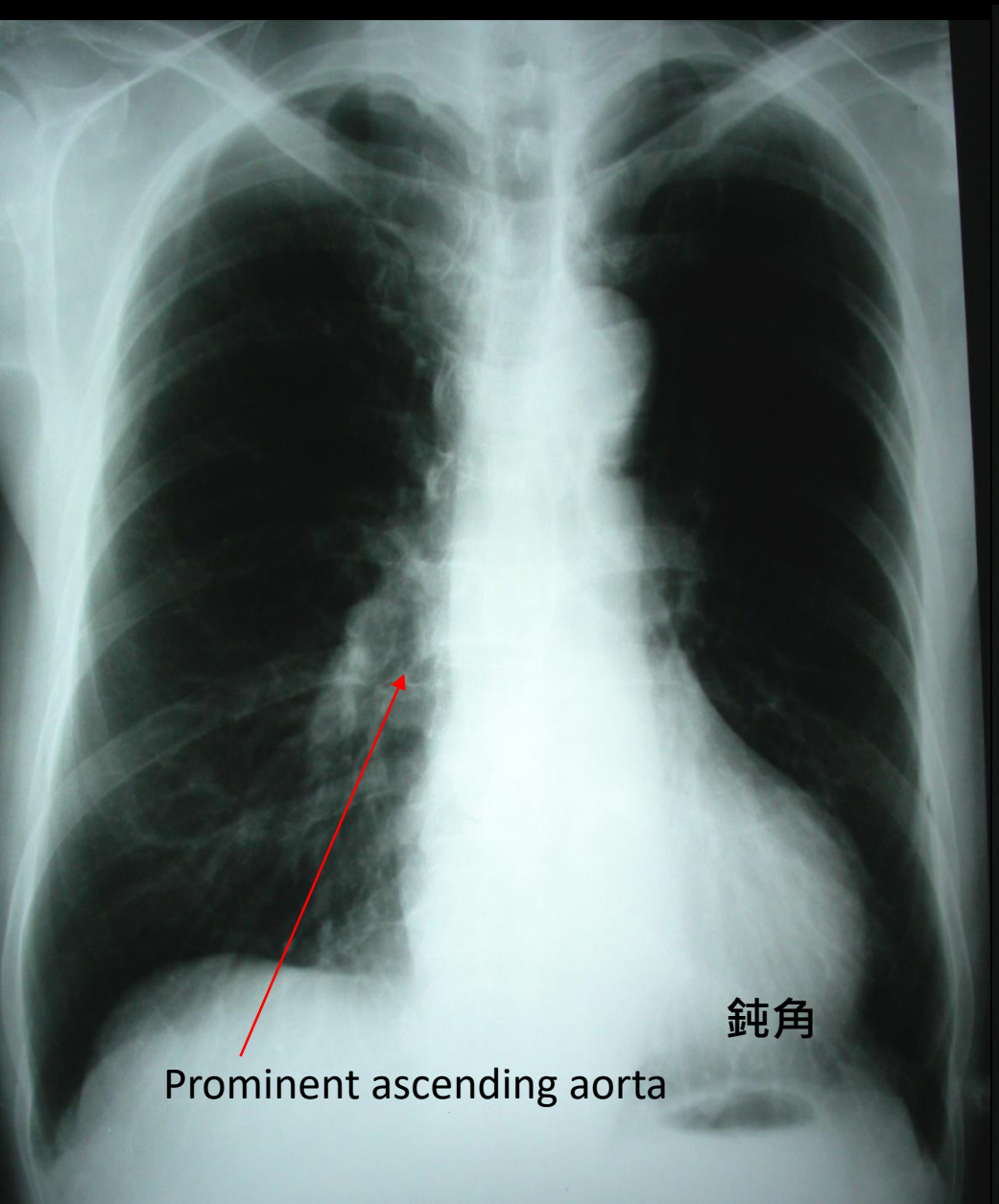




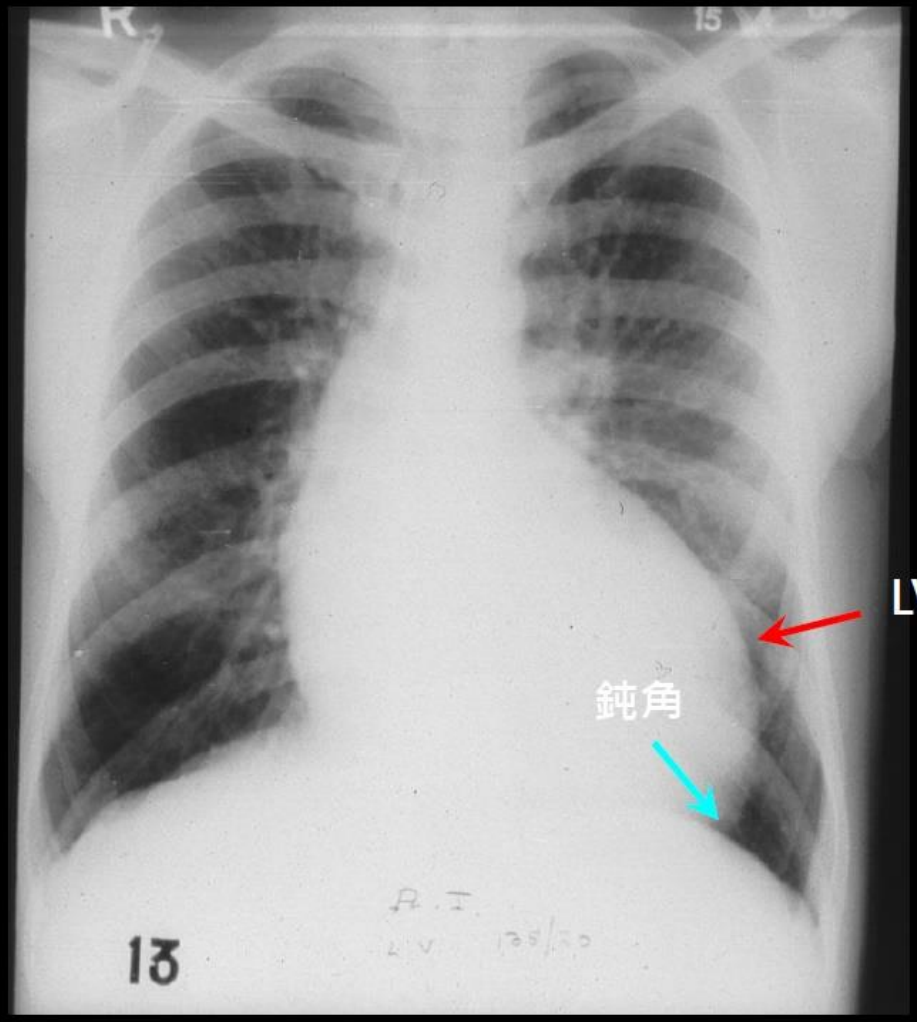


Mitral stenosis

Aortic stenosis



Aortic regurgitation

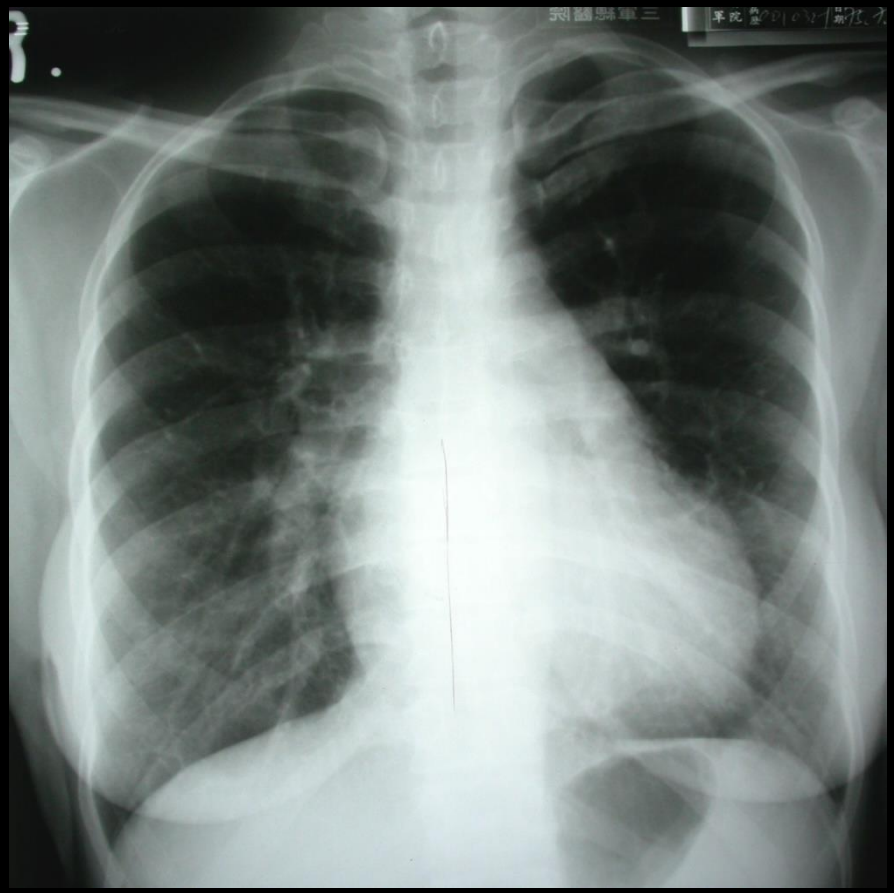


Summary of VHD

	LAE	LVH	RAE	RVH	Pul. vessel
MS	++	-	+	+	++
MR	++	++	+	+	++
AS	-	++	-	-	-
AR	-	+	-	-	-

1. Mitral valve lesion才會造成pulmonary vessels and right heart異常
2. Aortic valve lesion主要造成LVH

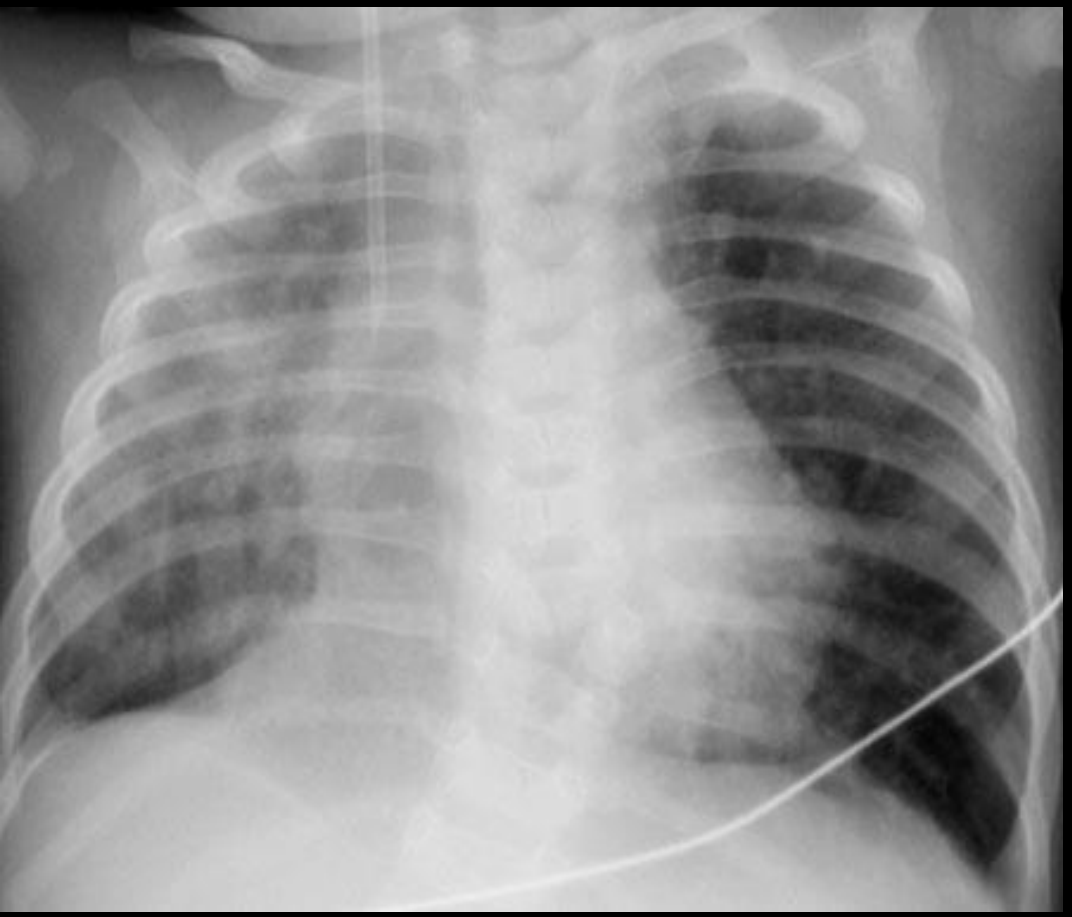
Atrial septal defect (ASD)



Increasedsize of the main pulmonary artery (seen best on the PA view)

An increase in the size of the right ventricle (seen best on the lateral view)
RAE, RVH but normal LA

Scimitar Syndrome
(Partial anomalous pulmonary venous return)



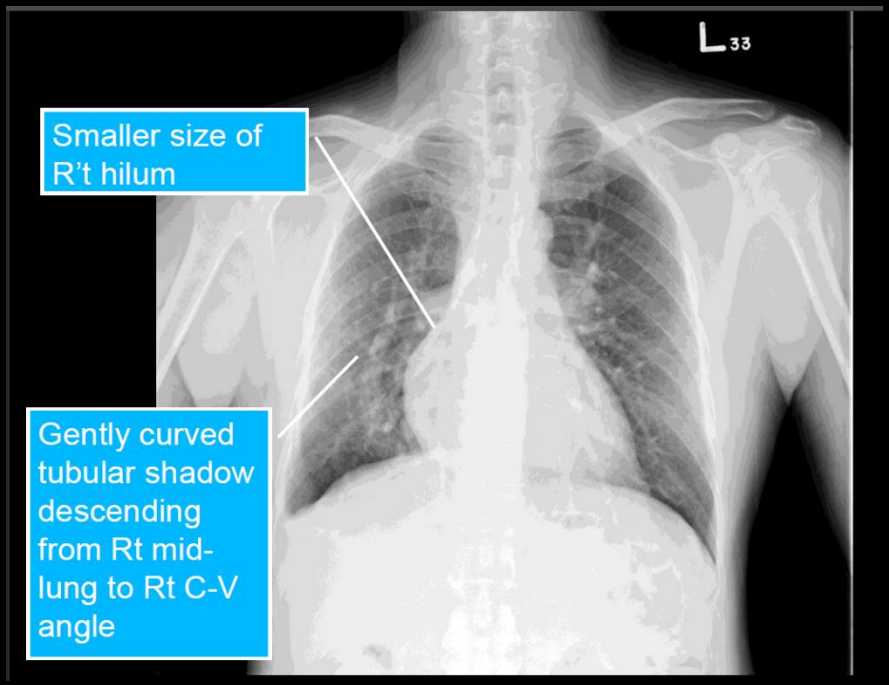
- Definition: hypoplastic right hemithorax, with shift of the mediastinum to the right and anomalous pulmonary venous drainage to IVC (most common)
- Characteristic "scimitar" vein
- Pulmonary venous hypertension
- Associated cardiac abnoralies

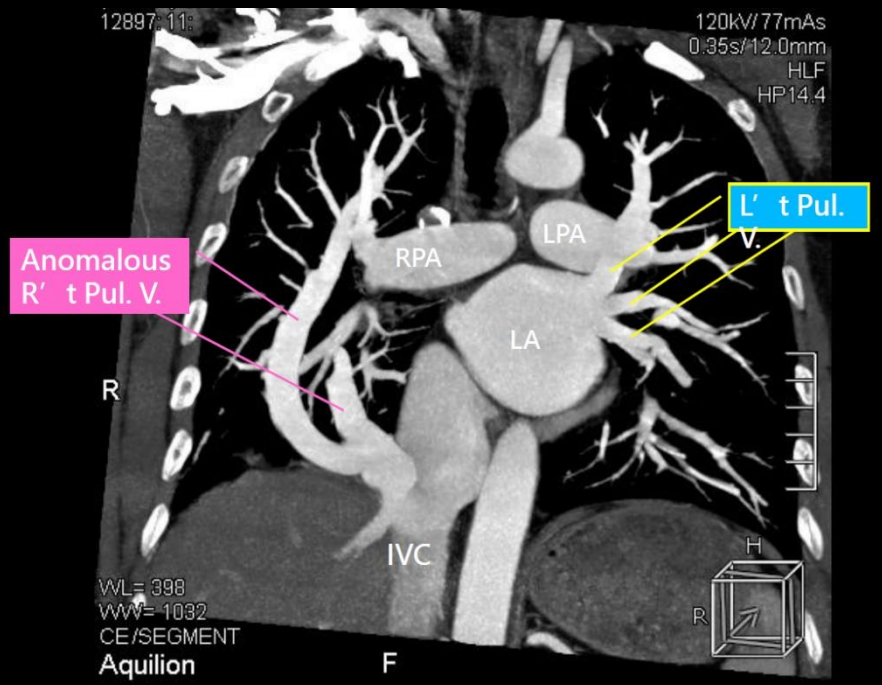
ASD: most common

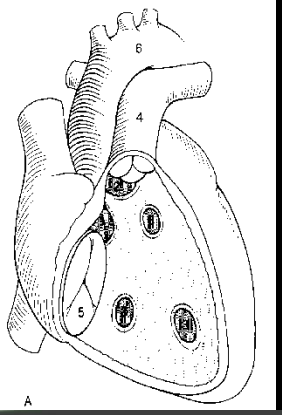
Others: VSD, TOF, PDA, CoA

Courtesy of William Weadock, M.D.

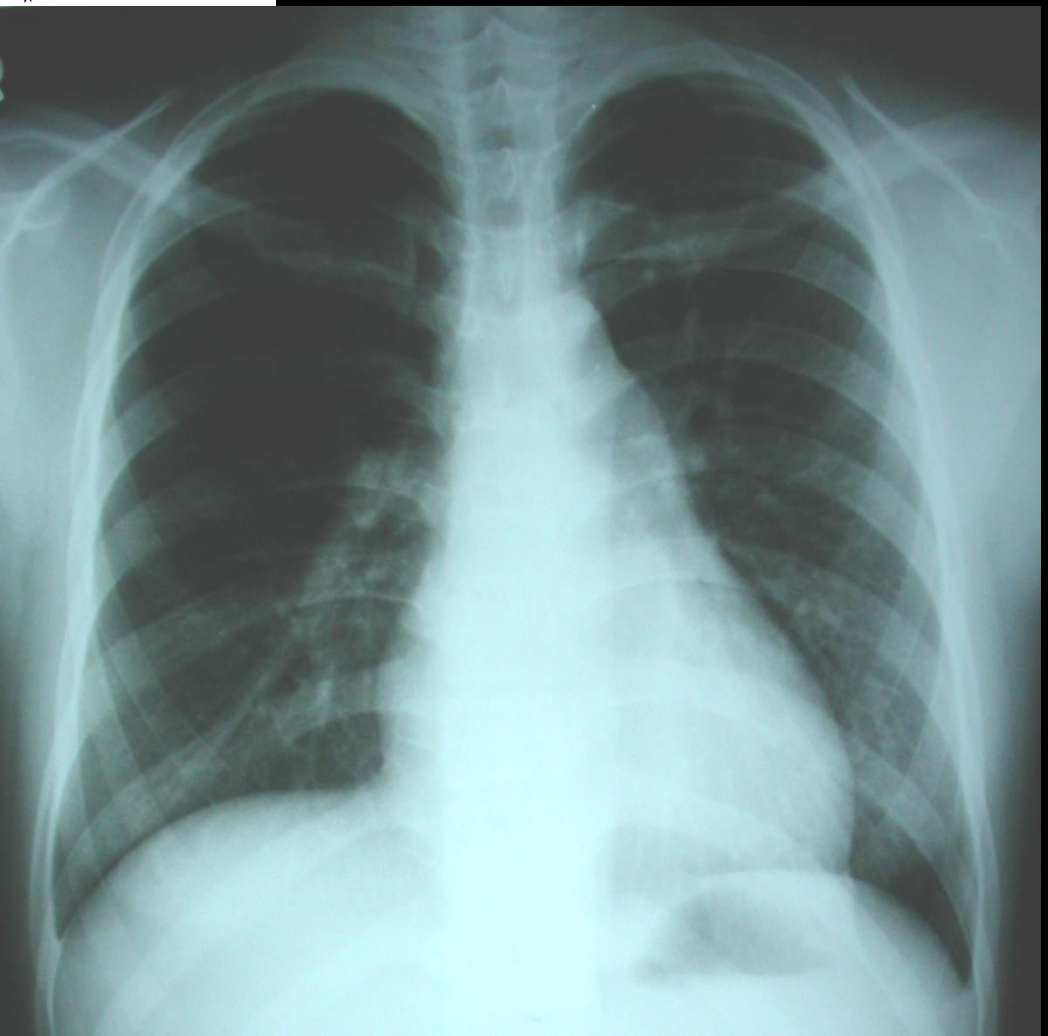
Scimitar Syndrome





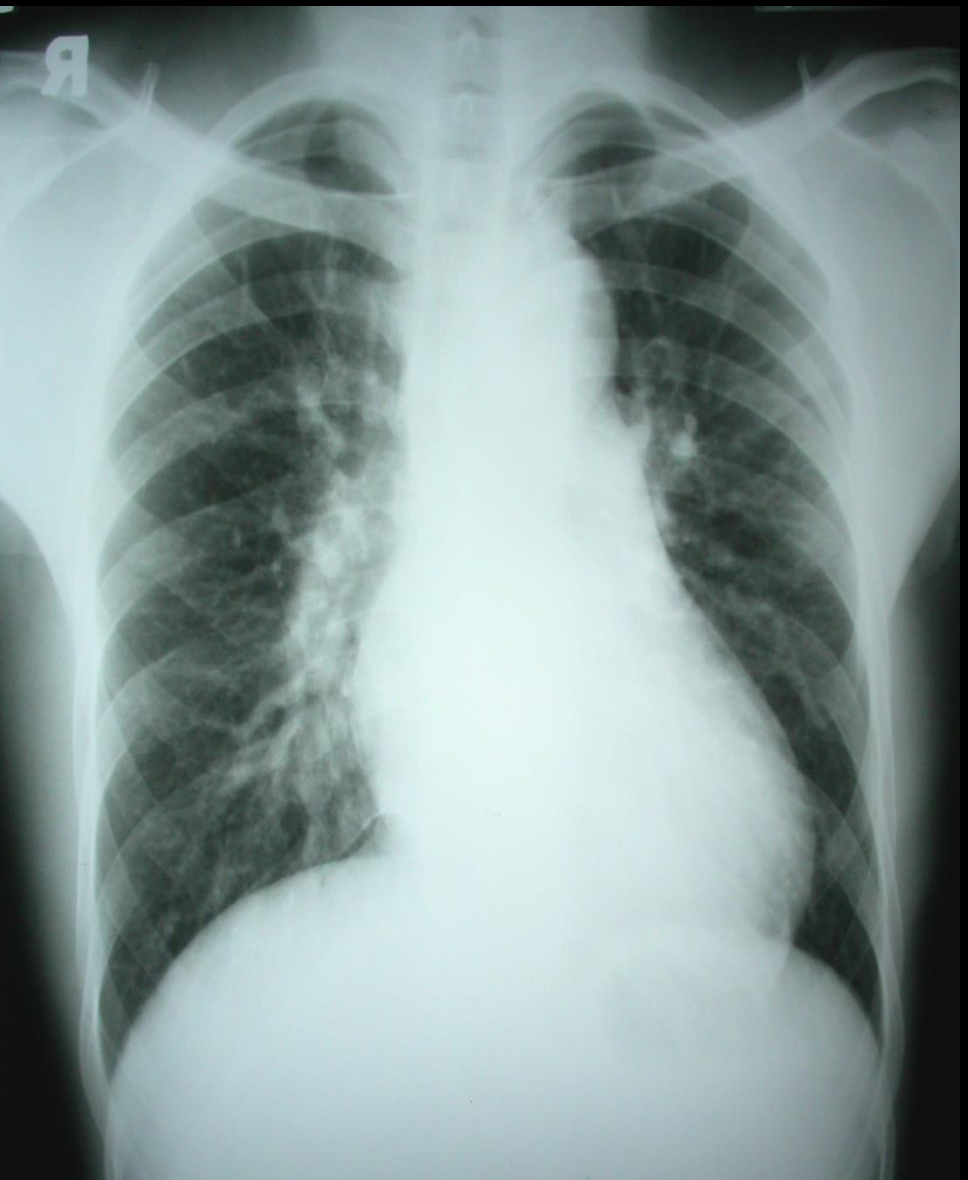


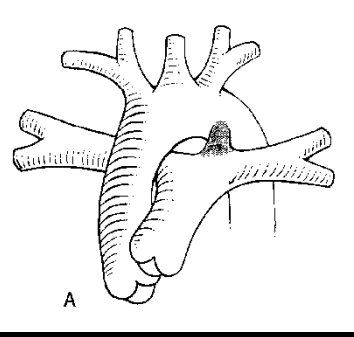
Ventricular Septal Defect (VSD)



- Small shunt without PAH
  - Usually normal
- Large shunt with moderately PAH
  - RVH, LAE
  - Normal to enlarged LV
  - Enlargement of pulmonary arteries and branches
  - Prominent medium-sized pulmonary vein : upper zone
- Eisenmenger syndrome
  - RVE
  - Dilatation of pulmonary trunk and central pulmonary branches
  - Decreased in size and number of small peripheral arteries

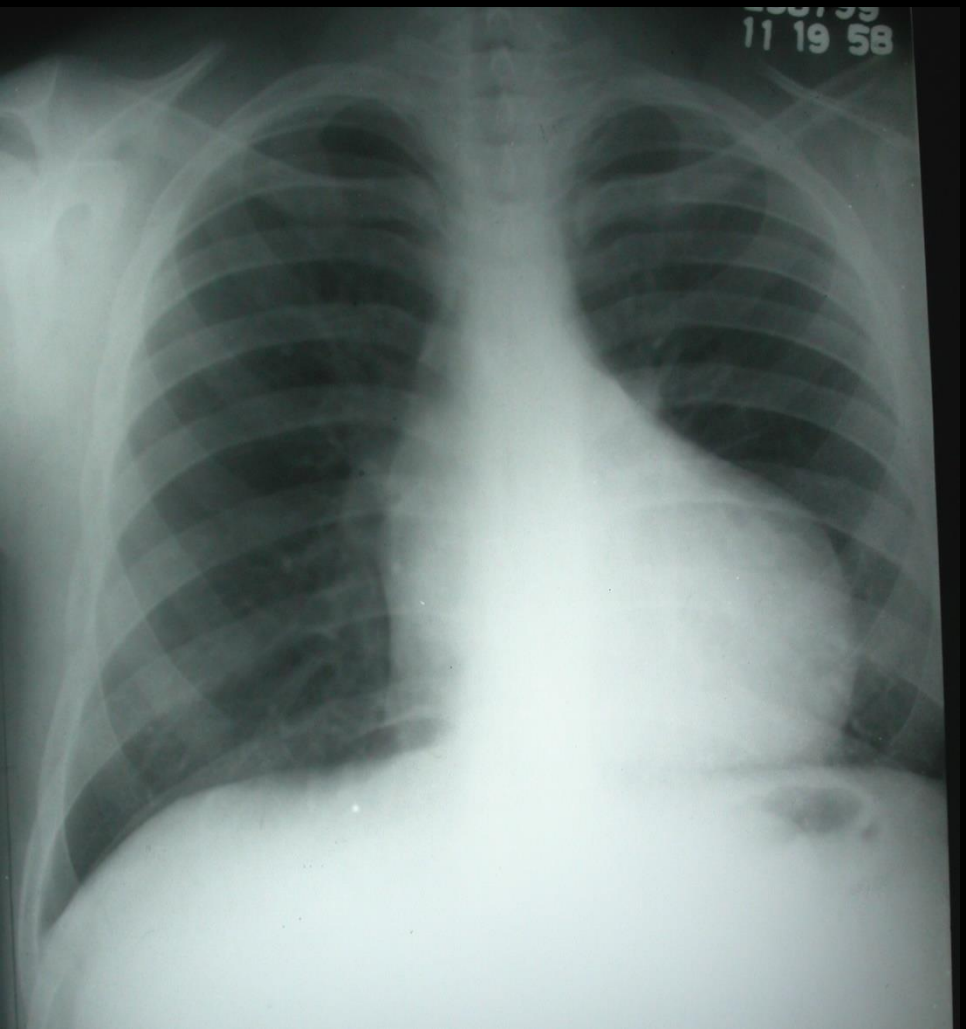
Patent ductus arteriosus (PDA)

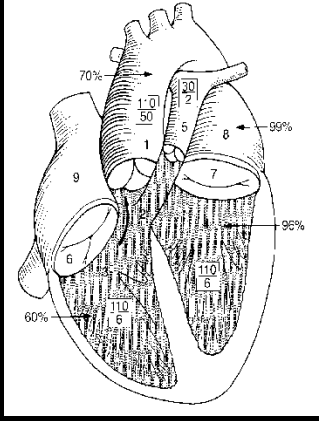




- Usually normal-sized heart
- Plethora
- Prominence of the ascending aorta and aortic arch
- Dilated ductus between aortic arch and left pulmonary artery
- Dilatation of the pulmonary trunk and pulmonary arteries
- Eisenmenger syndrome

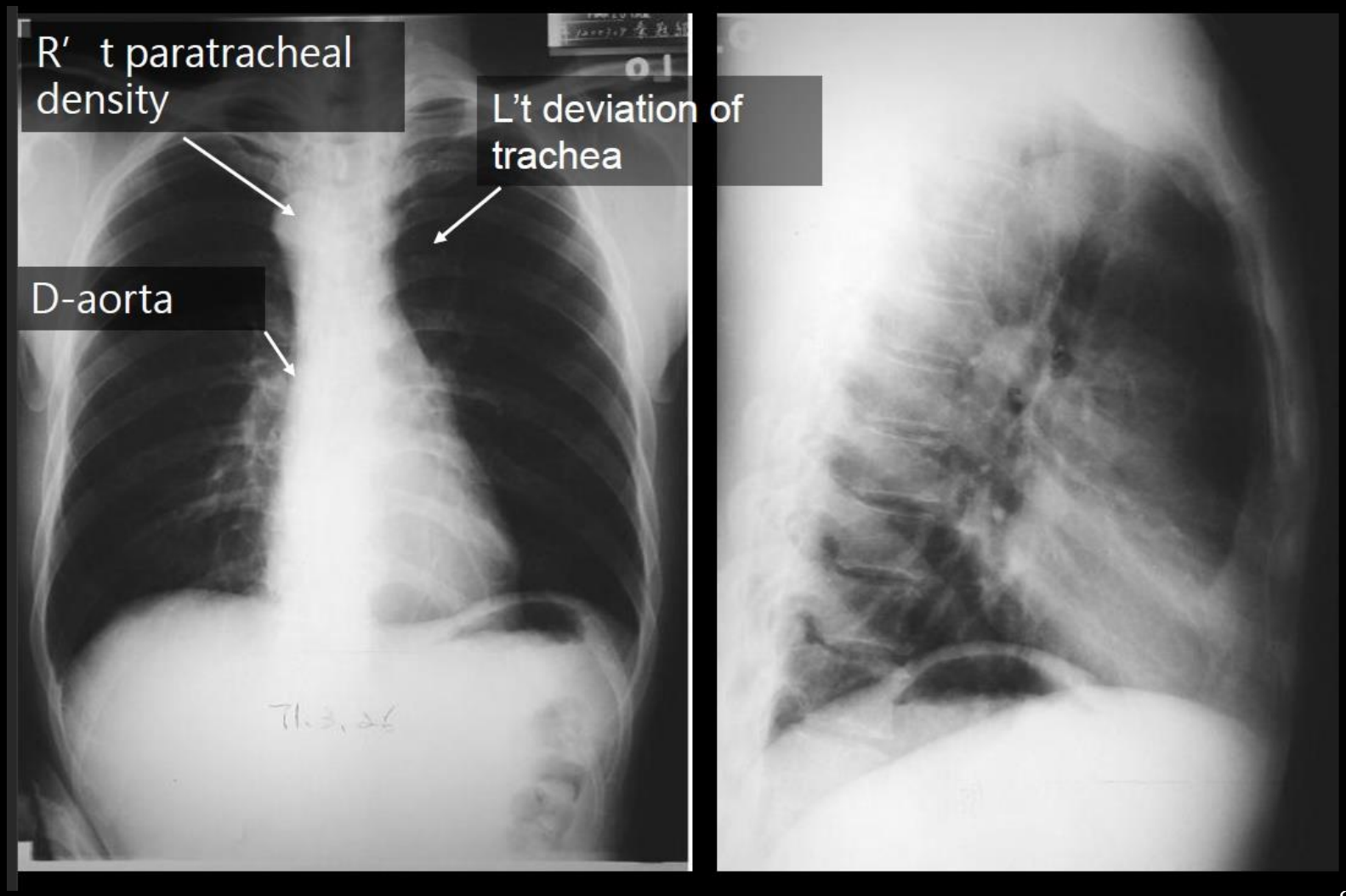
Tetralogy of Fallot (PS, VSD, Overriding Aorta, RVH)





- Normal-sized heart
- RVH (upturned apex, increased contact between the heart and anterior chest wall)
- Diminutive or inapparent pulmonary trunk
- Diminished pulmonary vascularity
- “Boot-shaped” heart

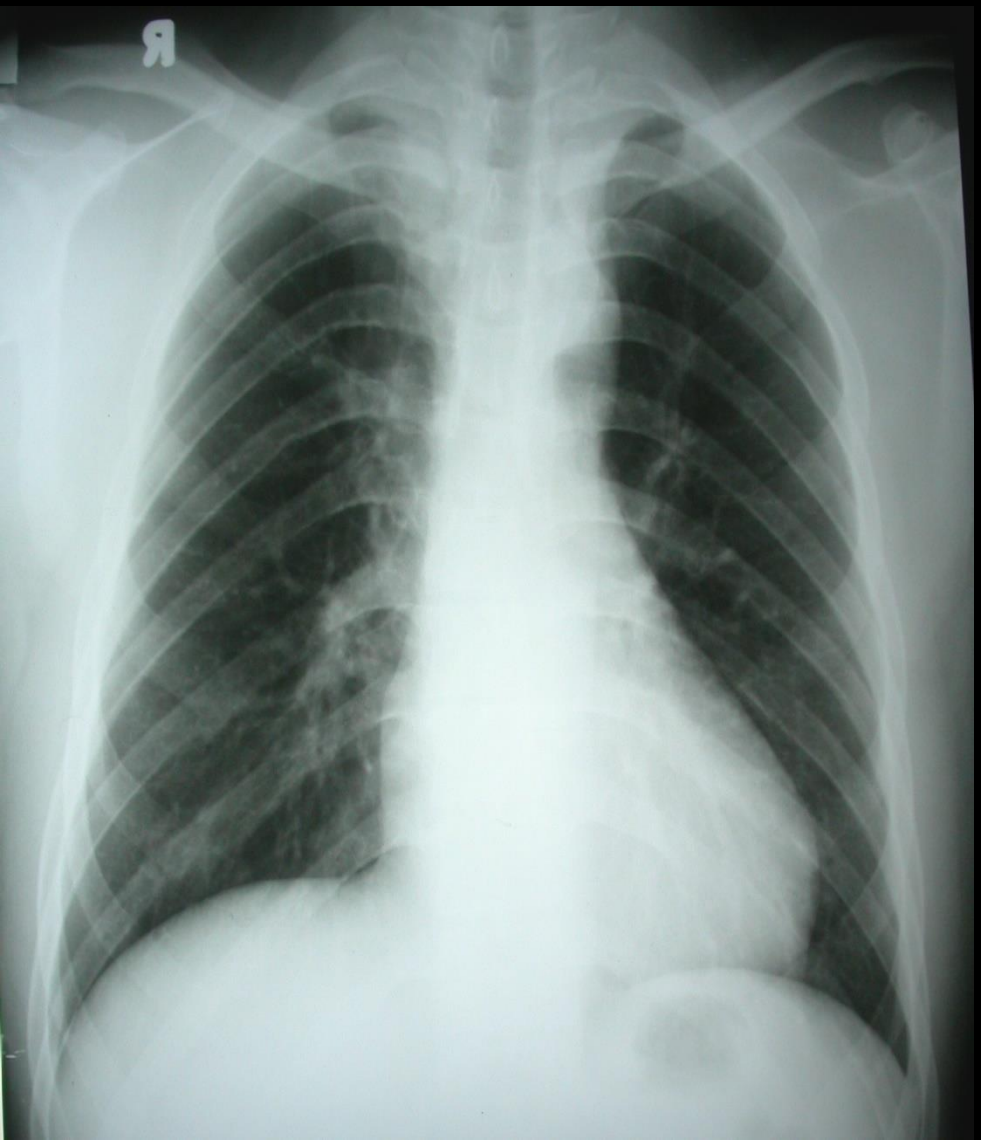
Right side aorta

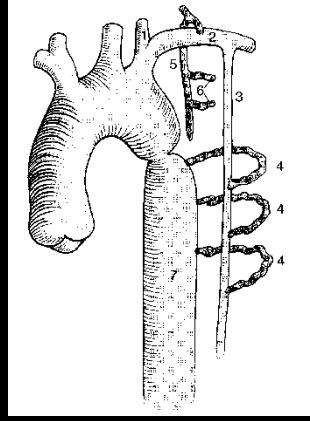


Double Aortic Arch

Typically right arch higher and larger than left one.

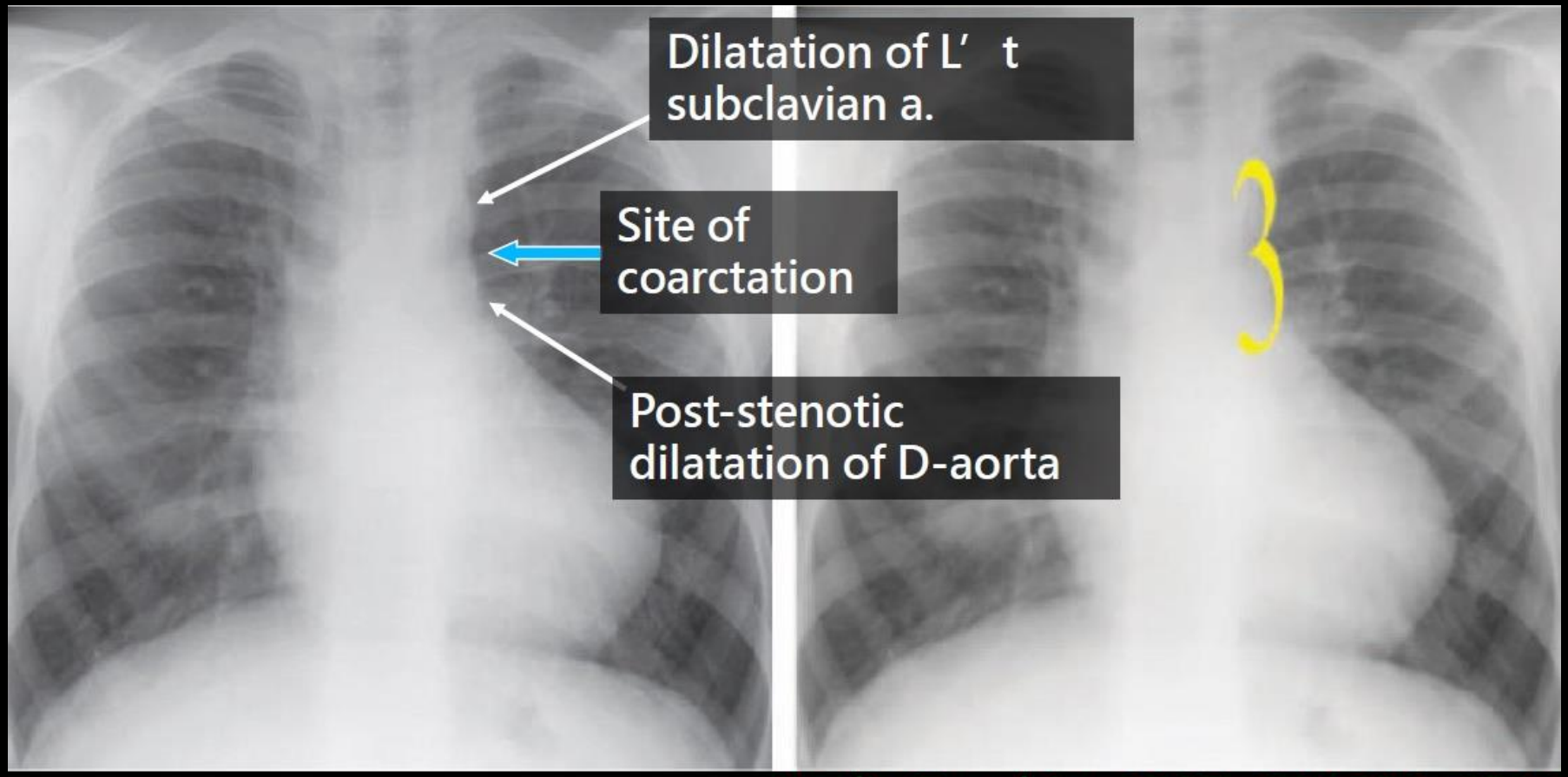
Coarctation of aorta





- Teenagers- adults
  - LVH
  - Inconspicuous hypoplastic distal aortic arch
  - Poststenotic dilatation of descending aorta
  - Dilated left subclavian artery
  - "3" or "reversed E" sign
  - "reversed 3" or "E" sign on frontal esophagram
  - Rib notching, 70-75%, proximal third, 3rd-8th ribs

Coarctation of aorta
Figure-of-3 sign



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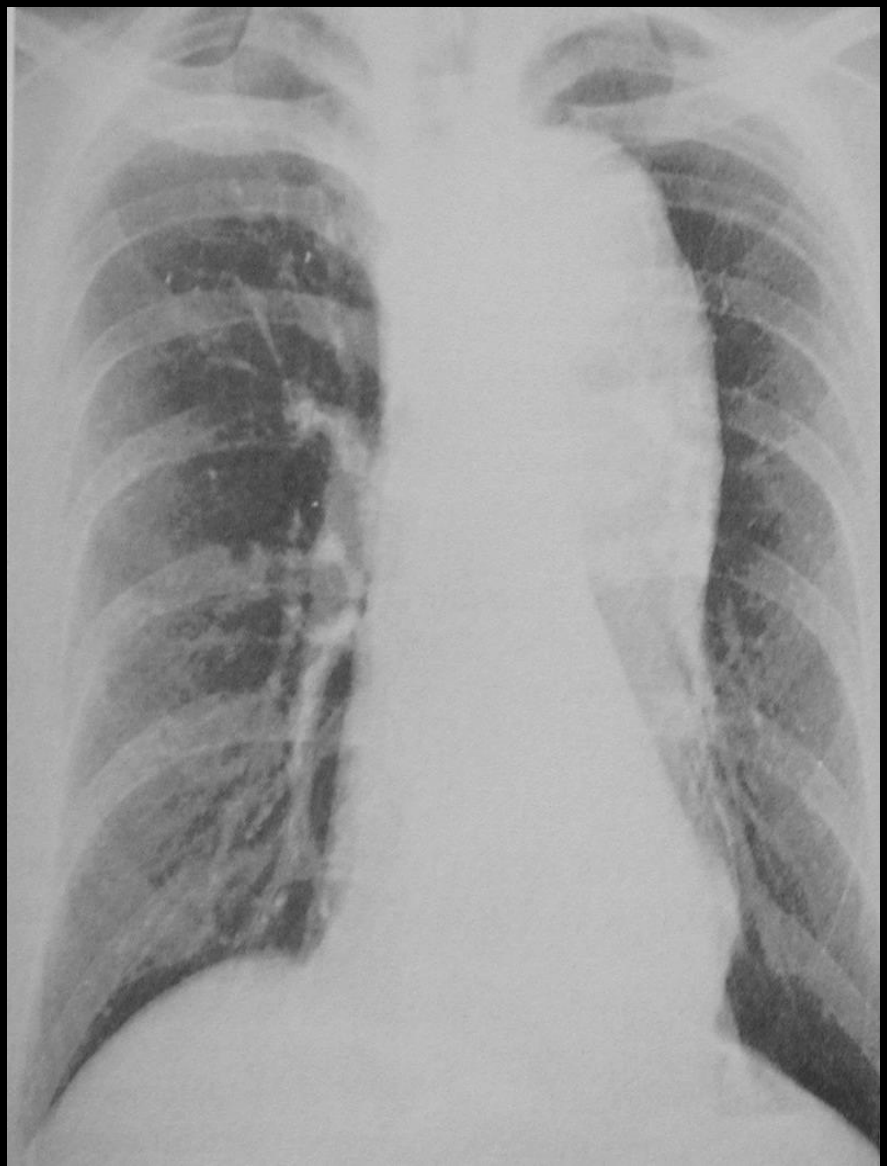
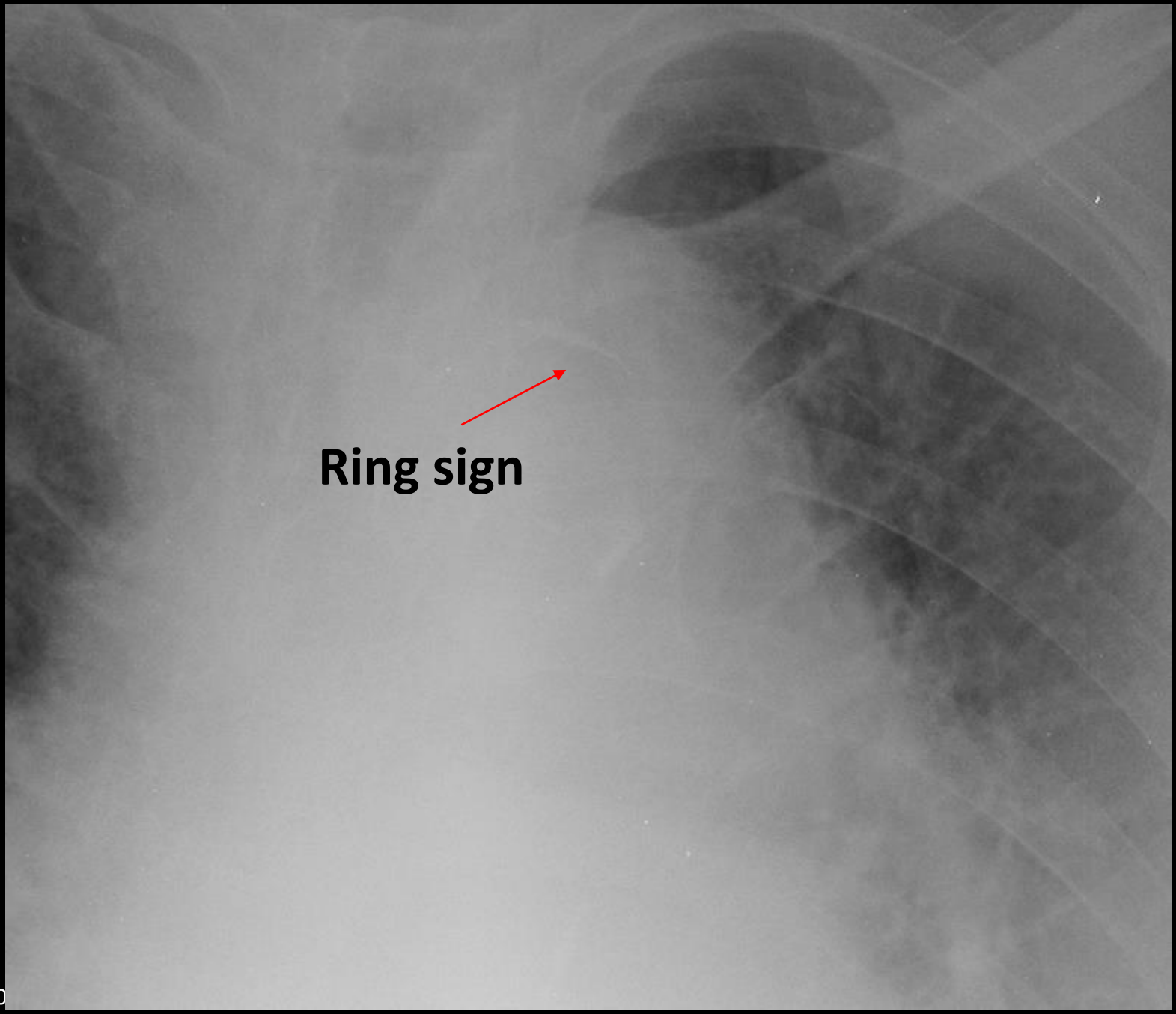
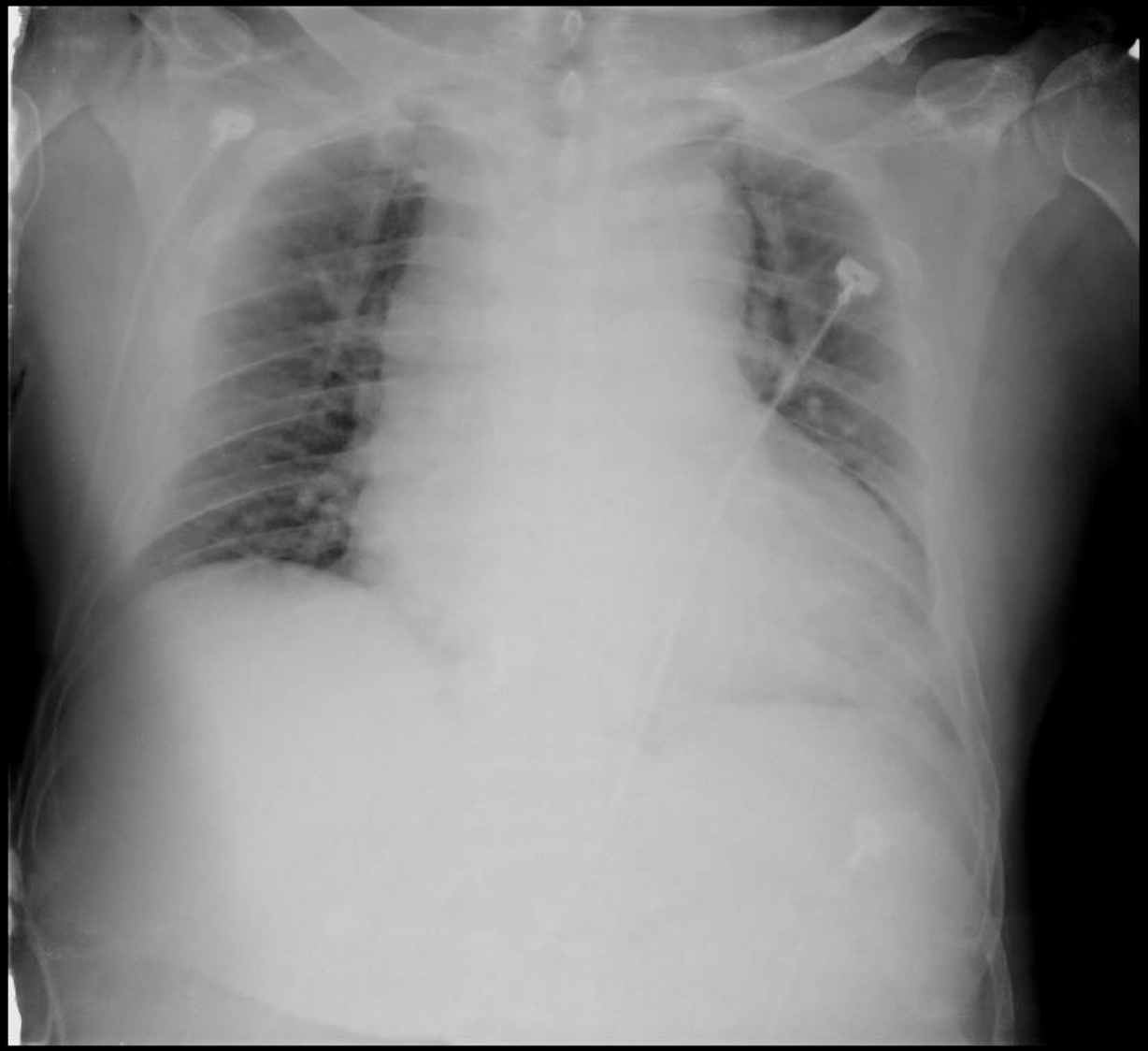
Aortic Dissection



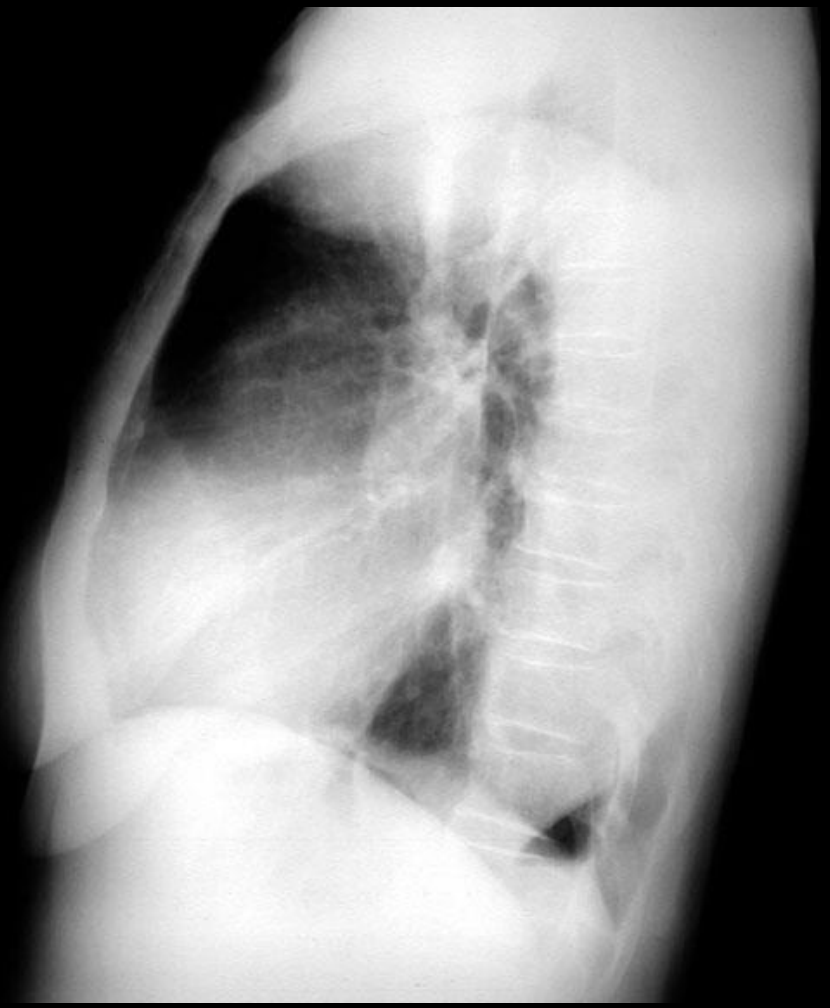
- Mediastinal widening
- Enlarged ascending aorta, aortic arch, descending aorta
- **Deformities of the aorta and blurring of its contours**
- **Ring sign: displacement of disruption of initimal calcification (>1cm)**
- **Double aortic knob sign**
- **A- and D-aorta size disparity**
- Deviation of trachea or NG tube
- Aortic rupture: left pleural effusion


Ring sign

Aortic dissection (Acending aorta)

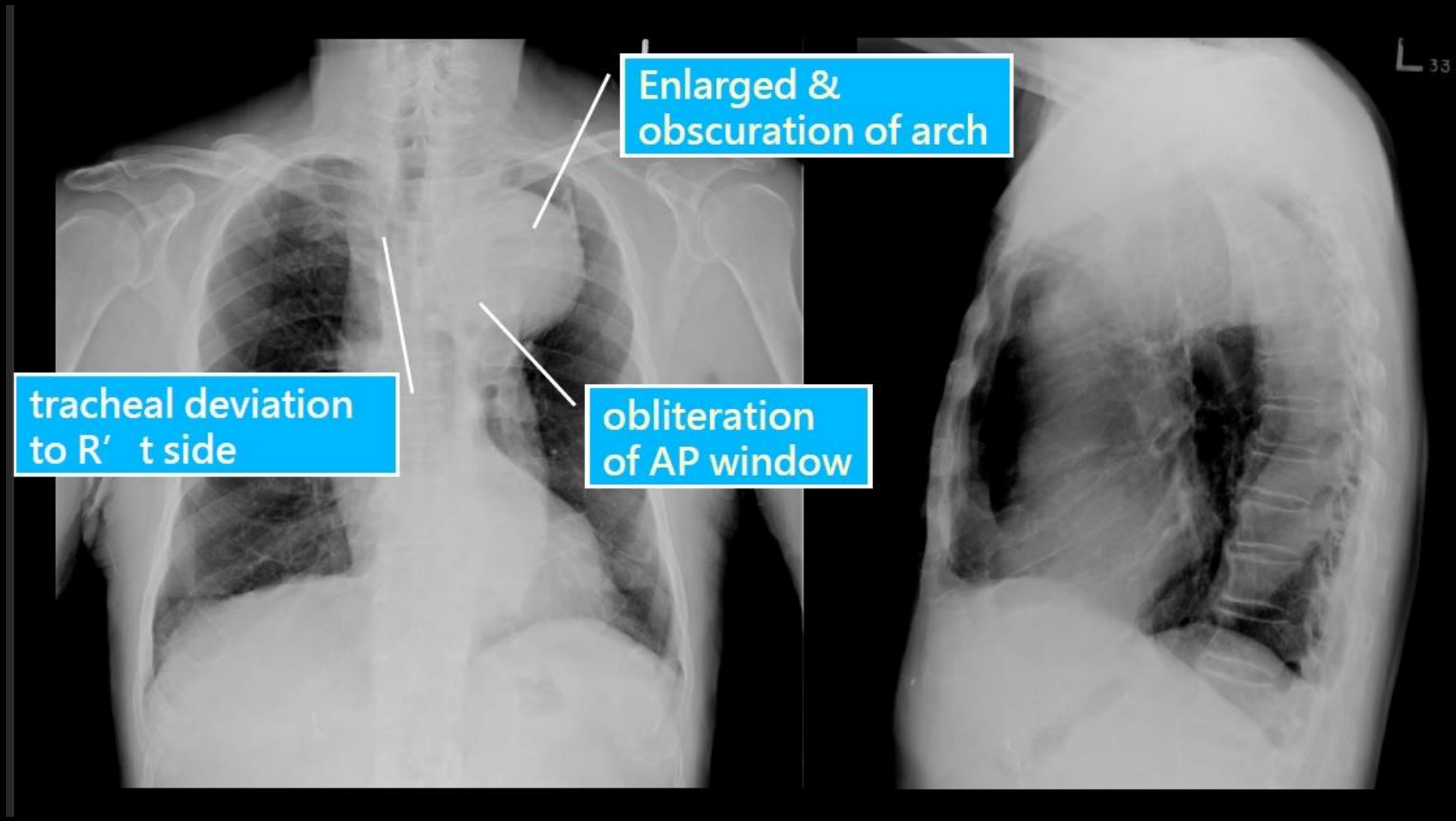


Aortic dissection (descending aorta)



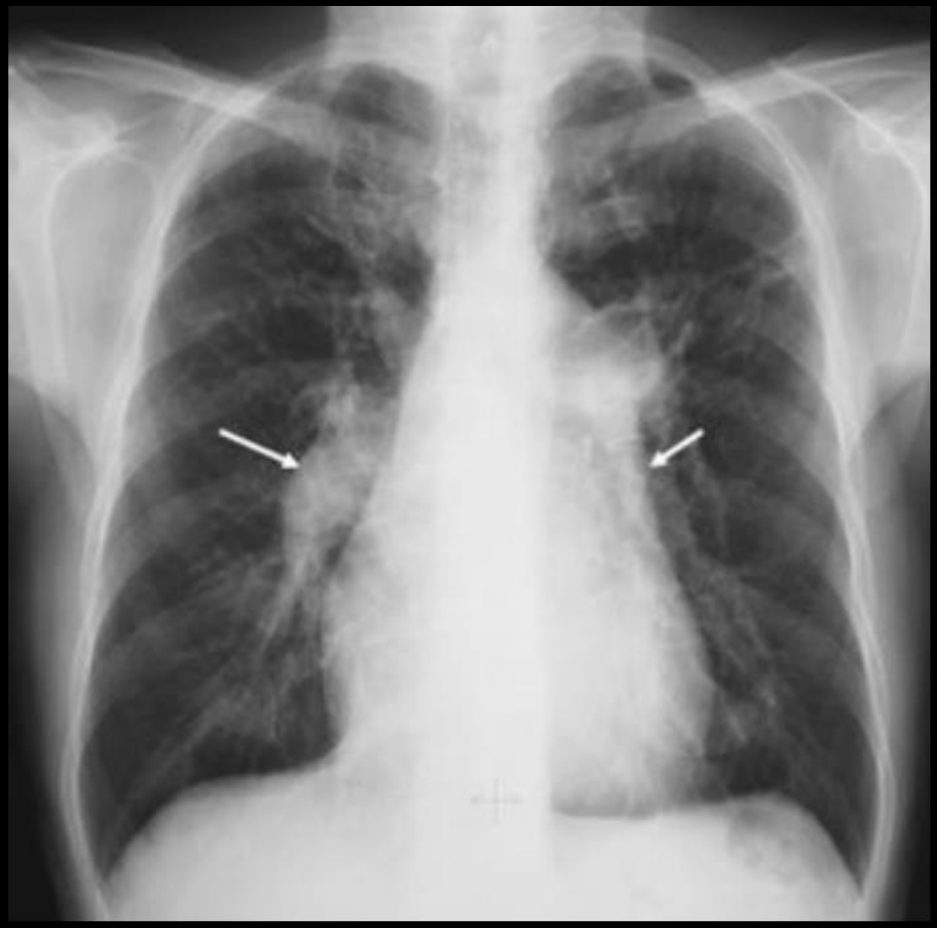
- Mediastinal widening
- **Inlet to outlet shadow** on left side
- Retrocardiac: Intact silhouette of left heart margin
- **Pulmonary artery overlay sign:** Density behind left lower lobe
- Wavy margin

Aortic aneurysm



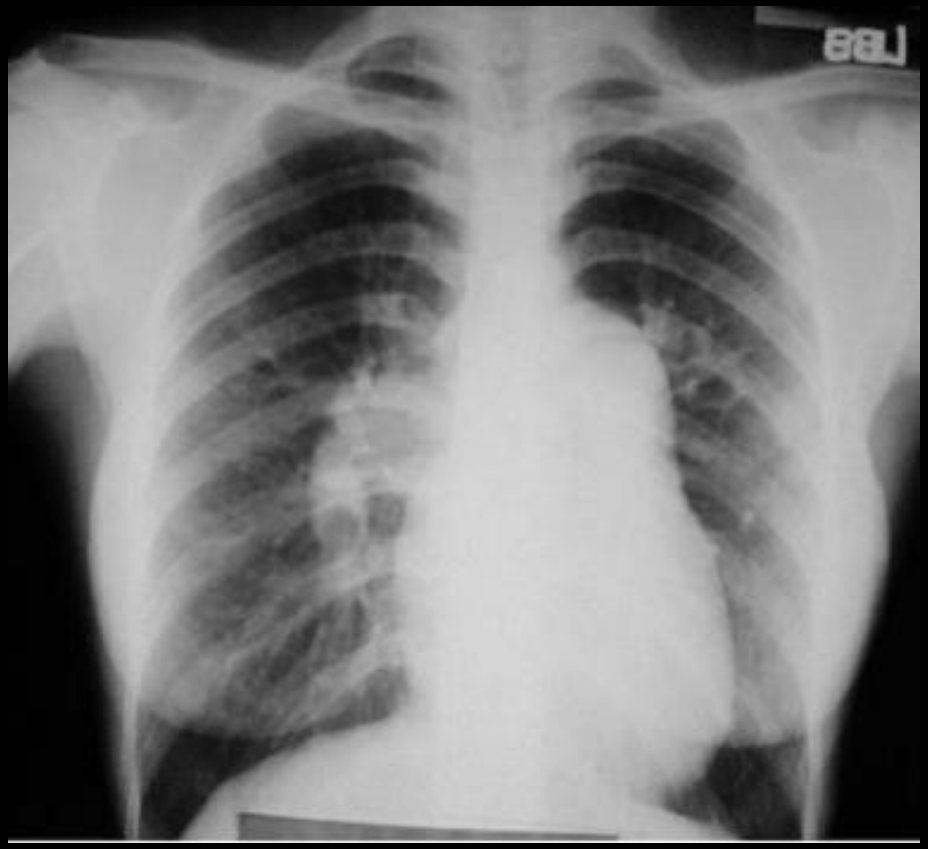
Aortic Aneurysm

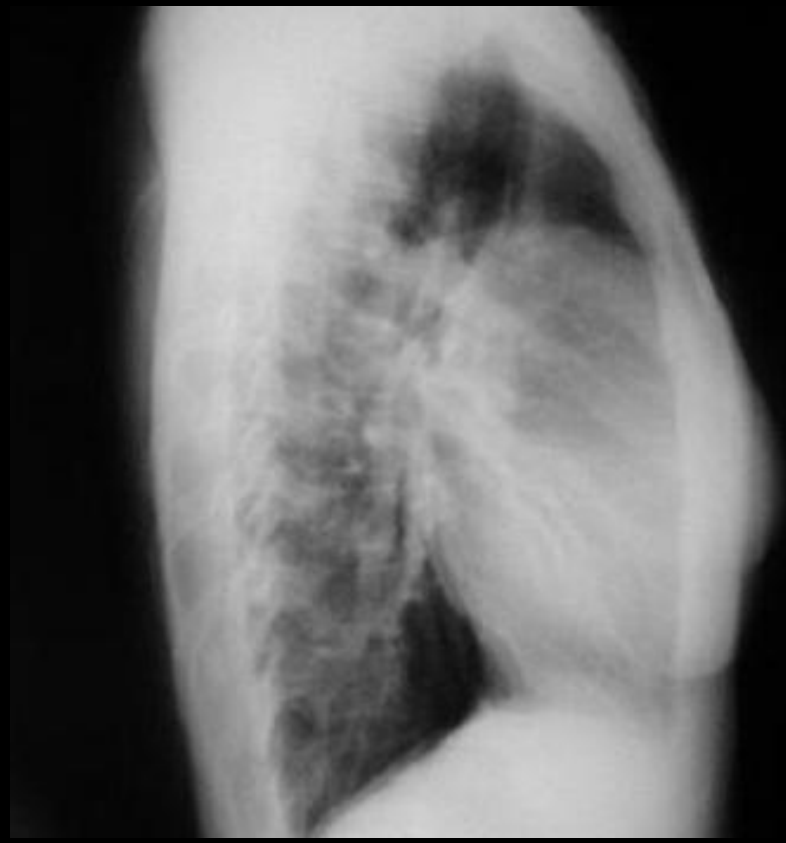
Pulmonary artery hypertension



RDPA >16 mm and LDPA >18 mm are considered abnormal and predictive of the presence of pulmonary hypertension.

Pulmonary artery hypertension

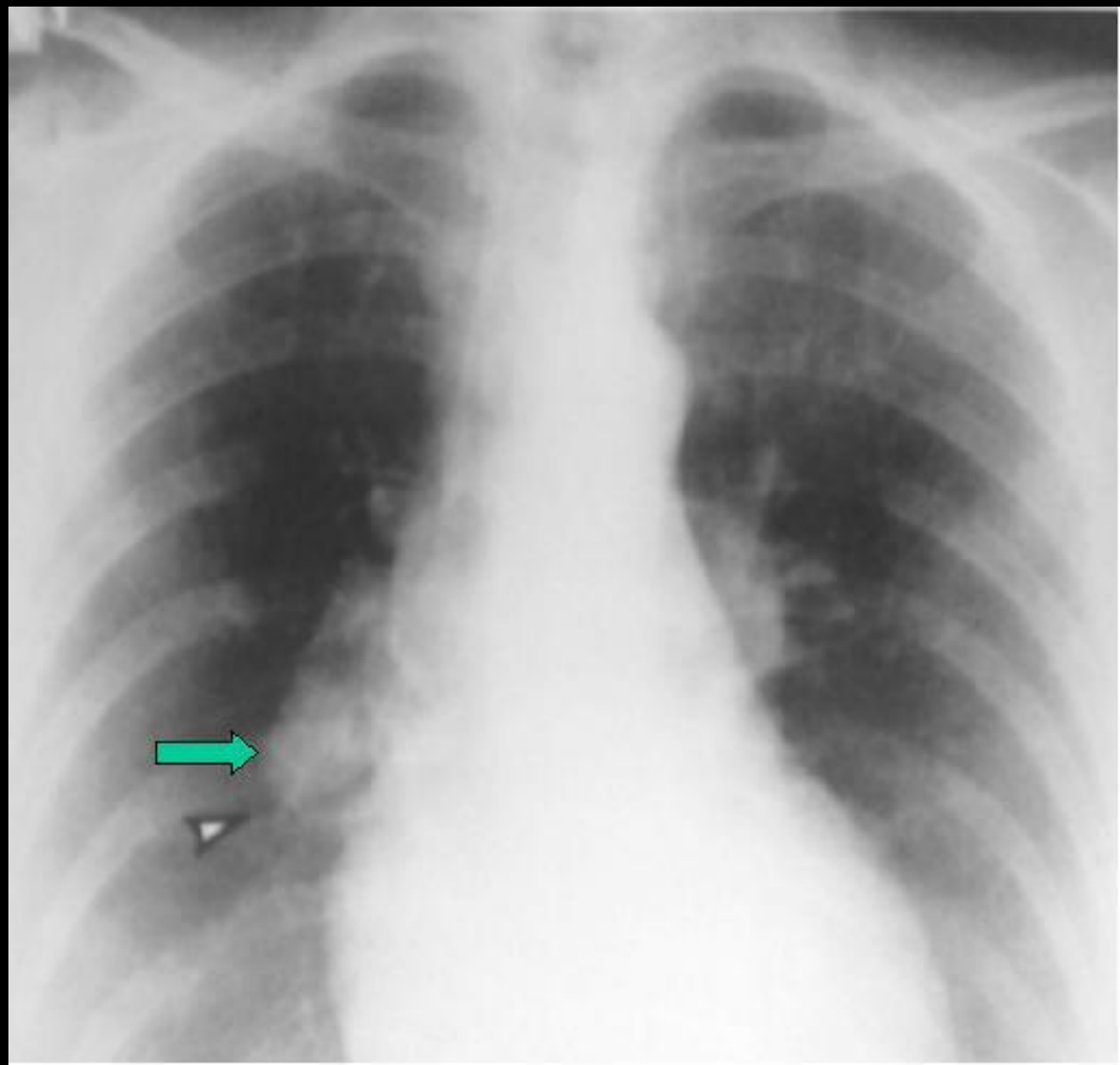




Outer 1/3 of the lung with rapid tapering of vessels consistent with vascular pruning

Pulmonary embolism

- Knuckle sign
- Thumb sign

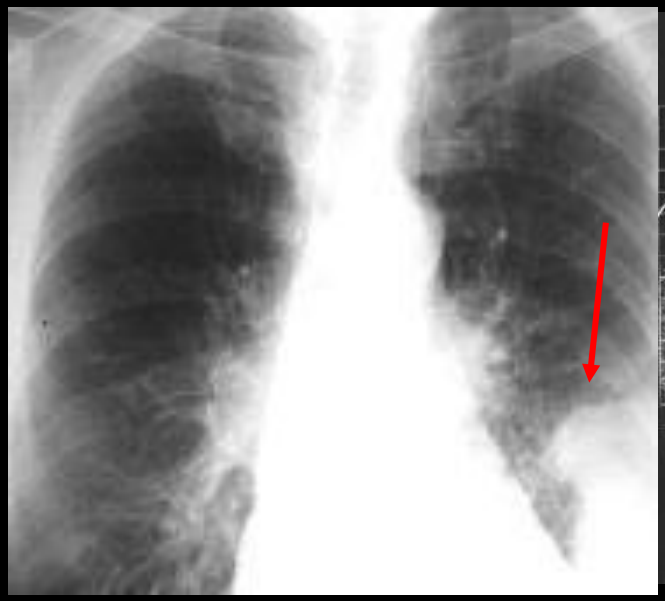


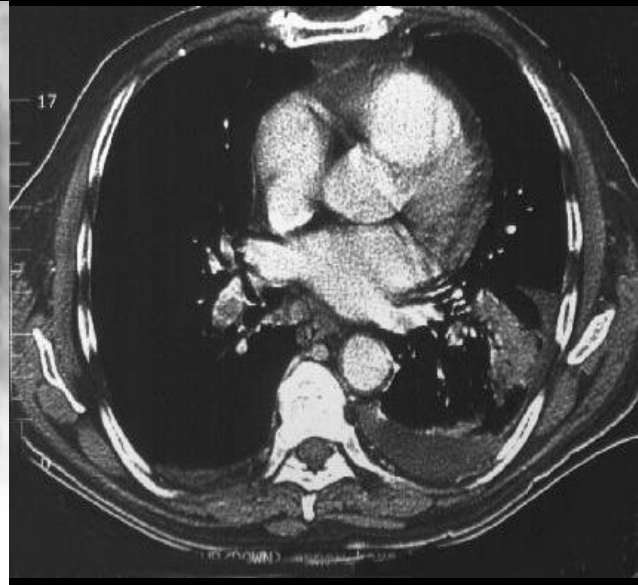
Pulmonary embolism

Hampton's hump sign

1. homogeneous wedge-shaped consolidation
2. pleural base and convex apex toward the hilum

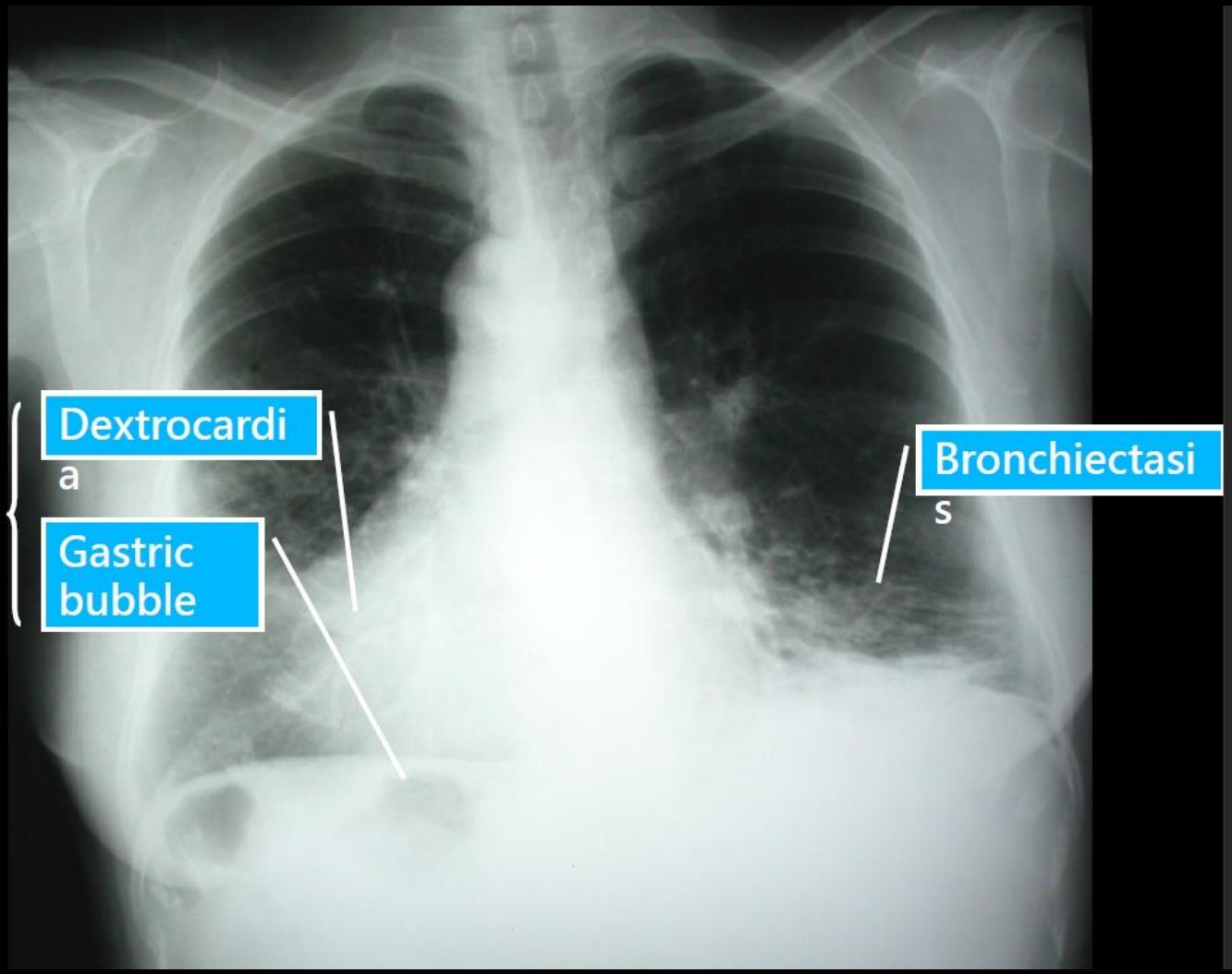
(三角/ 錐形, 尖端朝向hilum)





Kartagener's syndrome

Situs inversus



Take home messages

- Routine daily chest film is not mandatory in ICU
- Change in the clinical condition or placement of catheters were indicated for a chest film
- Evaluate all catheters before looking other lesions
- Examine any signs of barotrauma
- Check for cardiovascular and fluid status
- Differentiate causes of pulmonary opacities
- Famililar with normal cardiovascular anatomy is critical in interpretating cardiovascular images

謝謝您的用心聆聽