대한흉부심장혈관외과학회 제 12차 전공의 연수교육, 2019. 05. 23 - 25

Diagnosis and management of pleural diseases

조 석 기

서울대학교 의과대학 흉부외과학교실
분당서울대학교병원 흉부외과

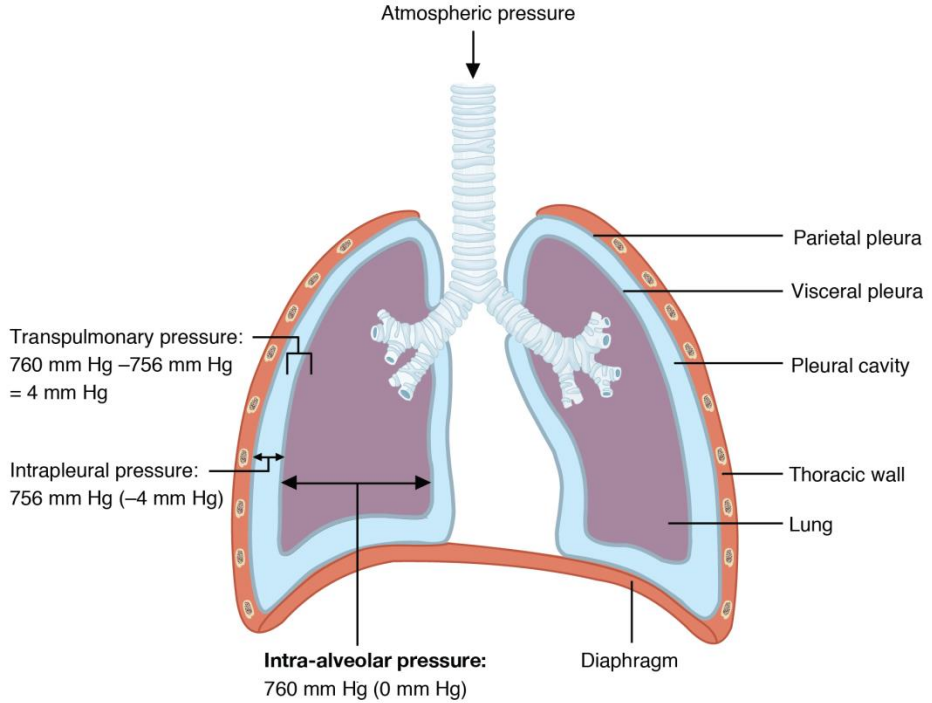
Pleural disease

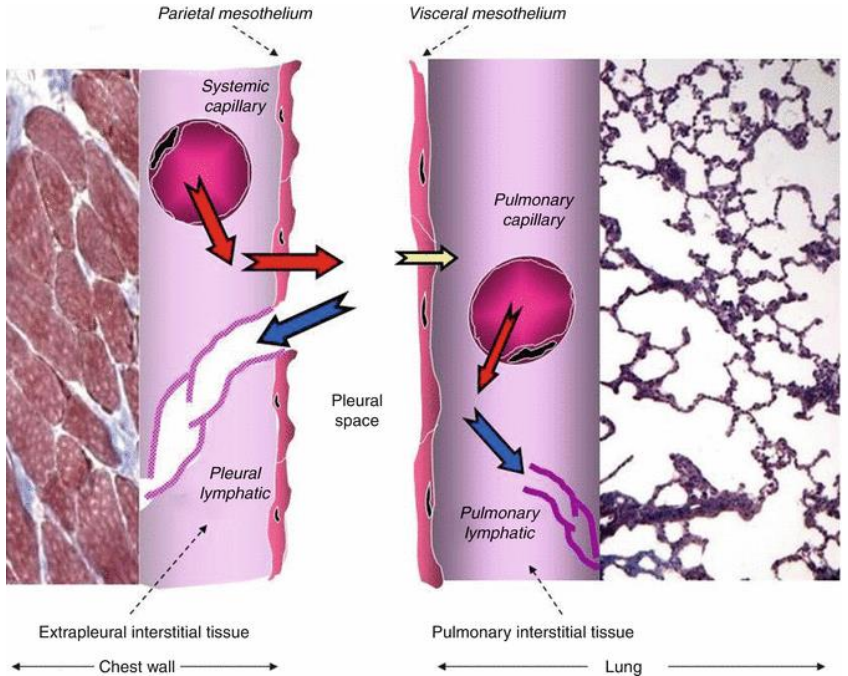
- Pneumothorax
- Pneumomediastinum
- Pleural effusion
  - Parapneumonic
  - Hemothorax
  - Chylothorax
  - Empyema
- Pleural tumor
- Diaphragm

AIR

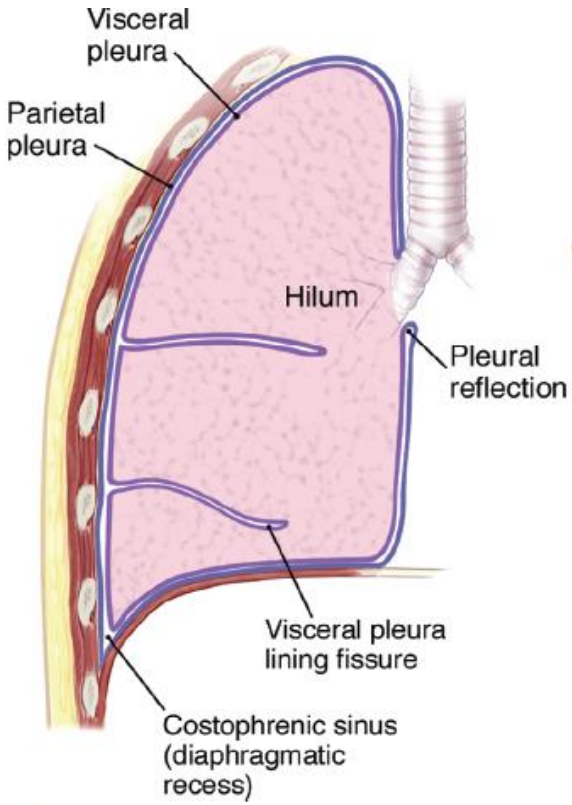
FLUID

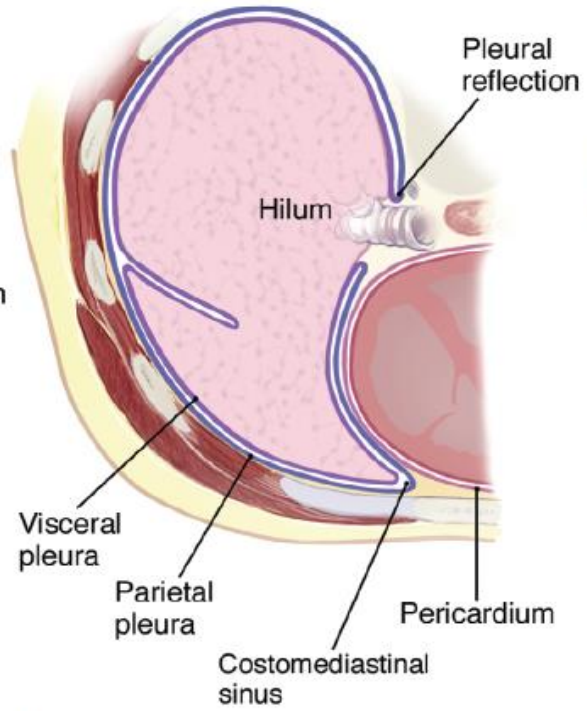
SOLID

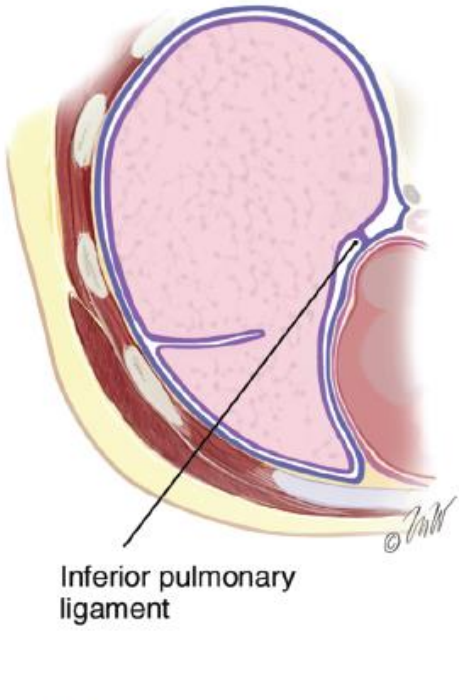




Pleura







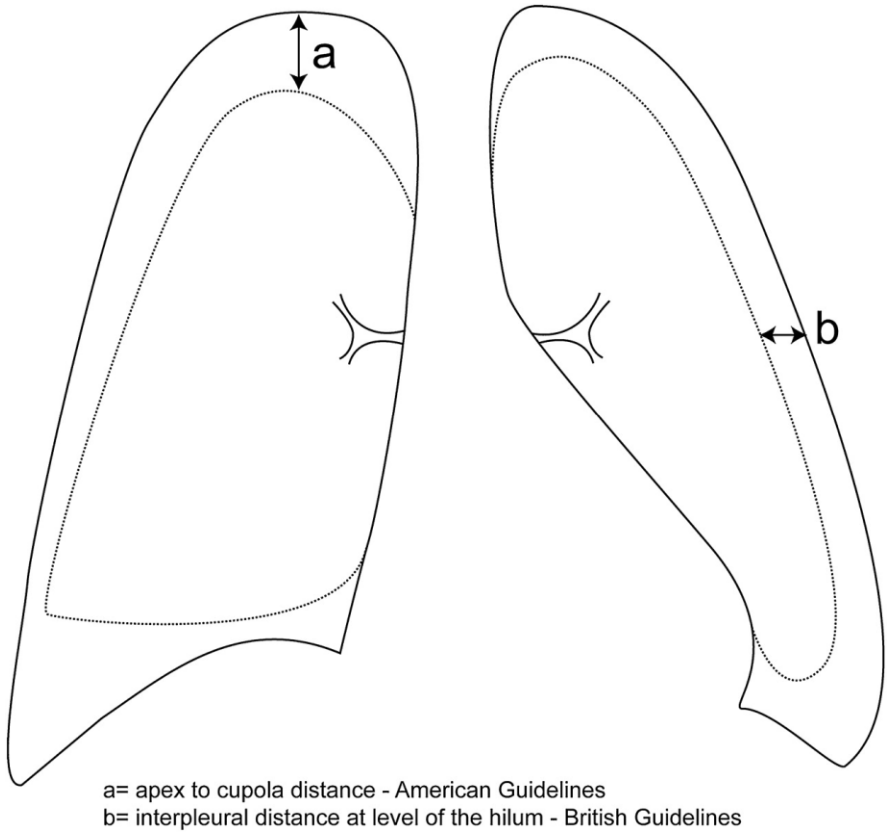
Parietal pleura
Visceral pleura

Transition between PP and VP at hilum

Fusion of ant. and post. leaves of VP at IPL

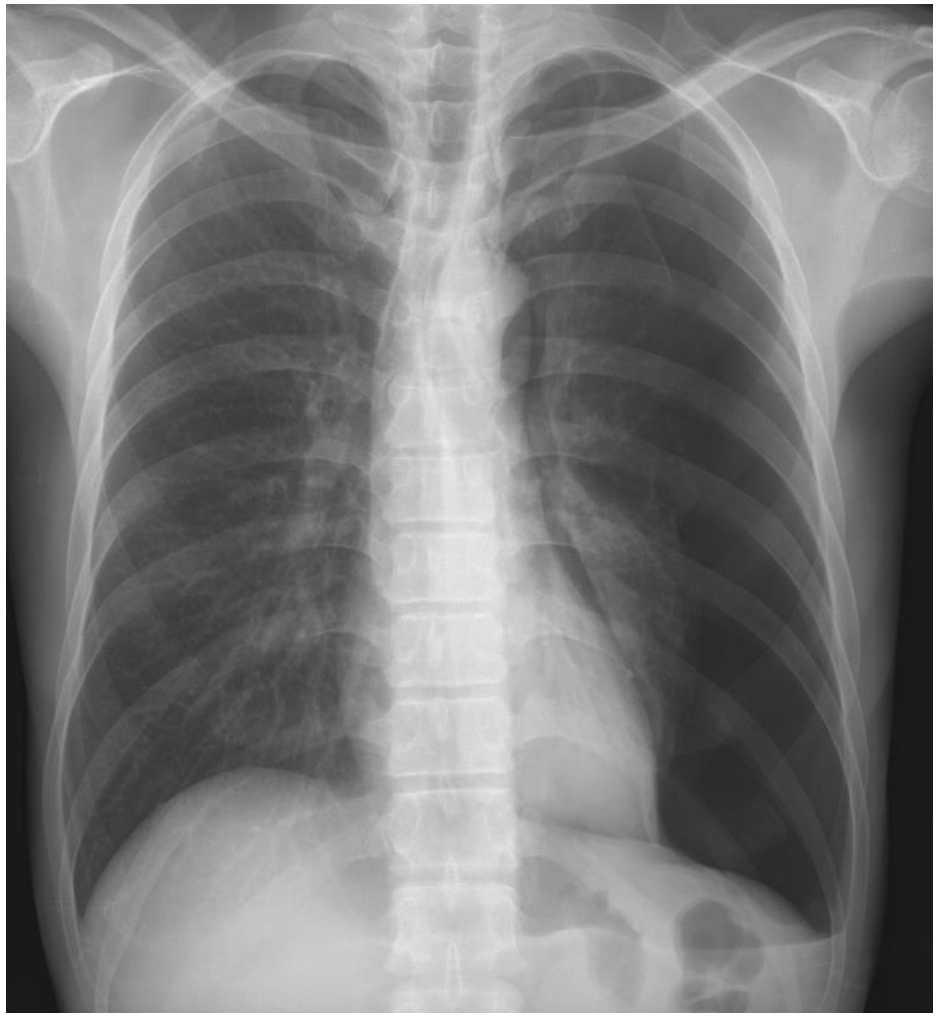
Pneumothorax

- **Spontaneous**
  - Primary (PSP)
  - Secondary (SSP)
- **Traumatic**
  - Rib fracture
- **Iatrogenic:**
  - PCNBx
  - Central line insertion
- **Catamenial**
- **Tension**

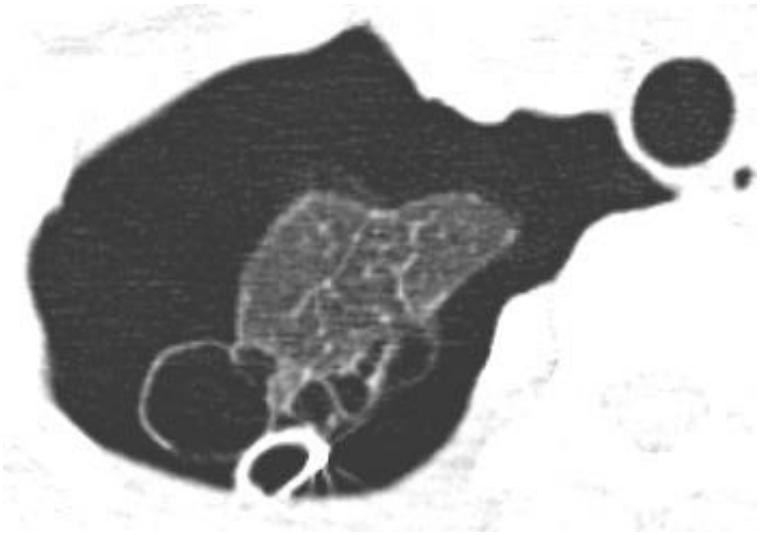


Size of pneumothorax

Primary Spontaneous Pneumothorax (PSP)



HRCT



- Chest tube
  - Small caliber : 10 Fr
  - Large caliber : 24 Fr
- Chemical pleurodesis
  - Fibrinogen
  - Antibiotics
  - Betadine
  - Chemoagents

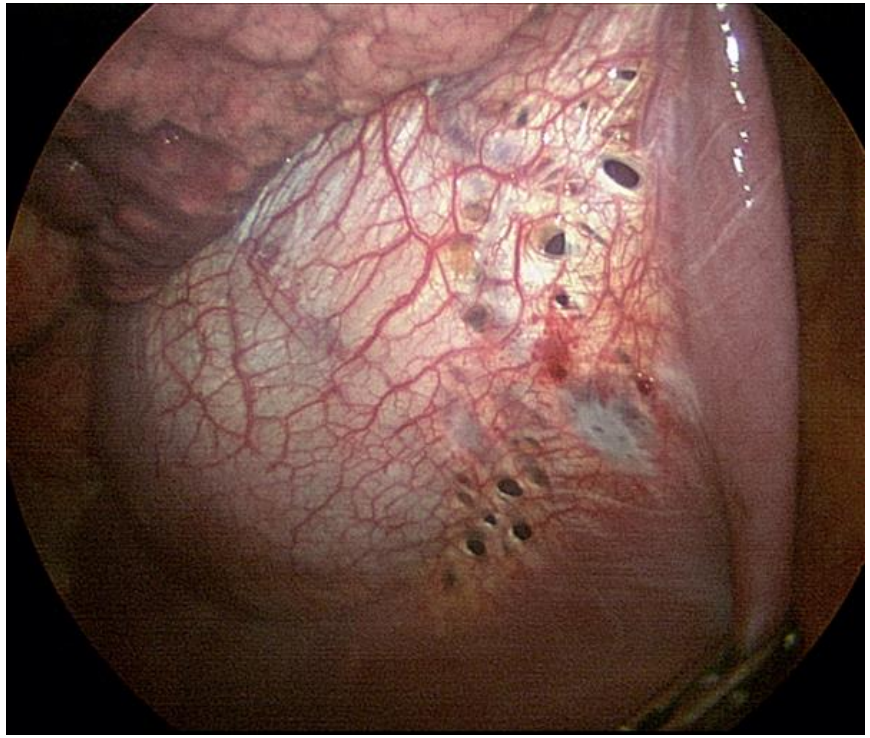
- **Surgical indications**

1. Recurrent pneumothorax (pntx)
2. Persistent air leak > 5 days
3. Hemopneumothorax
4. Previous contralateral pntx
5. Simultaneous bilateral pntx
6. Large bulla visible on chest x-ray
7. Professional at risk (pilot, diver)

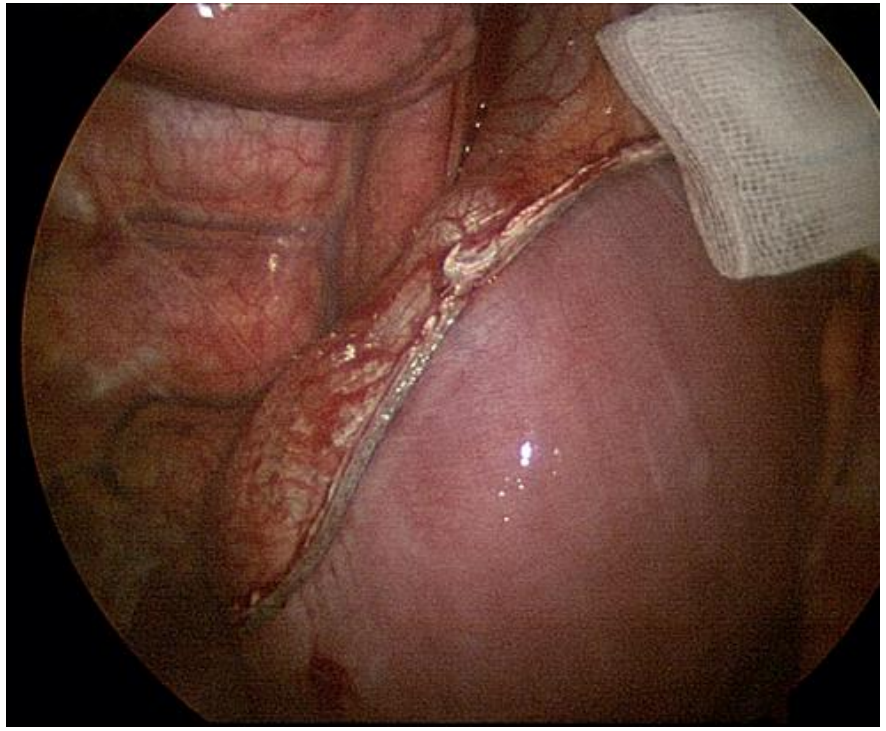
intraoperative finding

Catamenial Pneumothorax

- Female (20-30yr), recurrent, menstrual cycle (48-72hr),
- Right dominant (90%)
- No pneumothorax if ovulation does not occur
- Surgery (diaphragm resection), ovulatory suppressive drug



Multiple holes in diaphragm, Right

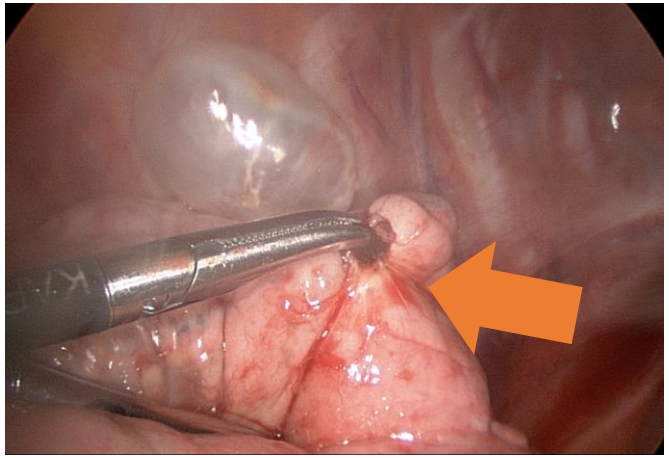


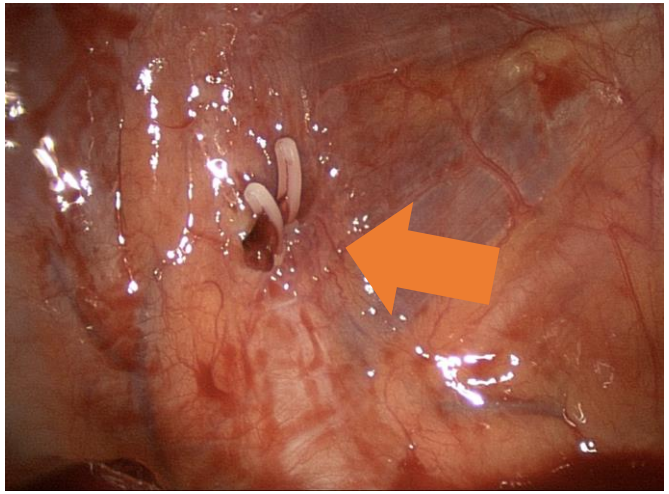
Diaphragm resection using endo- linear stapler

Hemopneumothorax

Pneumothorax, right
→ Loss of negative pressure in cavity
→ Bleeding stopped

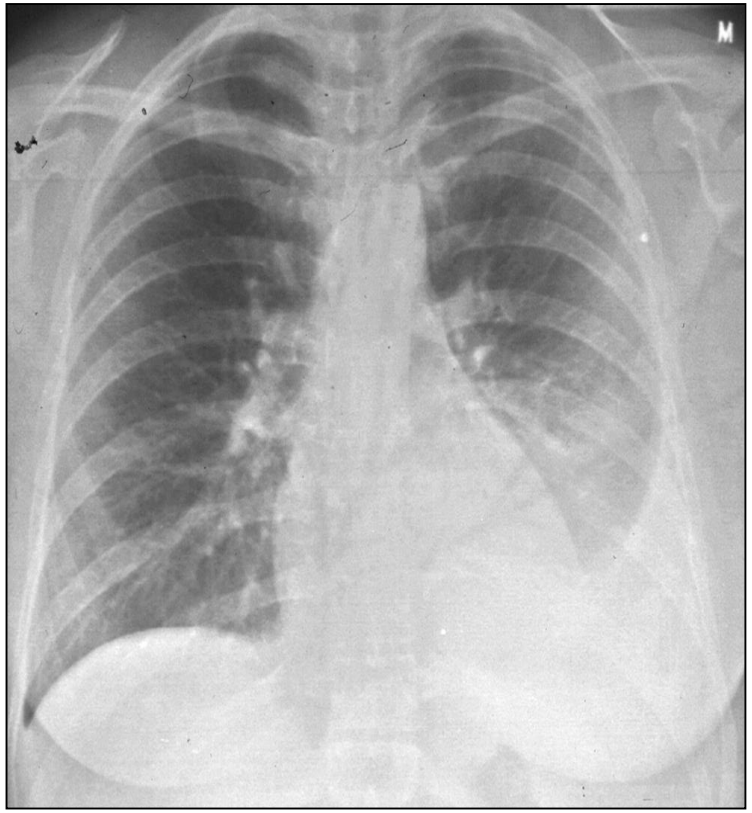
Chest tube insertion and suction
→ Restore negative pressure in cavity
→ Rebleeding
→ Emergent operation



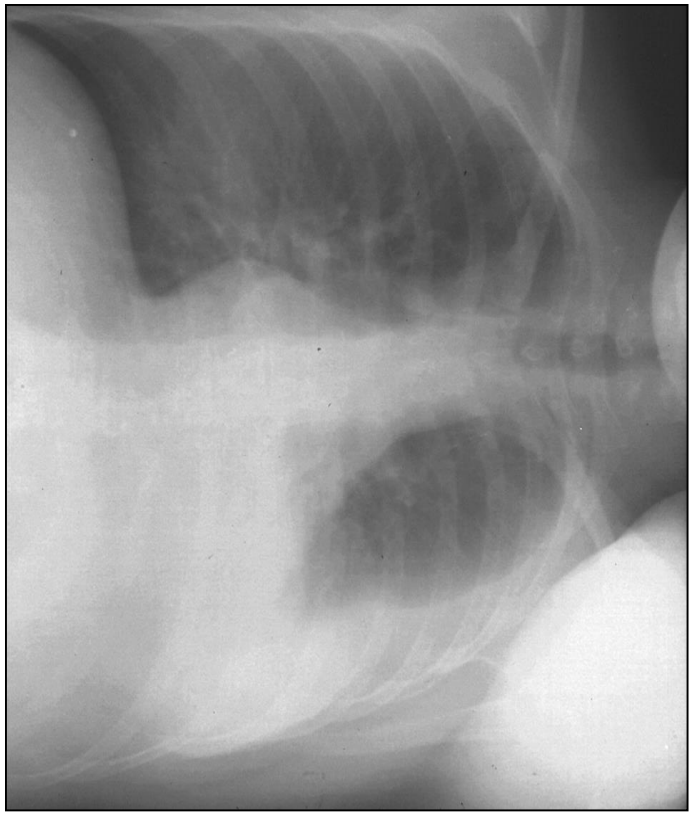


Bridging vein

Pleural effusion



Left sided effusion



Left lateral decubitus
free flowing effusion

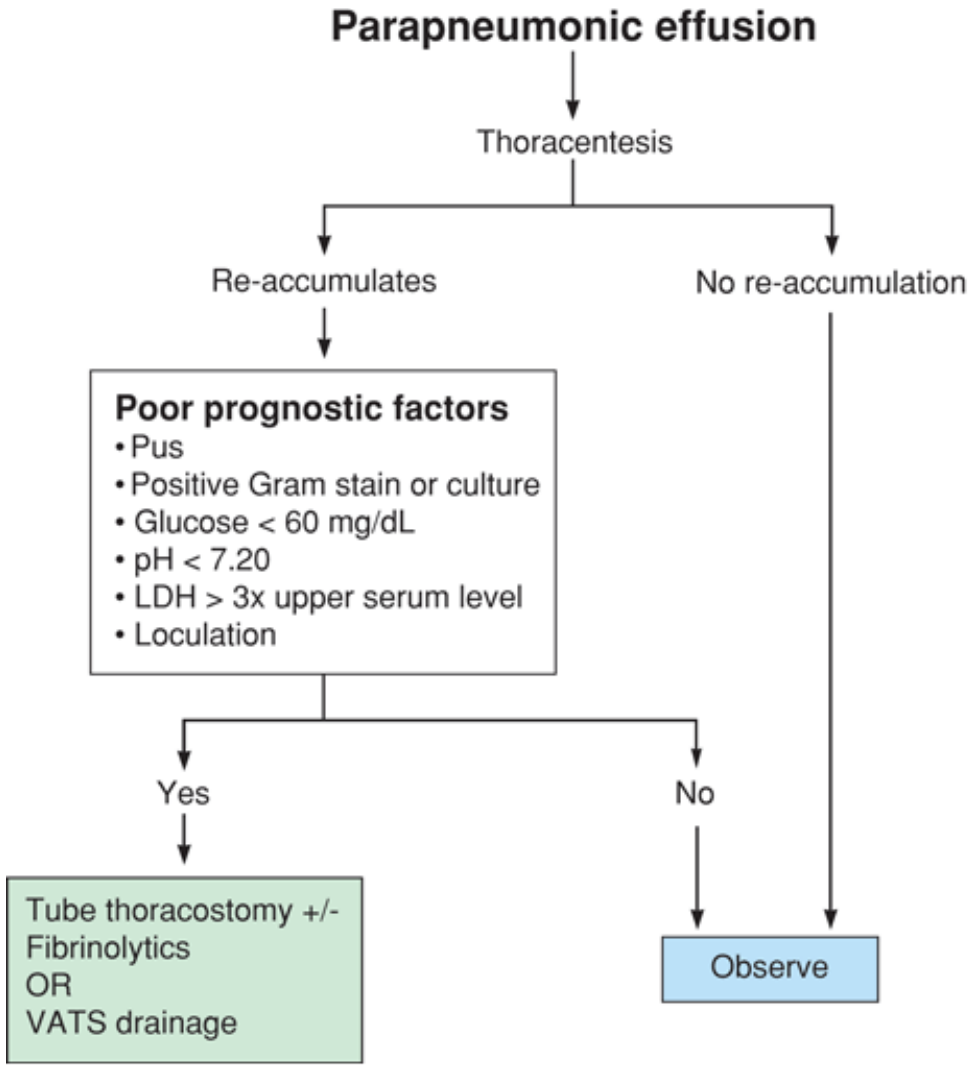
transudate

bloody

chylous

pus

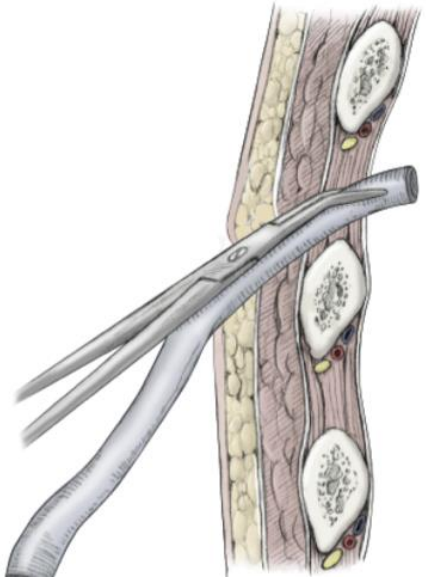
Parapneumonic effusion



Indications of tube thoracostomy

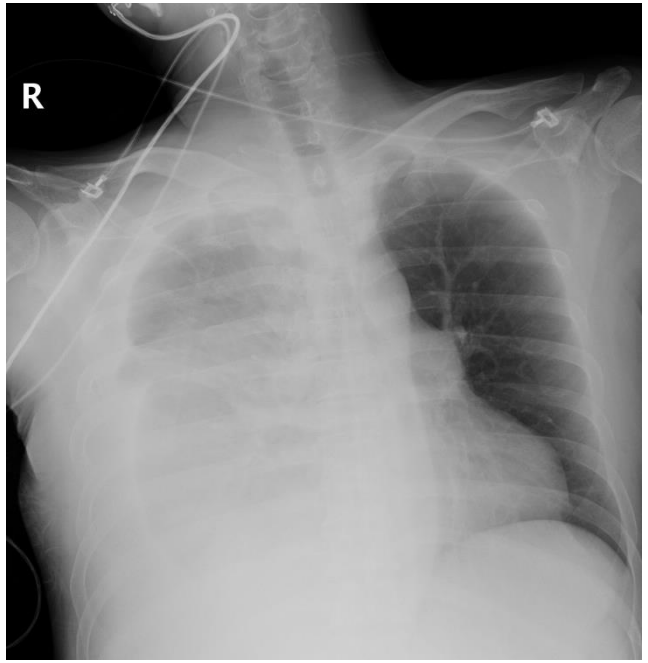
(or VATS drainage)

- Pus
- Positive Gram stain or culture
- Glucose < 60mg/dl
- pH < 7.20
- LDH > 3x upper serum level
- Loculation

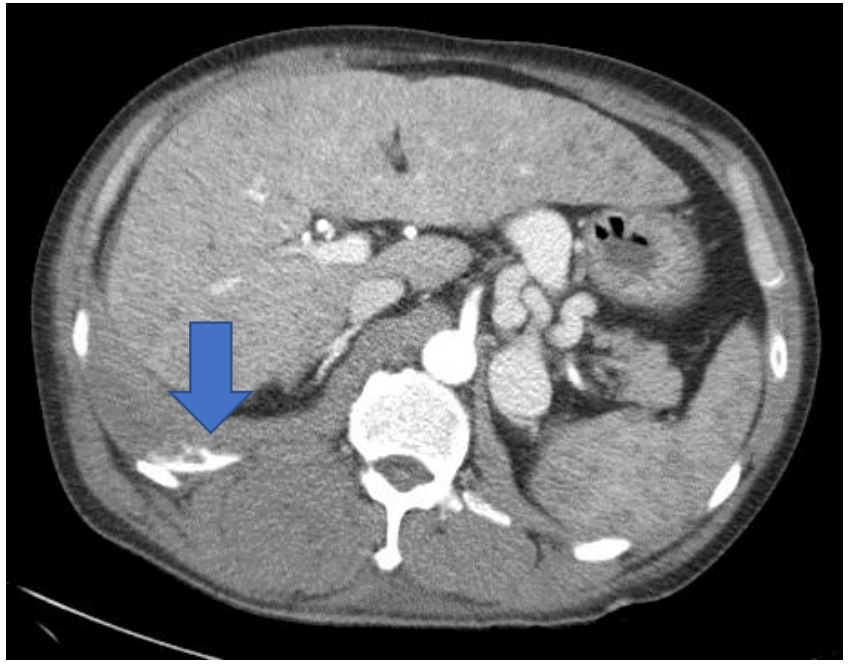


Upper margin of rib
Tunneling

Hemothorax, Embolization



Traffic accident,
Rt. 10th rib fracture
Right pleural effusion
Tube thoracostomy → blood



CT; bleeding from intercostal artery
No injury of liver, spleen, right lung

Angiography; bleeding focus (+)
Embolization
Decreased bleeding from tube

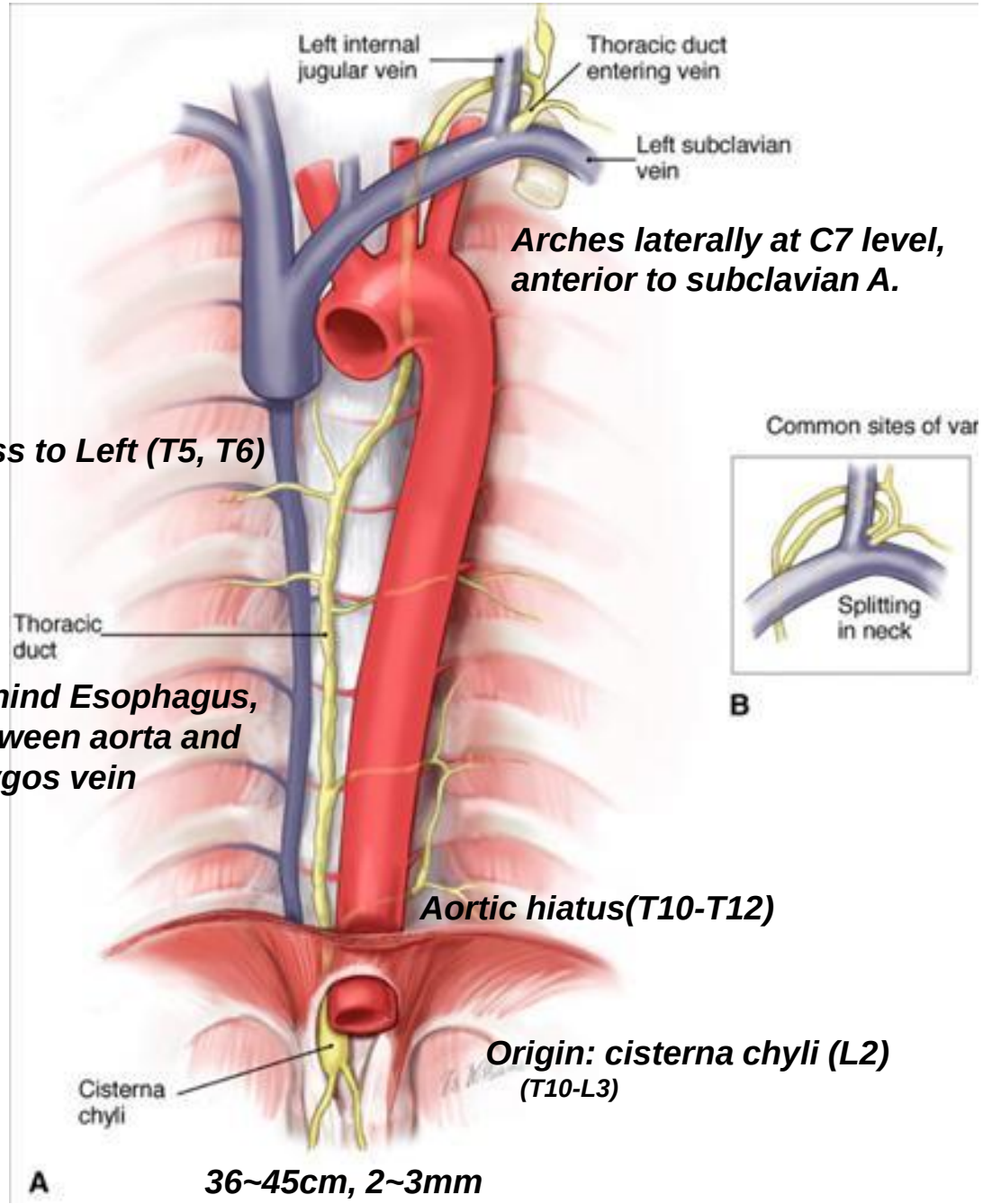
Hemothorax, Indications of exploration

- **Massive hemothorax;** > 1,000 to 1,500mL of initial drainage
- **Continued bleeding;** > 300mL in 1st hr, >200mL/hr for 3hr
- Increasing size of hemothorax or **clotted hemothorax**
- Combined with **persistent or large air leak**

Chylothorax

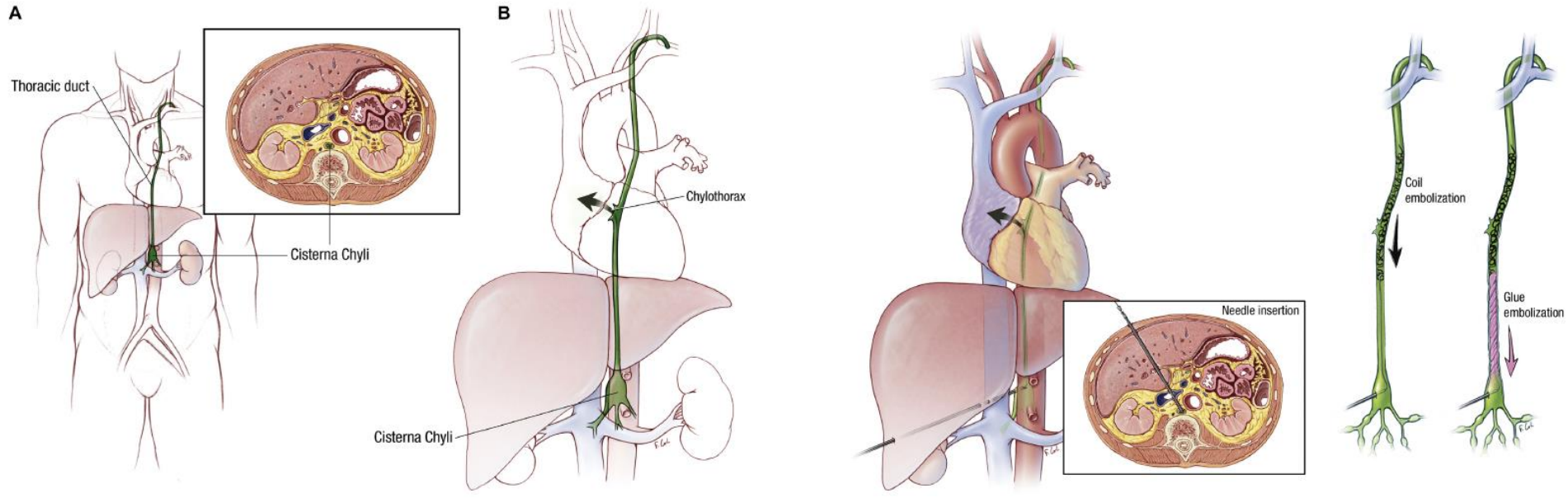
- **Diagnosis**
  - Color of drain
  - TG > 110 mg/dl
  - Lymphangiography

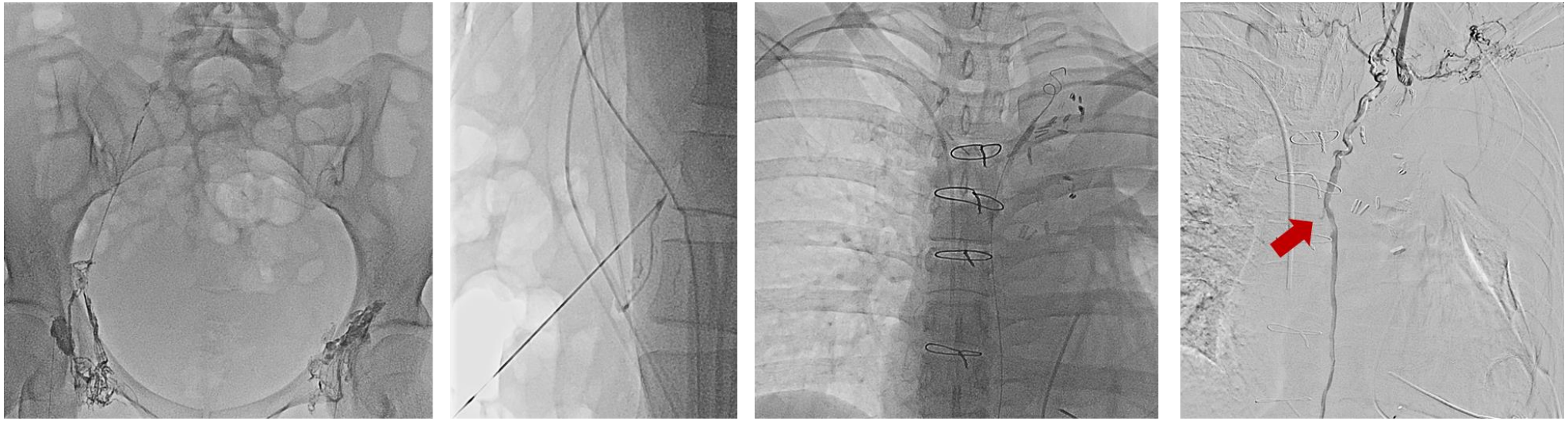
- **Suspicions**
  - Lung cancer, LND @ paratracheal, subcarinal
  - Post mediastinal tumor, @ above aortic arch
  - Esophageal cancer, @ any level
  - Aortic surgery, @ arch



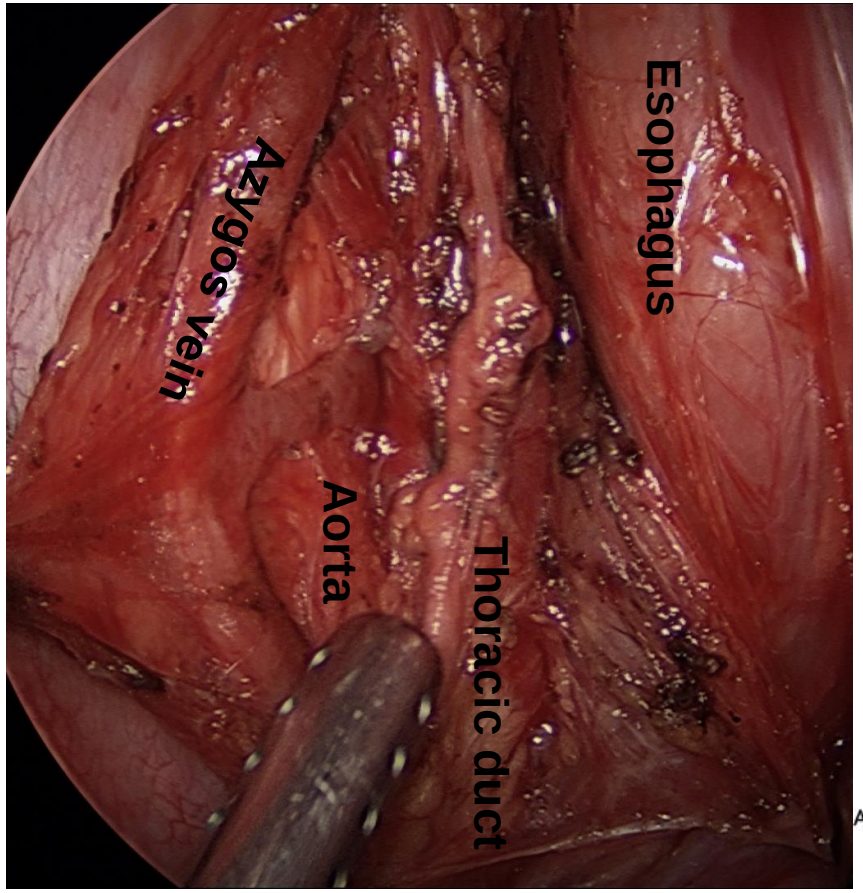
Thoracic duct embolization for Chylothorax from extended thymectomy

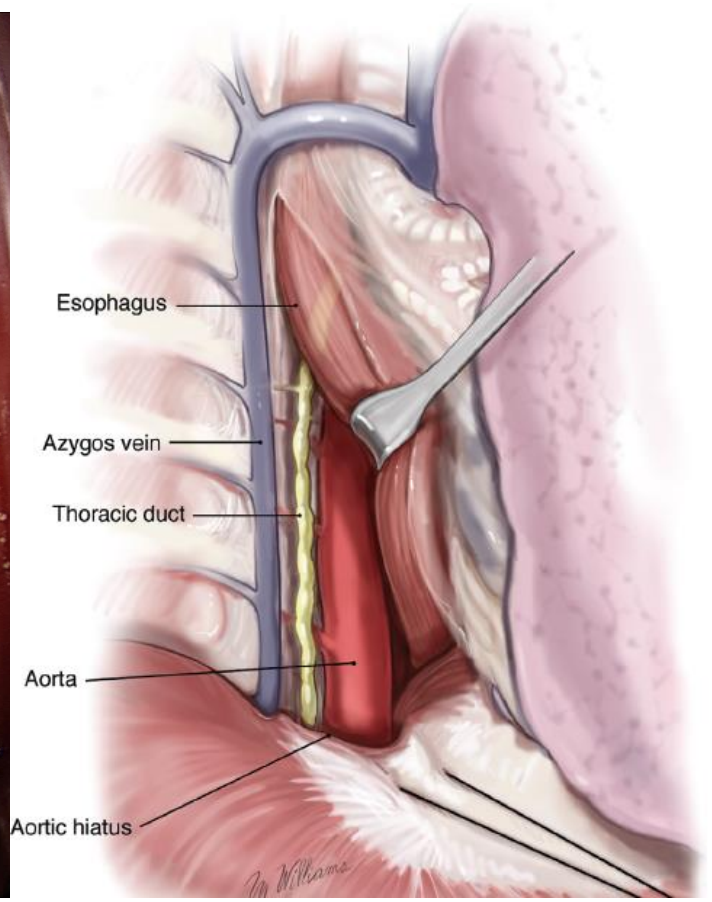
Success rate : 45~71%
Contralx: previous abdominal OP.

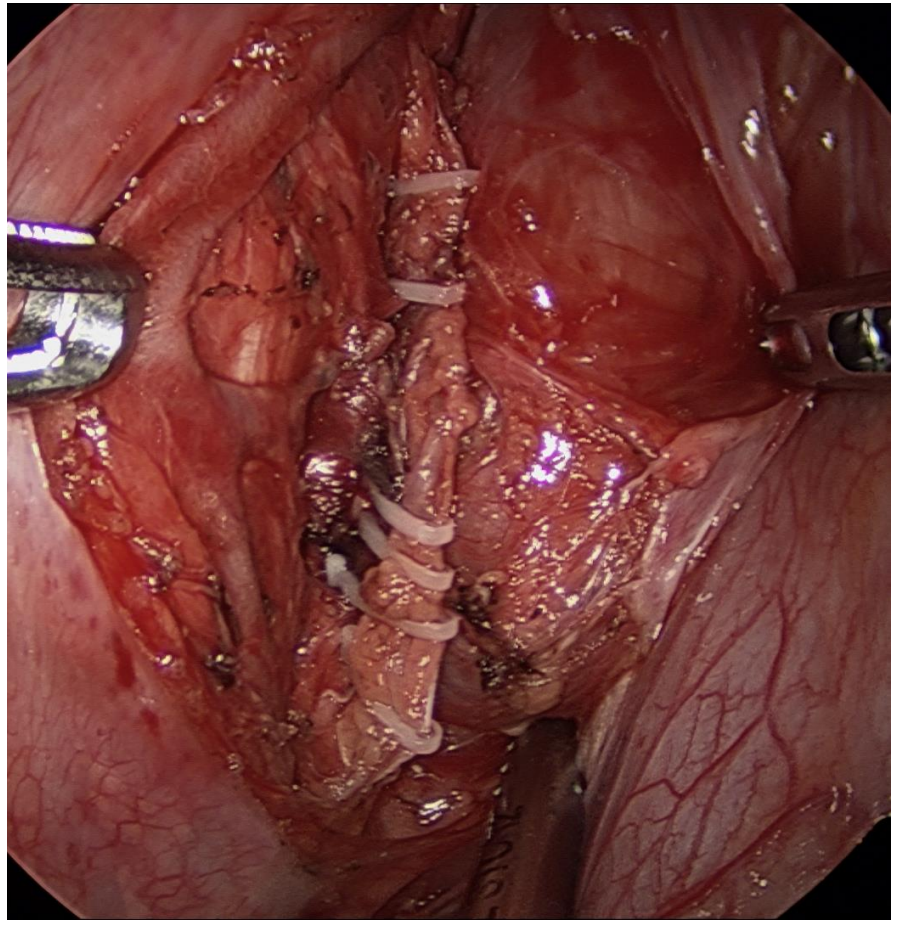




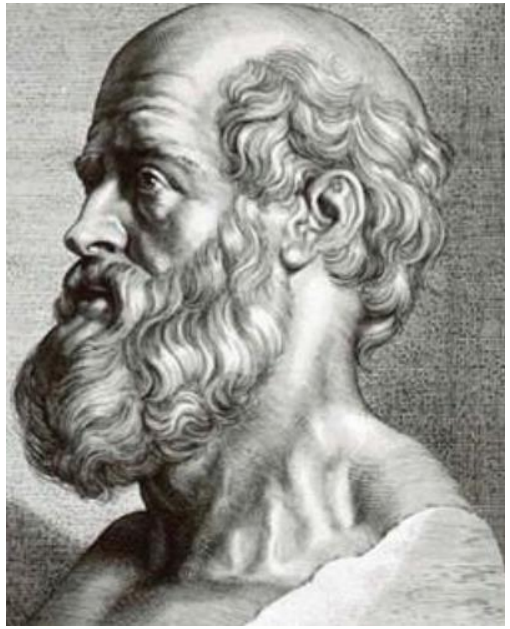
Thoracic duct ligation







Empyema



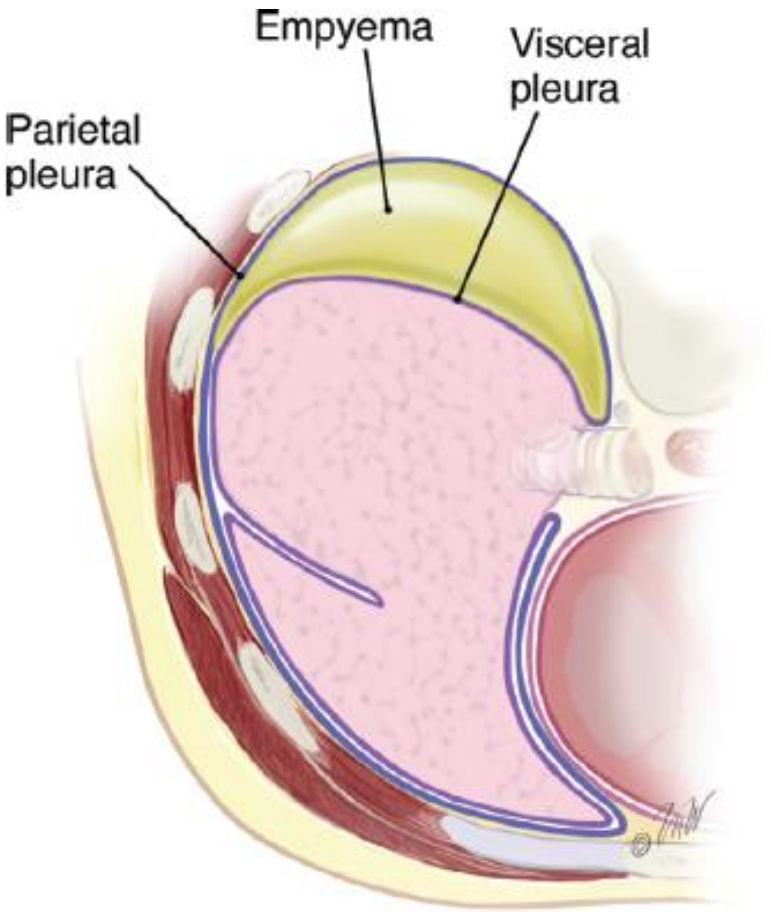
(460-370B.C)

- Hippocrates
  : drainage operation for empyema

When empyemata are opened by cautery or by knife; and the pus flows pure and white, the patient survives, but if it is mixed with blood; muddy and foul smelling, he will die

Empyema

Pus in a pleural space

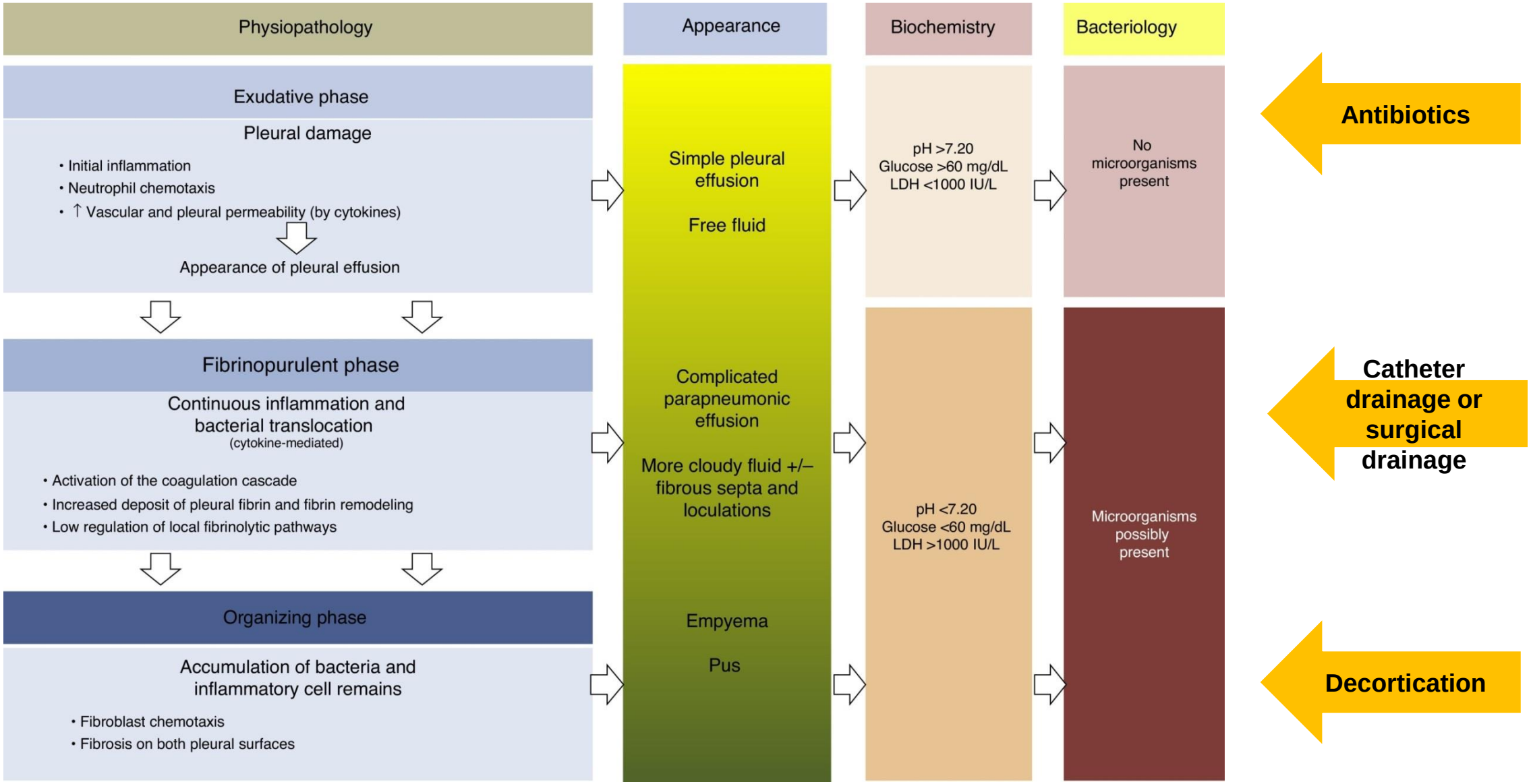


Empyema sac
Visceral & parietal peels
Narrow ICS
Chest wall contraction

- **Causes**
  - Bacterial pneumonia
  - Tuberculosis
  - Post-resection

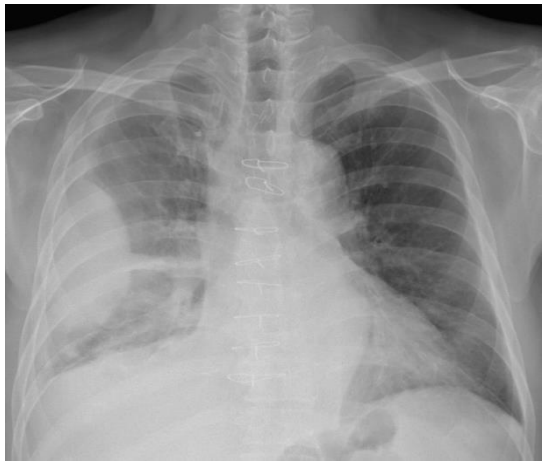
    ;postpneumonectomy
  - Post traumatic
  - Intra-abdominal process

Evolution from parapneumonic effusion to empyema



VATS decortication

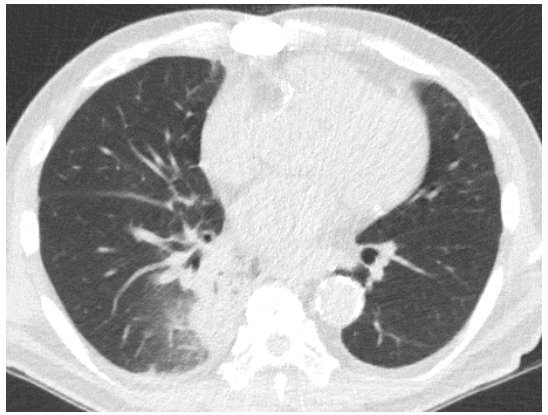
mild fever, cough, sputum



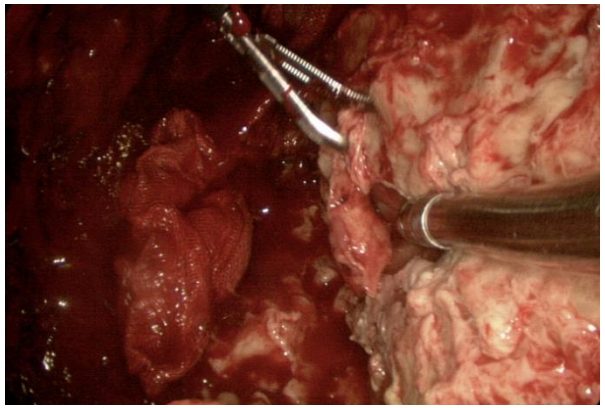
Large amount effusion

PCD insertion, no change

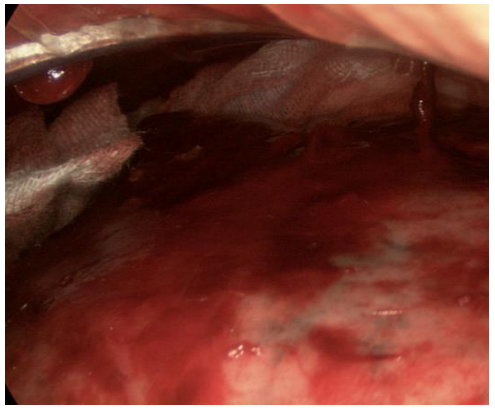
1 year after VATS decortication



RLL basal segment, infiltration



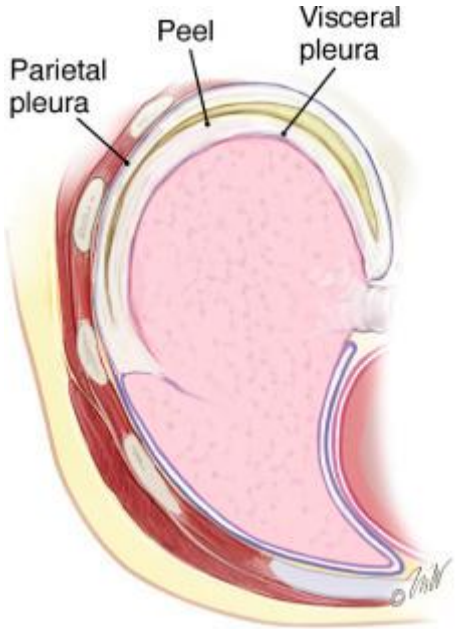
VATS decortication

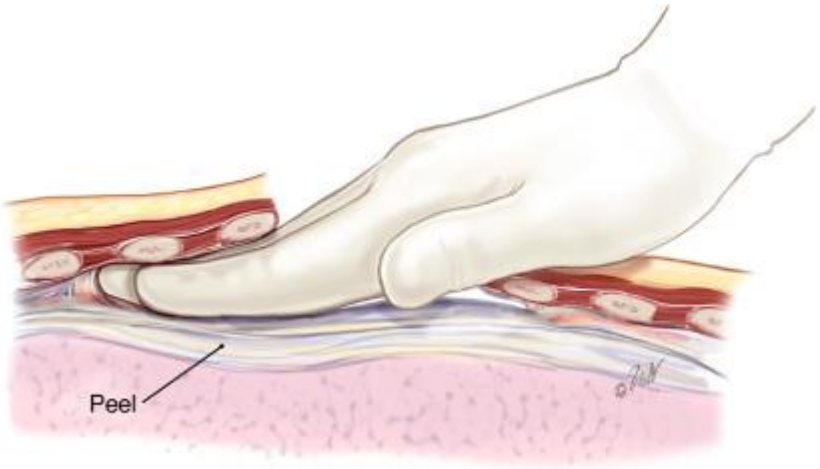


Well expansion

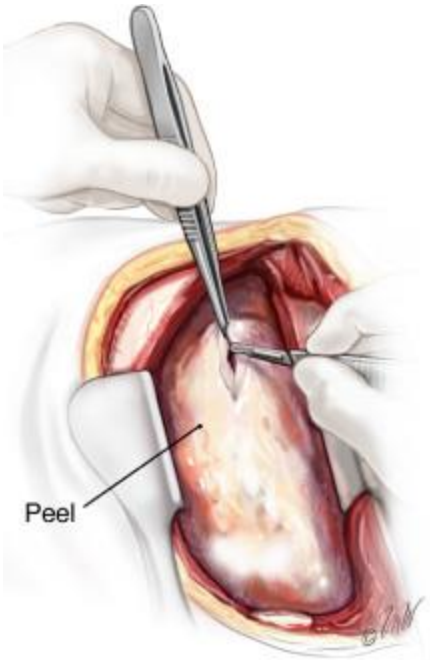
Empyema_Decortication

Timing-controversial





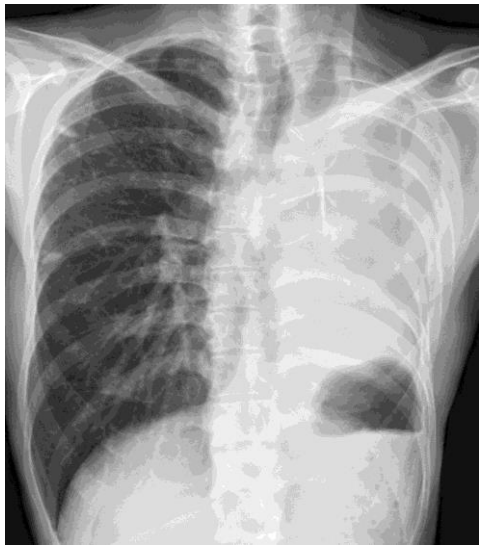
Extrapleural dissection
Parietal peel
Careful of major vessels
Bleeding control-gauze,,,,

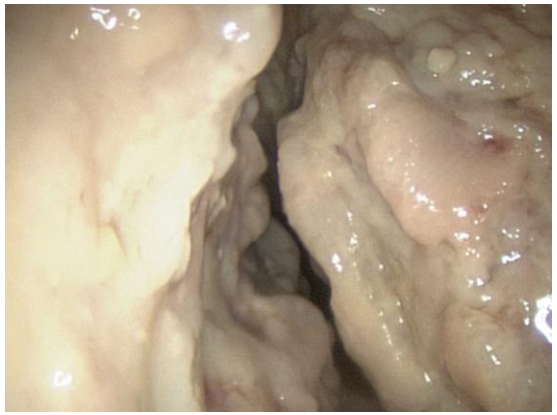


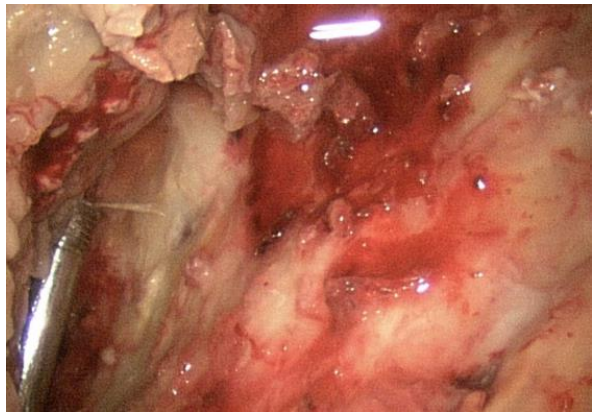
During CPAP or ventilation
Minimizing lung injury

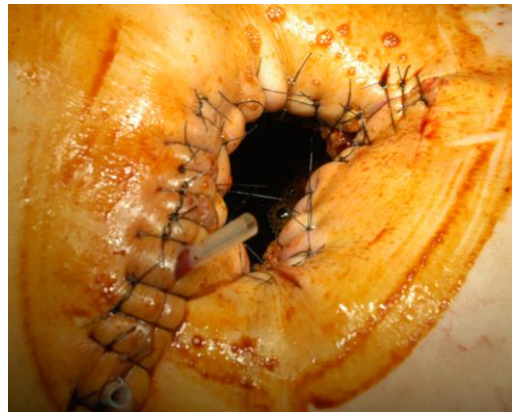
more than 6 weeks
maturation of the pleural peel
establishes a plane of dissection

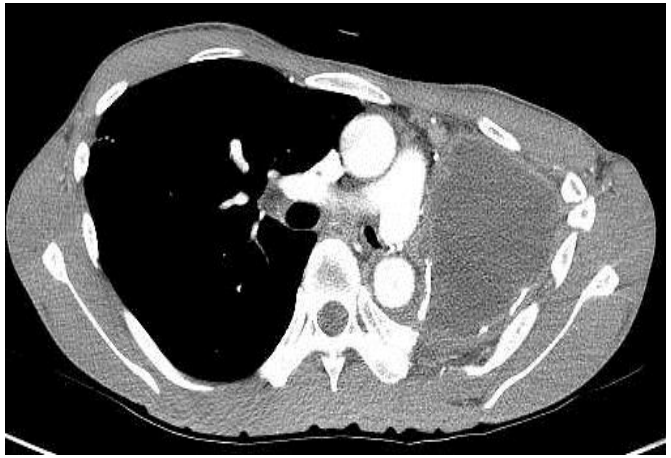
Postpneumonectomy empyema

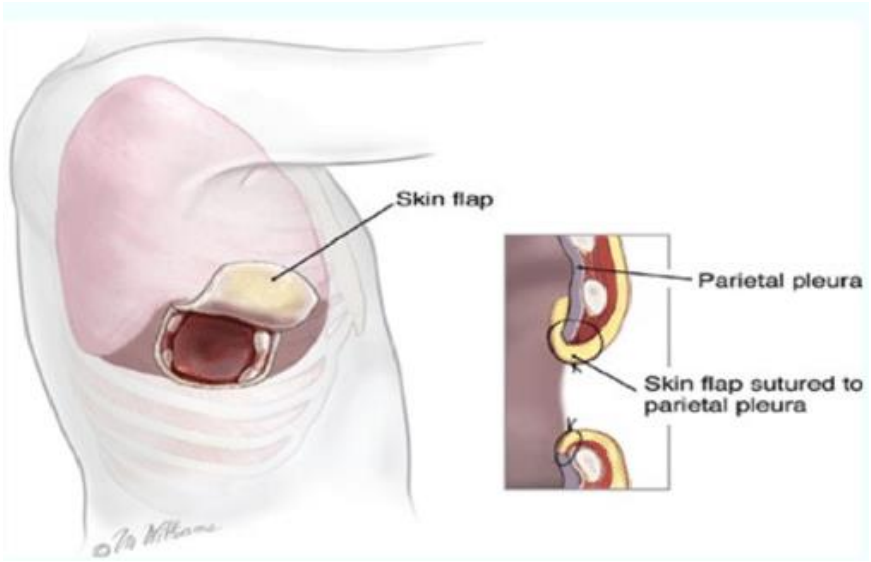










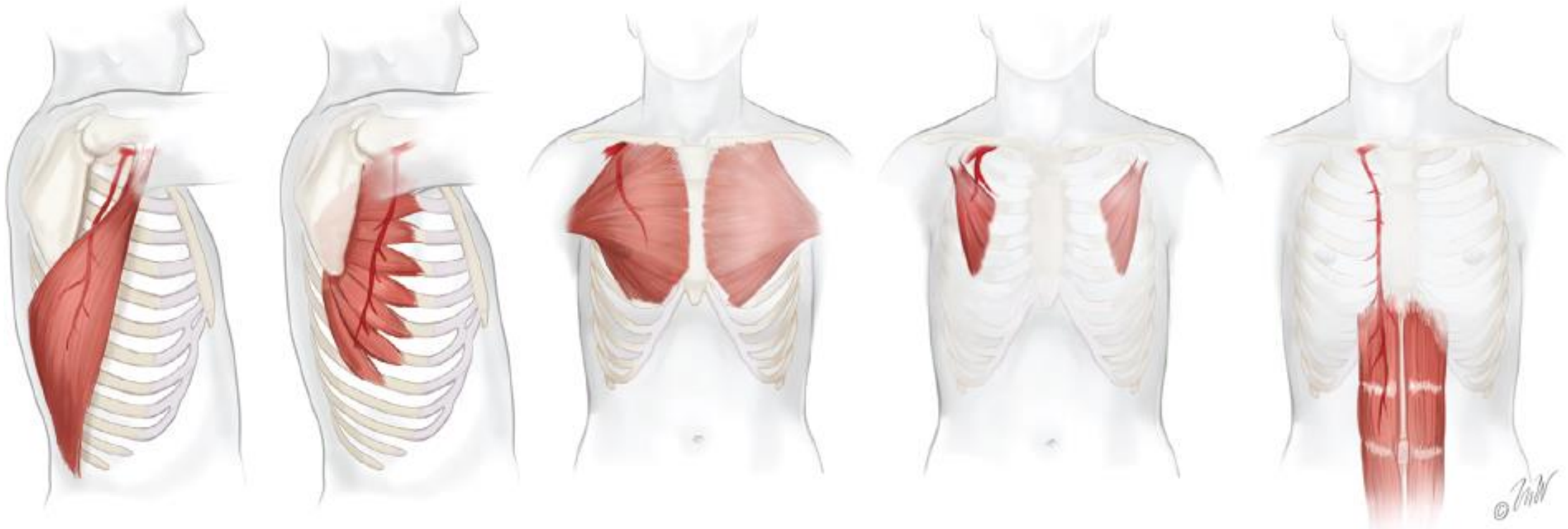


Open thoracic drainage
:Eloesser procedure

Space sterilization

Space filling procedure
:Muscle transposition
:Omental flap

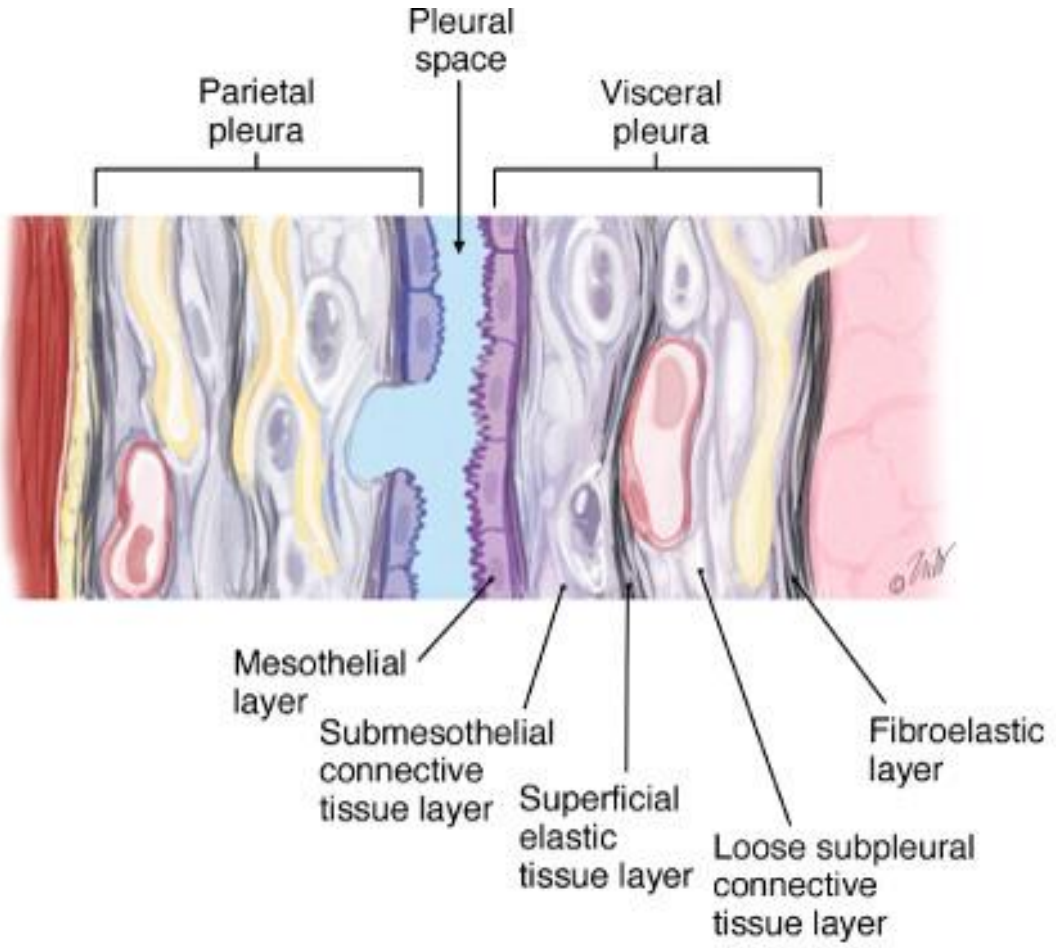
Extrathoracic muscle flaps



	Latissimus dorsi muscle – thoracodorsal artery	Serratus anterior muscle – lateral thoracic artery	Pectoralis major muscle – thoracoacromial artery	Pectoralis minor muscle – thoracoacromial artery	Rectus abdominis muscle – superior epigastric artery
Muscle:					
Artery :					

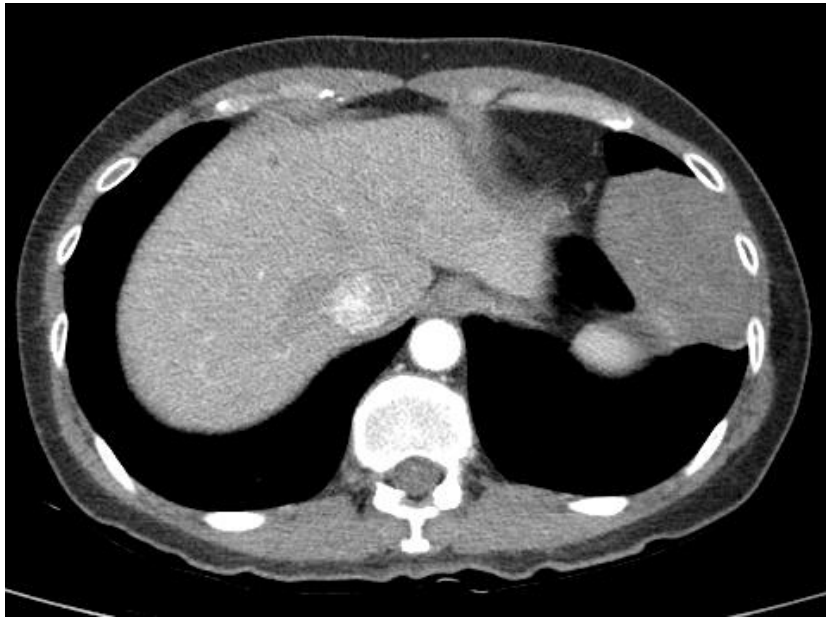
Benign tumors of the pleura

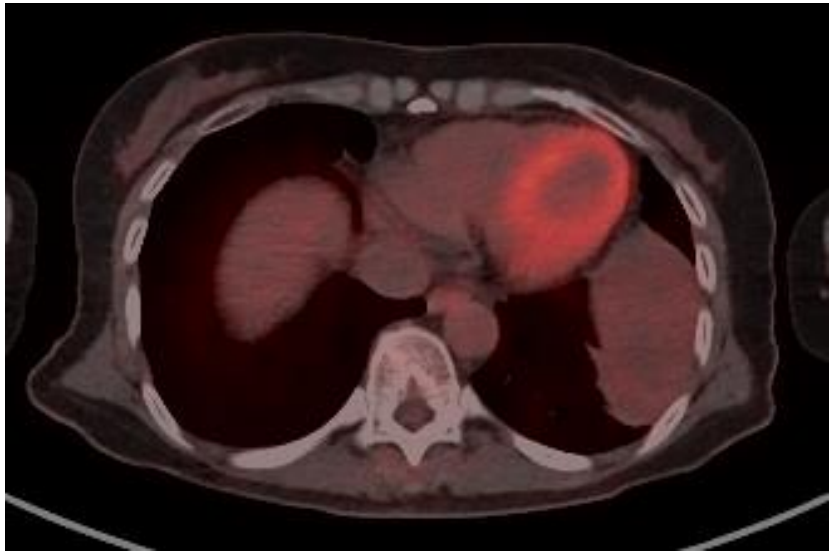
- **Solitary fibrous tumor**
  - 5% Hypoglycemia (Doege-potter synd)
- Lipoma, lipoblastoma
- Adenomatoid tumor
- Calcifying fibrous tumor

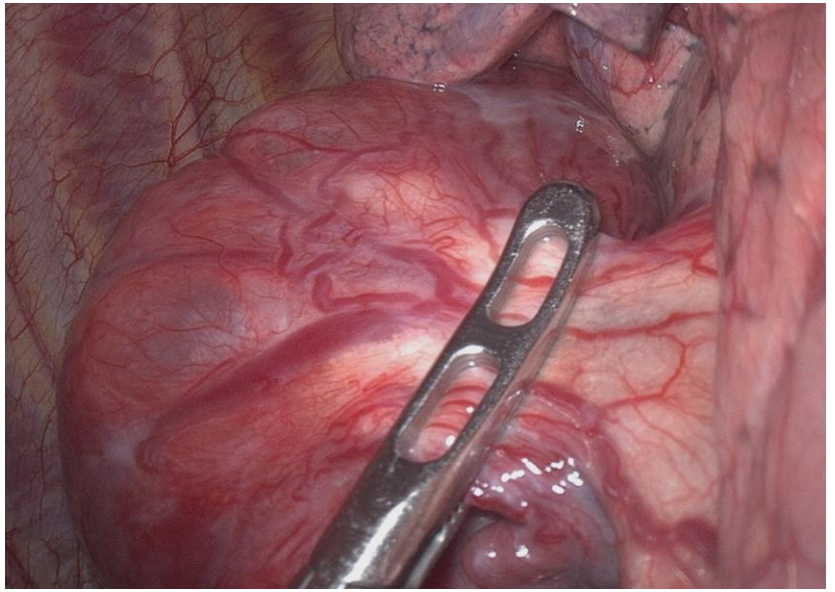


5 layers of pleura
SFT originate from mesenchymal cell in submesothelial layer

Solitary fibrous tumor







- Malignancy
- ✓ 12%
- ✓ especially if size >10 cm,
- ✓ heterogenous feature on CT

- Visceral pleura > parietal pleura
- Pedunculated
- Hypervascular pedicle
- Complete resection

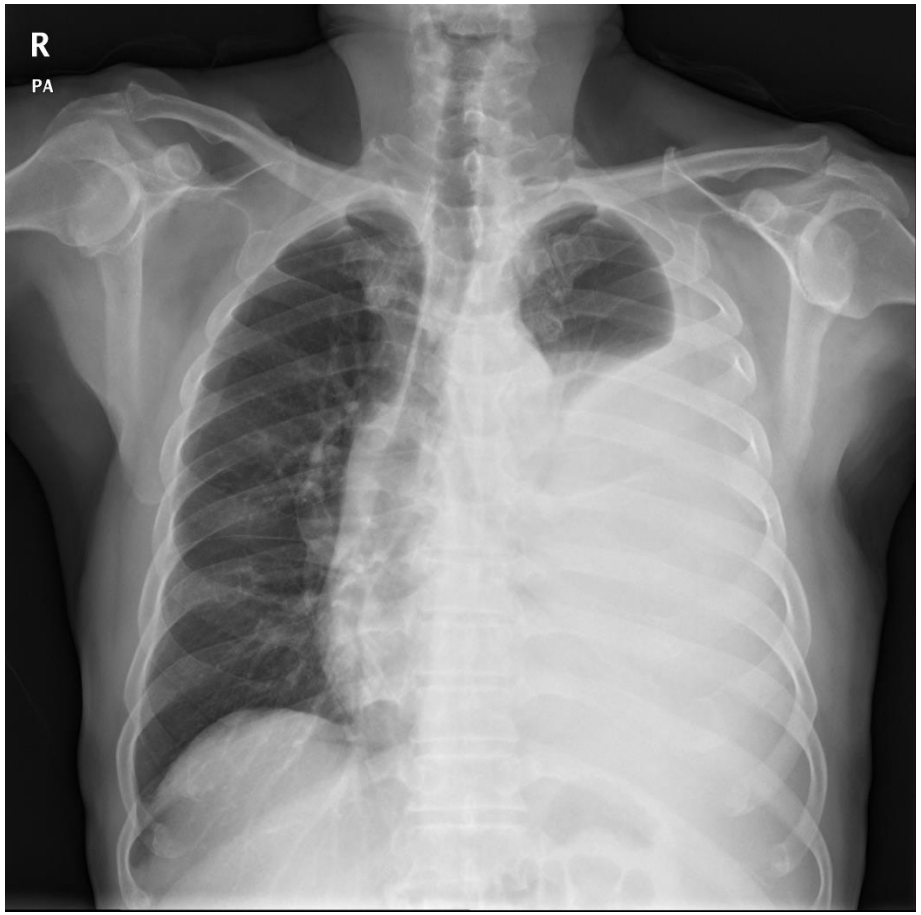
  (+wedge or lobectomy)

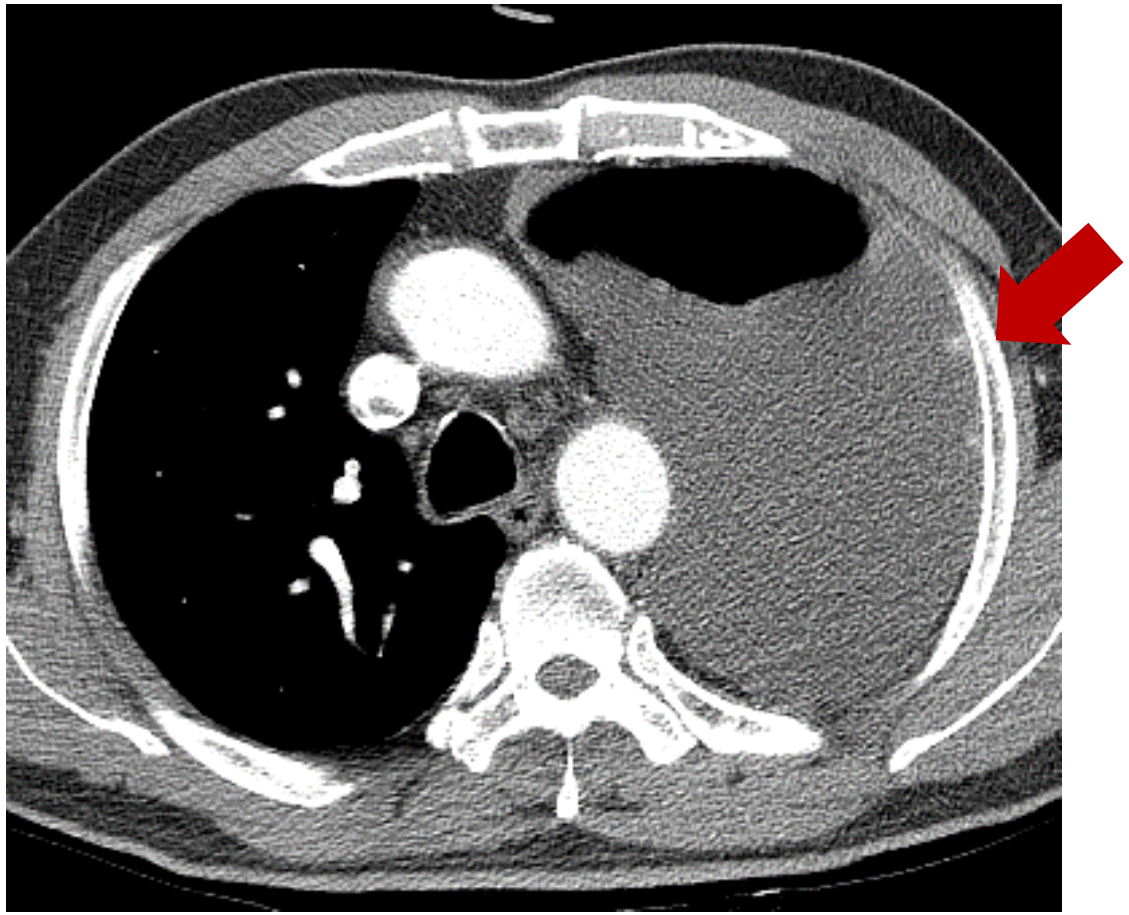
Malignant pleural mesothelioma (MPM)

- **Mesothelium of the pleural surface**
  - peritoneal mesothelium, pericardial mesothelium, tunica vaginalis mesothelium
- **Incidence** 1-2/million (80% of pleural mesothelioma)
- **Etiology** Asbestos (70% of cases), latent periods; **40 (25-70) years**
- **No clinical signs**
- **Poor prognosis** Median survival of less than 1 year from the time of diagnosis

	Proportion (%)	Median survival (months)
Epithelioid	50-70	21.5
Mixed or biphasic	30	11.8
Sarcomatoid	10-20	0.8

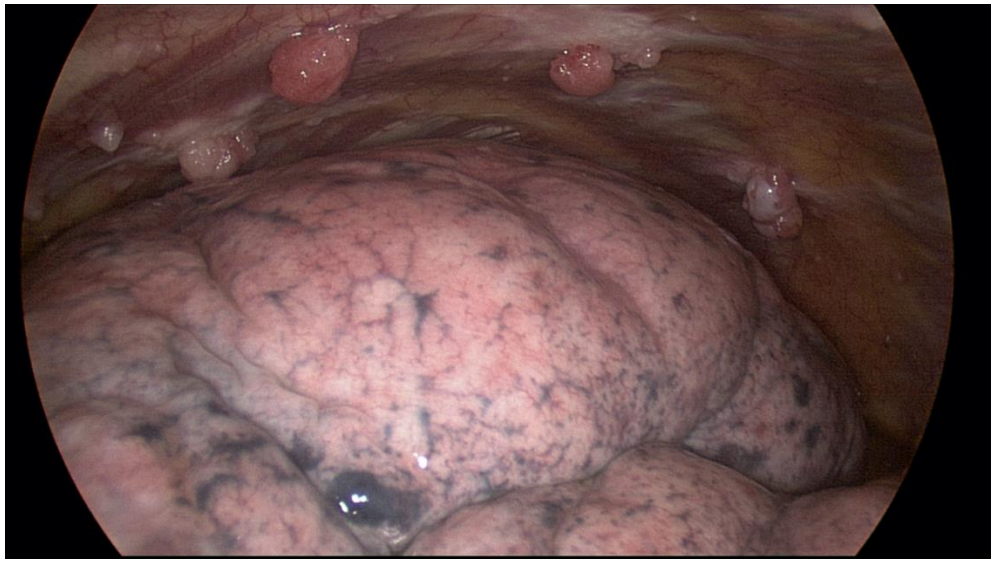
M/73, Recurrent hemothorax, Left





massive bloody effusion, mediastinal shifting, pleural nodularity

Thoracoscopic evaluation



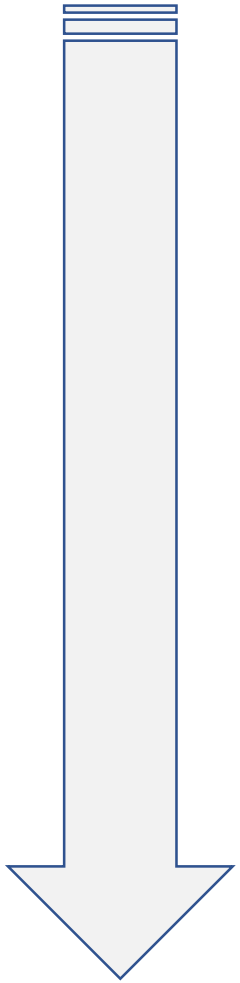
- Partial pleurectomy
- Minimizing ports
- Extents, visceral pleura, diaphragm
- Lavage cytology
- Biopsy; MPM, biphasic
- **IHC; Calretinin+, vimentin+, CK5/6+, TTF-1 –**
- Talc pleurodesis, optional

EPP (ExtraPleural Pneumonectomy)

- Surgical extents
  - ✓ Partial pleurectomy
  - ✓ Pleurectomy and decortication (P/D)
  - ✓ Extended-P/D
  - ✓ **Extrapleural pneumonectomy (EPP)**

- **Indications of EPP**
  - ✓ Good performance status
  - ✓ Epithelioid or mixed histology
  - ✓ N0 status

Definition of surgical procedures



Partial parietal & visceral pleura

→ VATS partial pleurectomy (v-PP)

Total parietal & visceral pleura

→ Pleurectomy and Decortication (P/D)

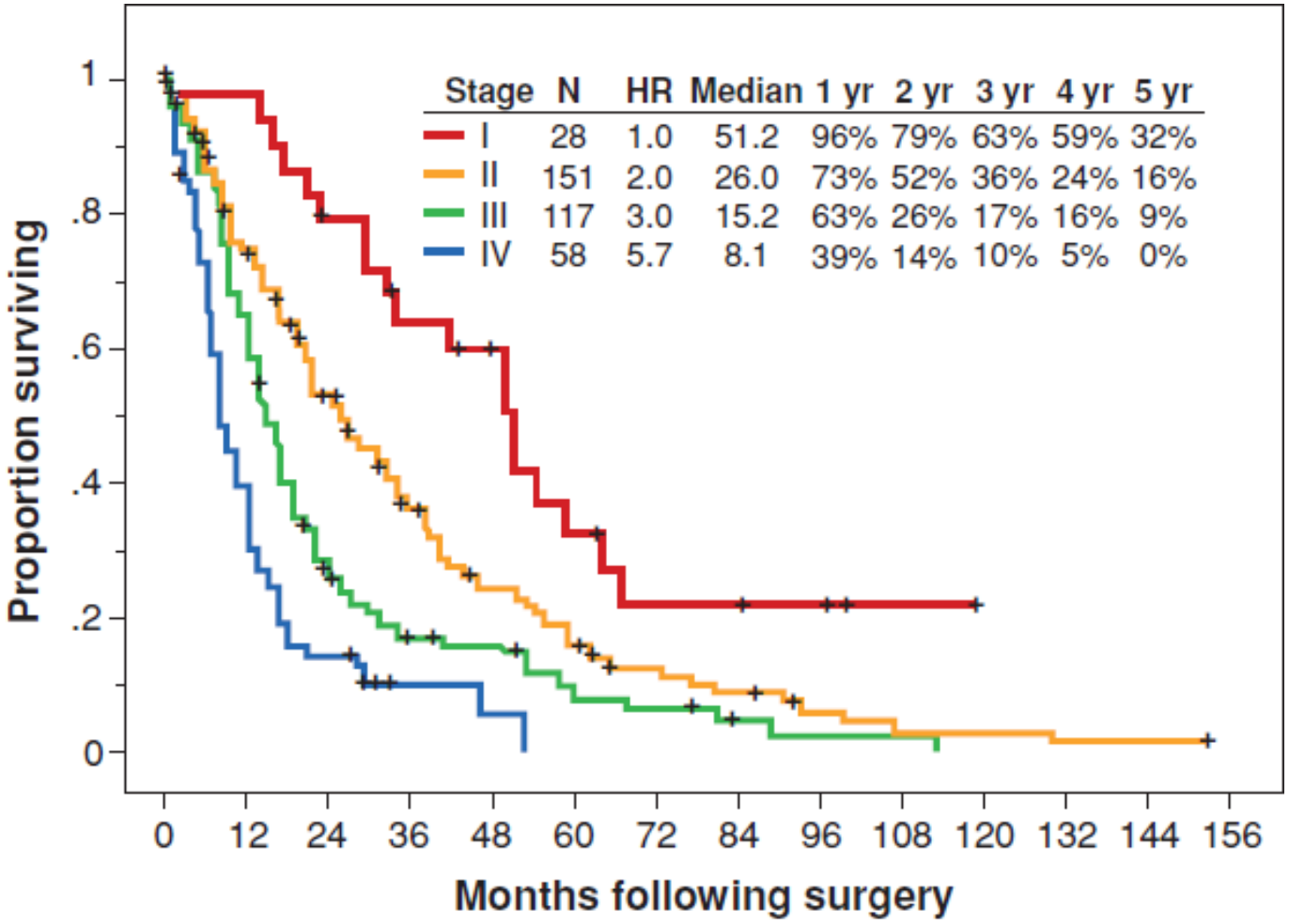
Pericardium, Hemidiaphragm

→ extended–P/D (e-P/D)

above all + Lung

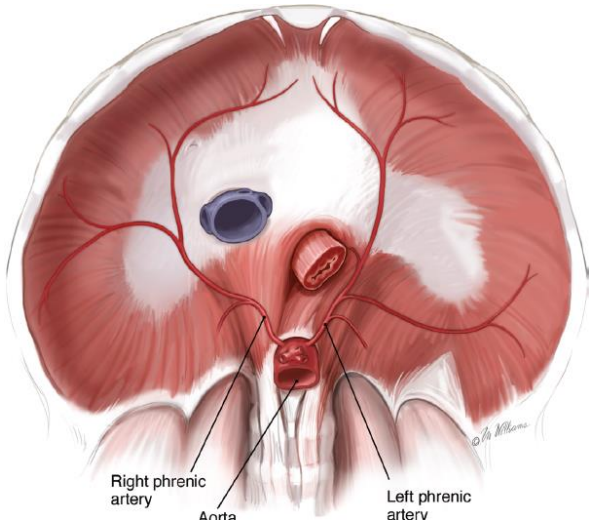
→ Extra-pleural Pneumonectomy (EPP)

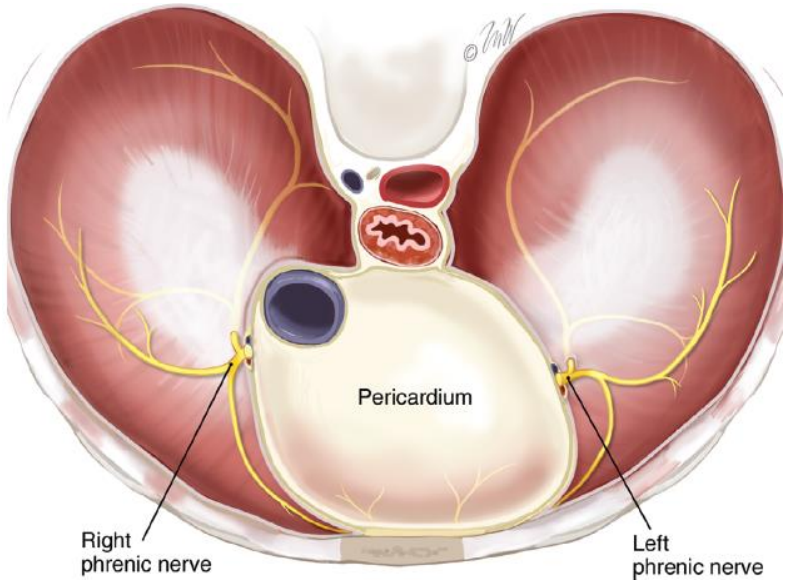
Survival according to pathologic stage

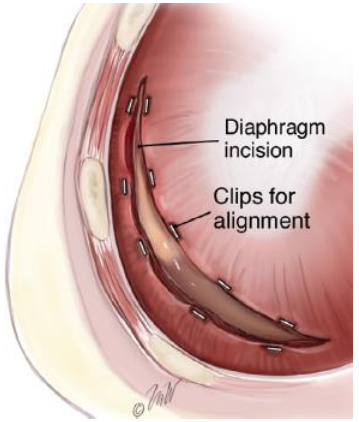


Cancer. 2010;116: 1510–1517

Diaphragm, incision

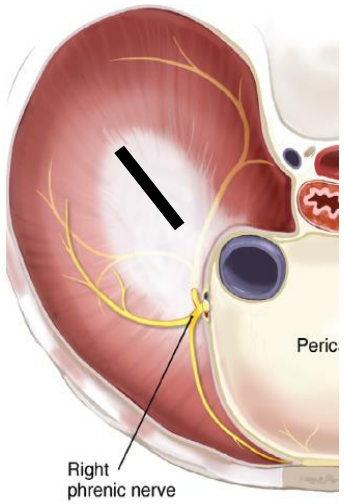


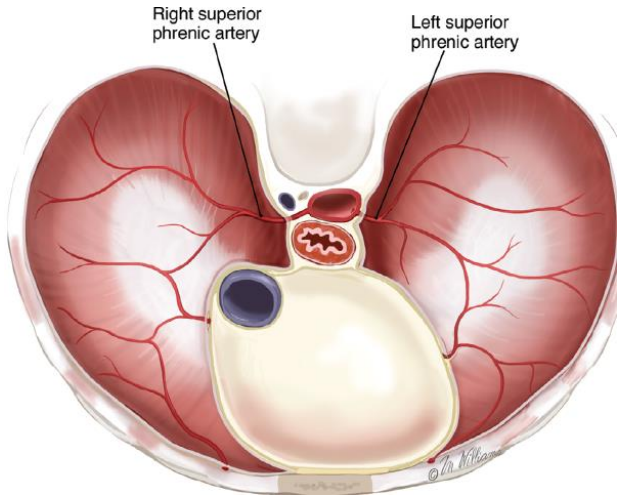




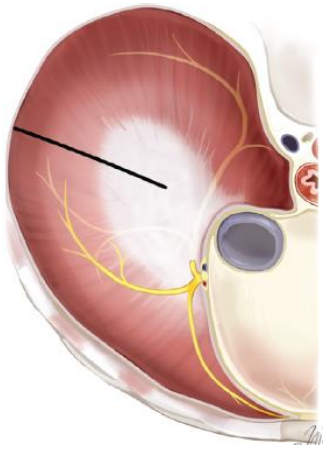
circumferential

central tendon



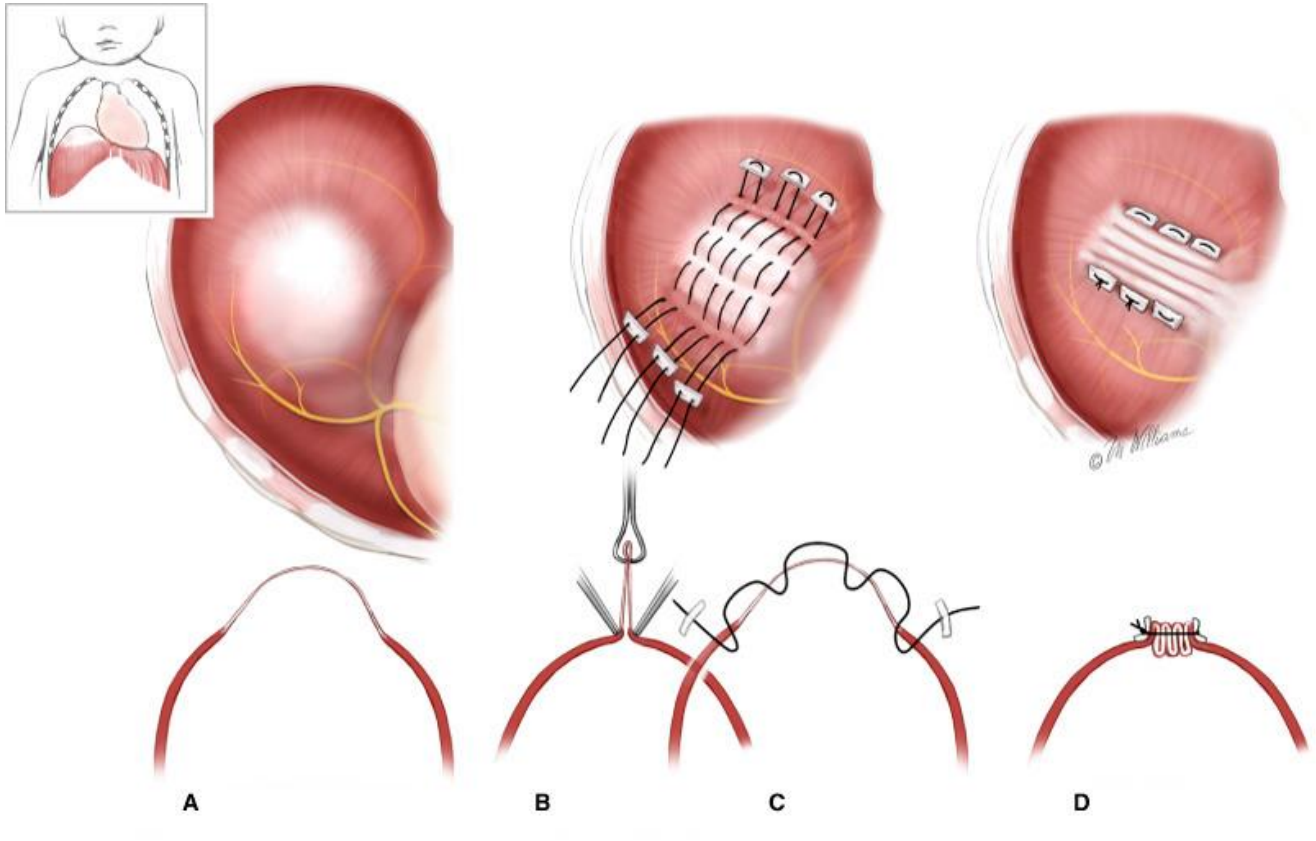


- Major blood supply :
  - pericardiophrenic
  - musculophrenic (from the internal thoracic artery)
  - superior phrenic (from the thoracic aorta)
  - inferior phrenic (from the abdominal aorta) arteries

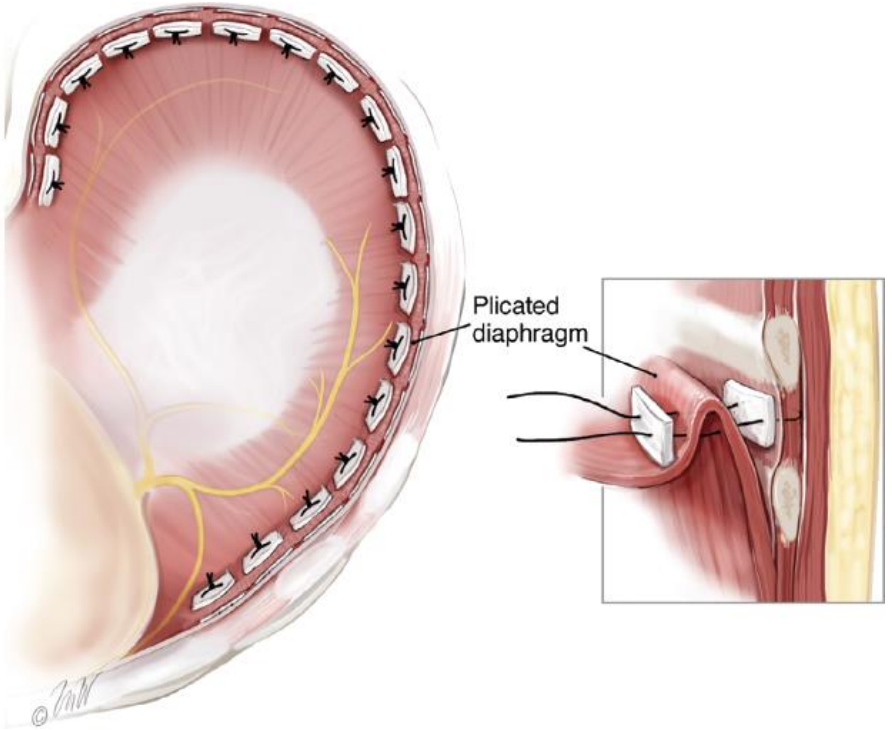


radial

Diaphragmatic Plication

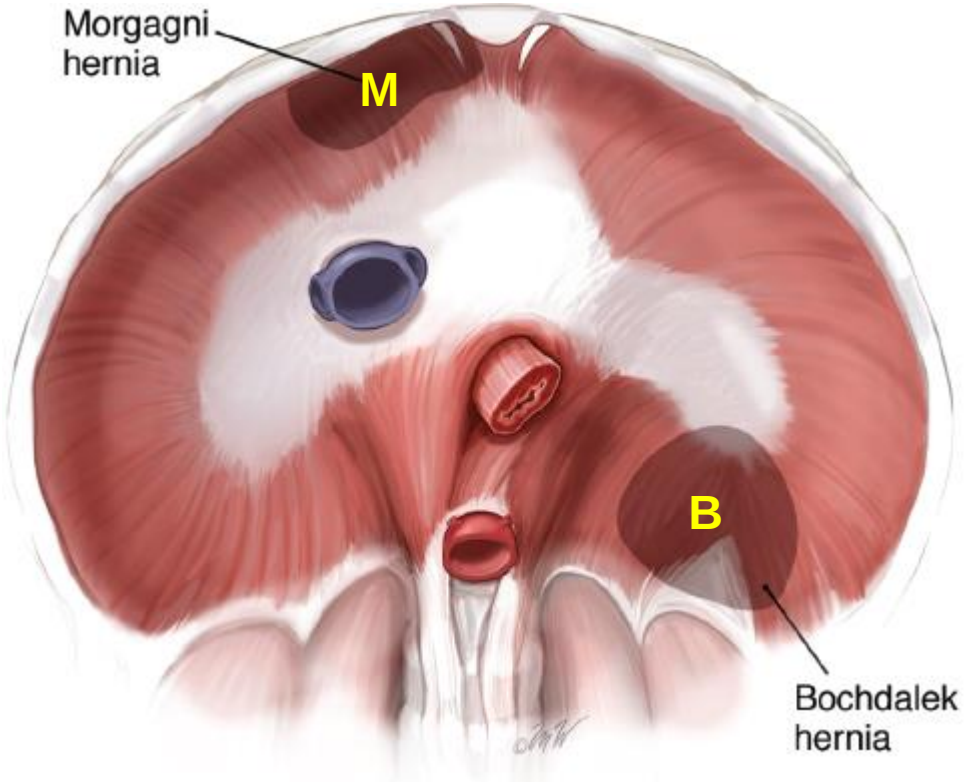


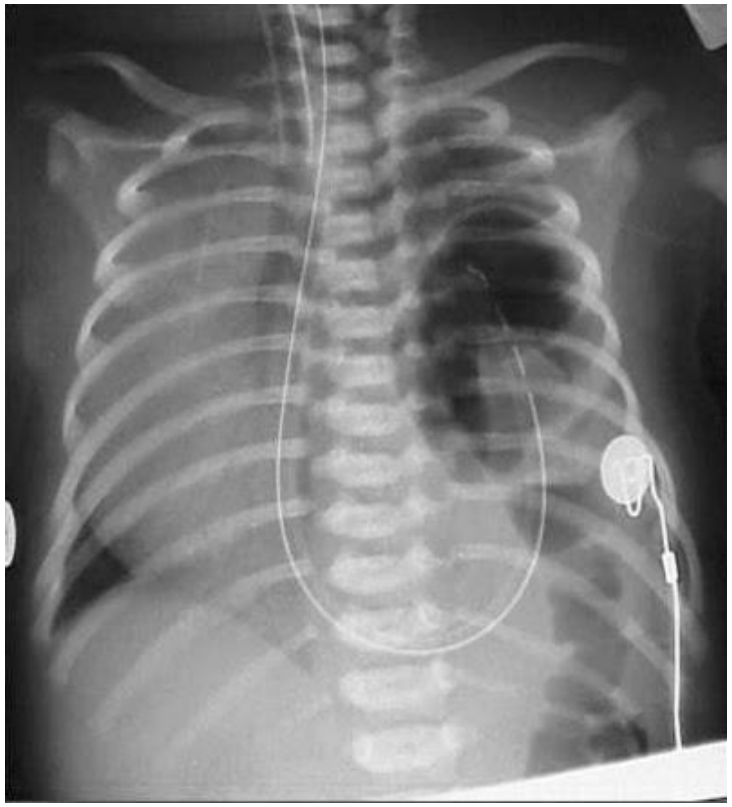
Central imbrication technique



Radial plication technique

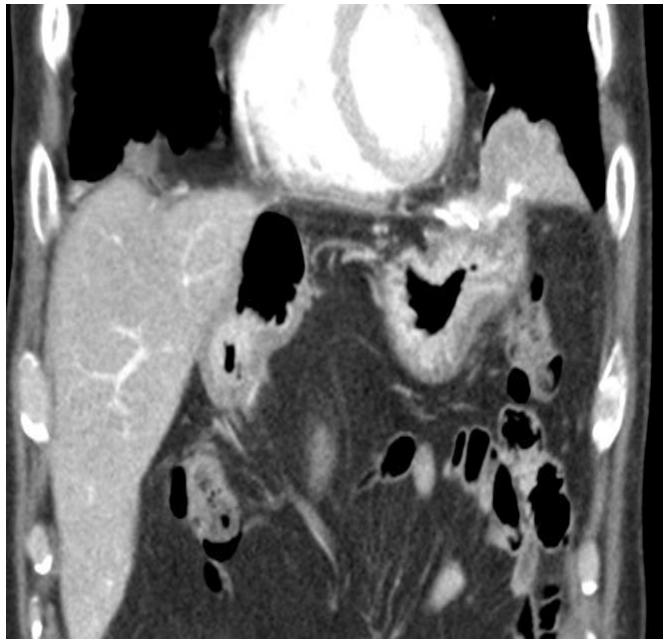
Congenital Diaphragmatic Hernia (CDH)





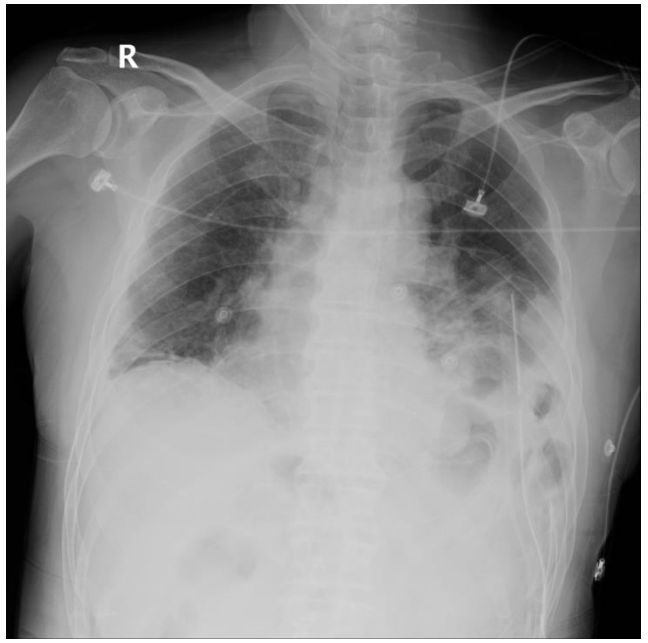
Baby, Bochdalek hernia, respiratory failure

Diaphragmatic rupture



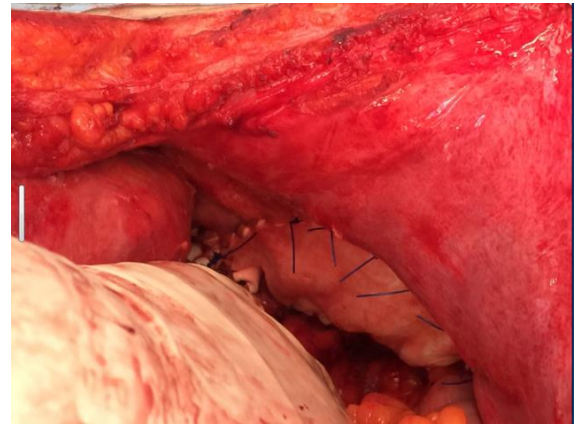
r/o local recurrence @ Lt diaphragm, s/p left hemihepatectomy with en-bloc Lt. diaphram excision for HCC

Diaphragm resection, Lt. with En-bloc splenectomy, resection of LLL, reconstruction of diaphragm with 2 mm Gore-Tex patch via laparotomy



POD #1 day
r/o diaphragmatic rupture

Reoperation



Thank You

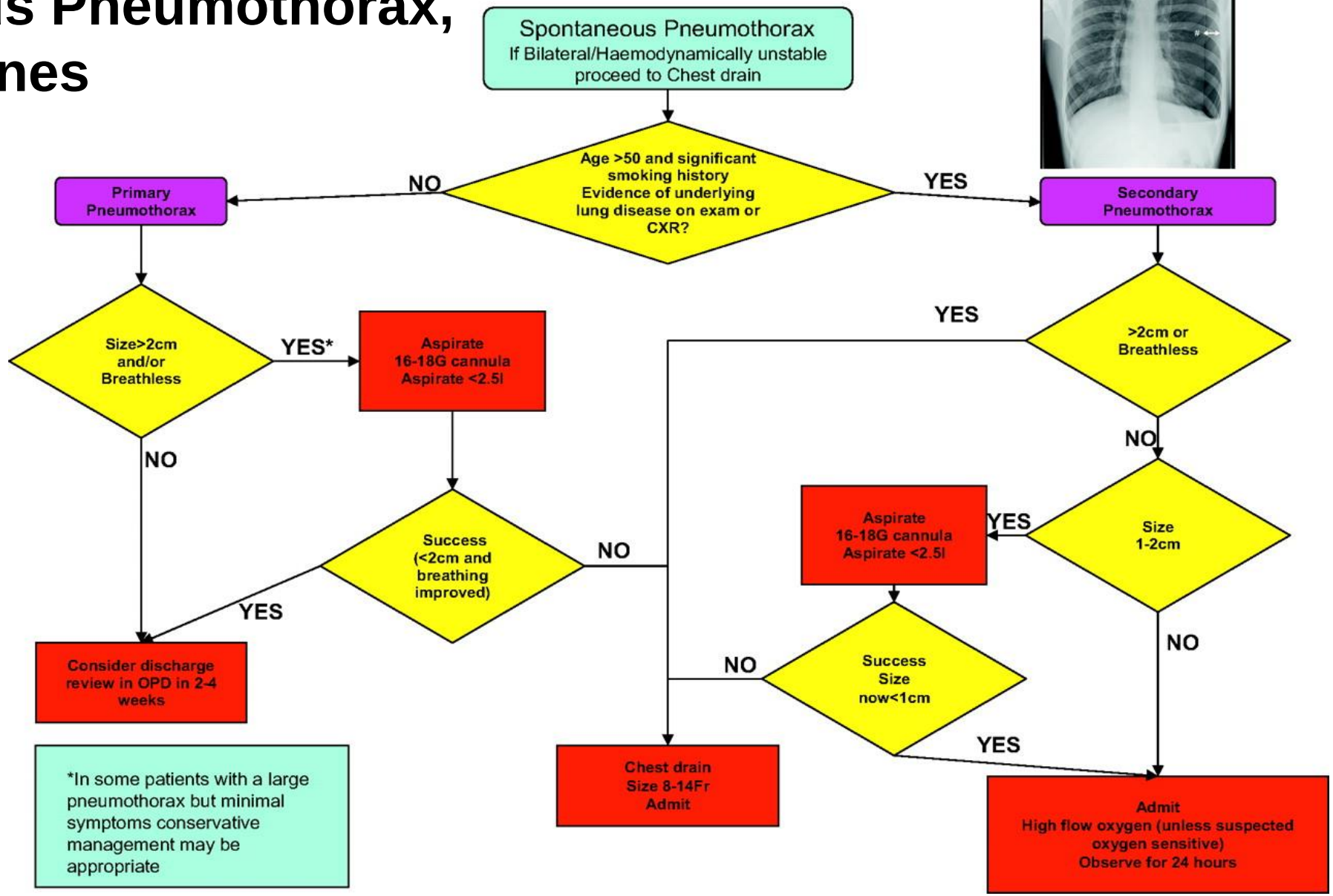
Q & A

skcho@snubh.org

Supplemental slides

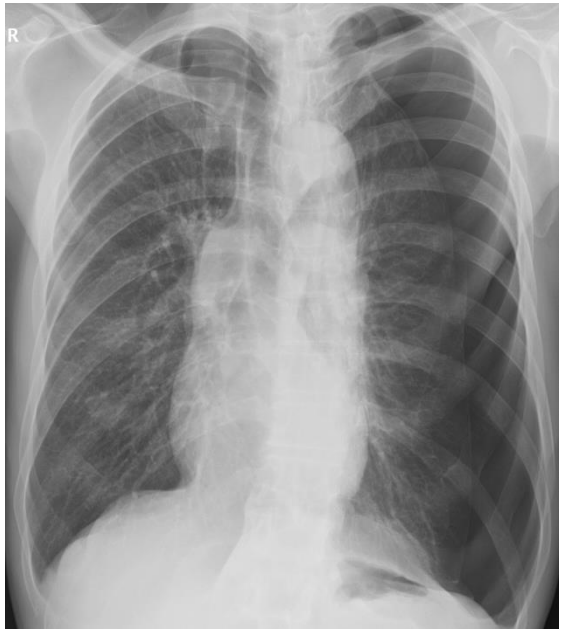
Pneumothorax

Management of spontaneous Pneumothorax, BTS guidelines

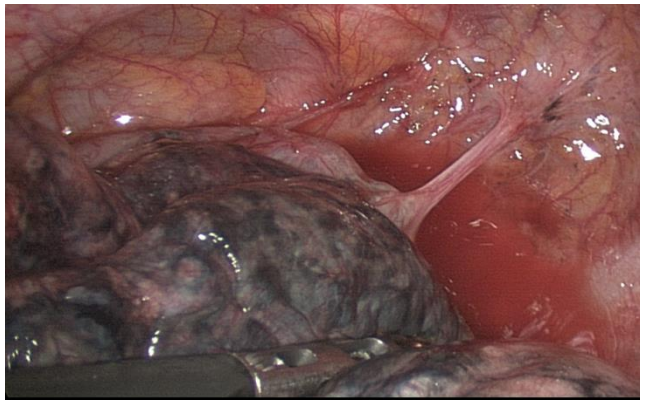


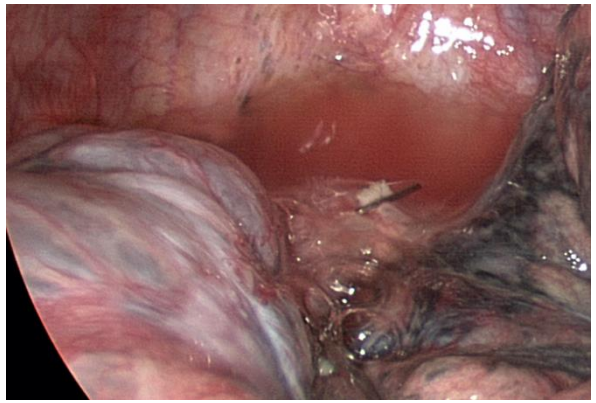
Thorax, 2010

SSP, M/65, COPD, recurrent, Left

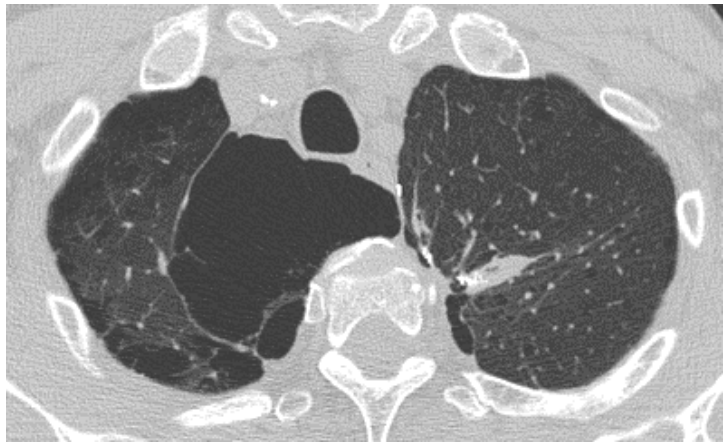


Preoperative





Intraoperative findings, adhesive bands, multiple bulla, air leak points, reinforcement by Gore-tex membrane

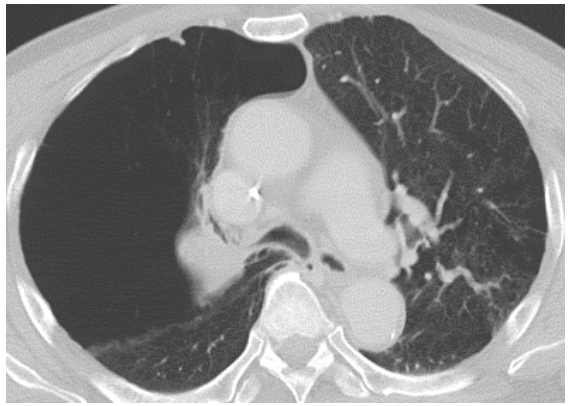


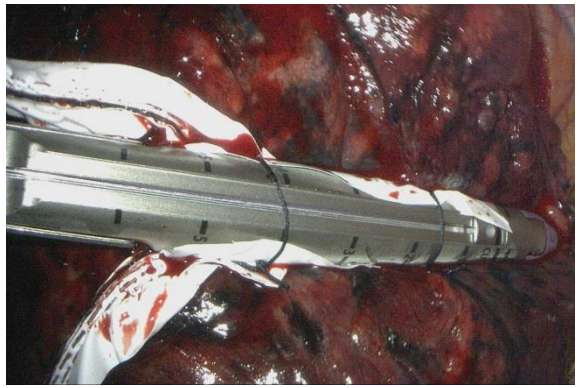
Postoperative

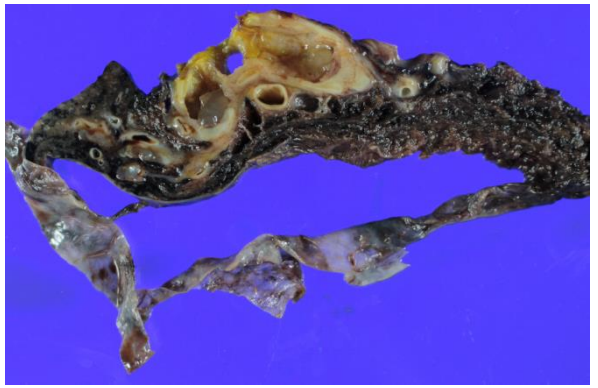
Management

1. Tube thoracostomy
2. Chemical pleurodesis using Talc
3. Surgical treatment
   - Adhesiolysis
   - Wedge resection of air leak points
   - Pleurodesis
     - Talc
     - Pleurectomy

Giant bulla, M/72, COPD







Preoperative PFT

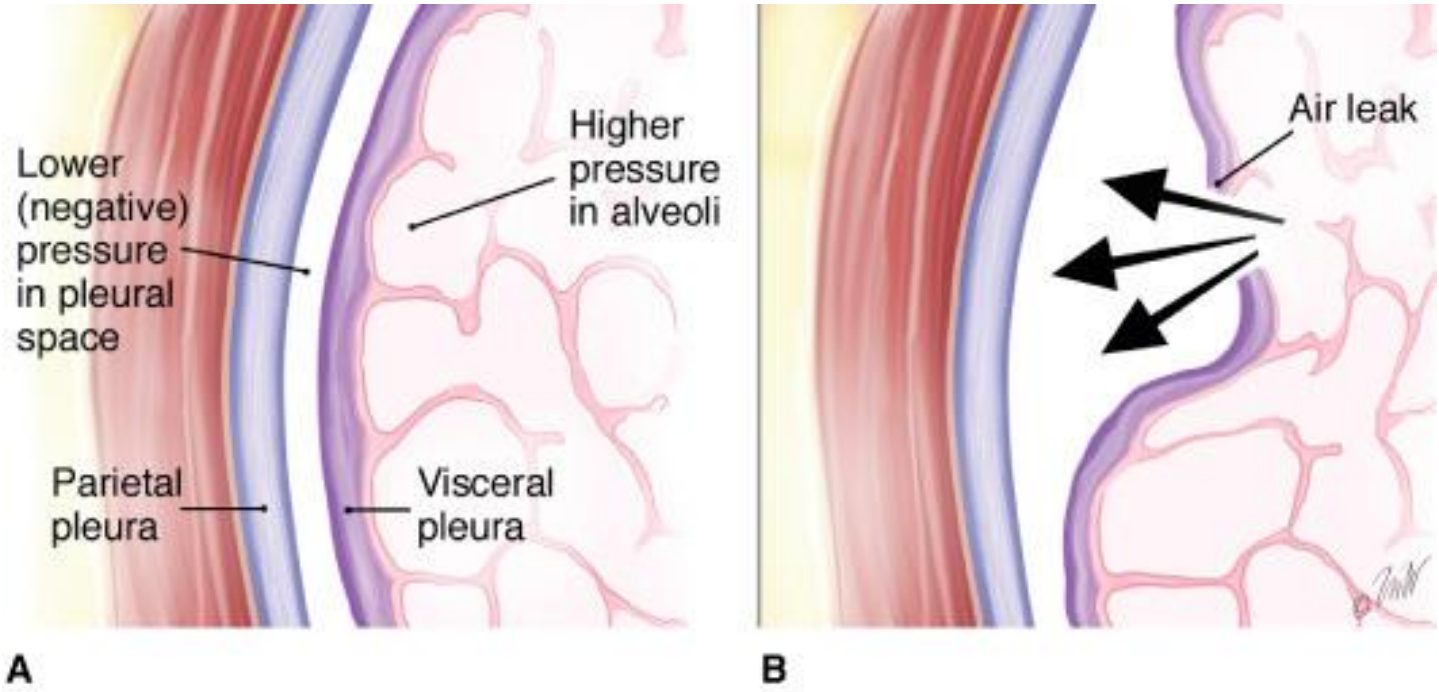
FVC 1.31 (34%)
FEV1 0.33 (12%)
FEV1/FVC 25%

Cartridge covered with GT membrane

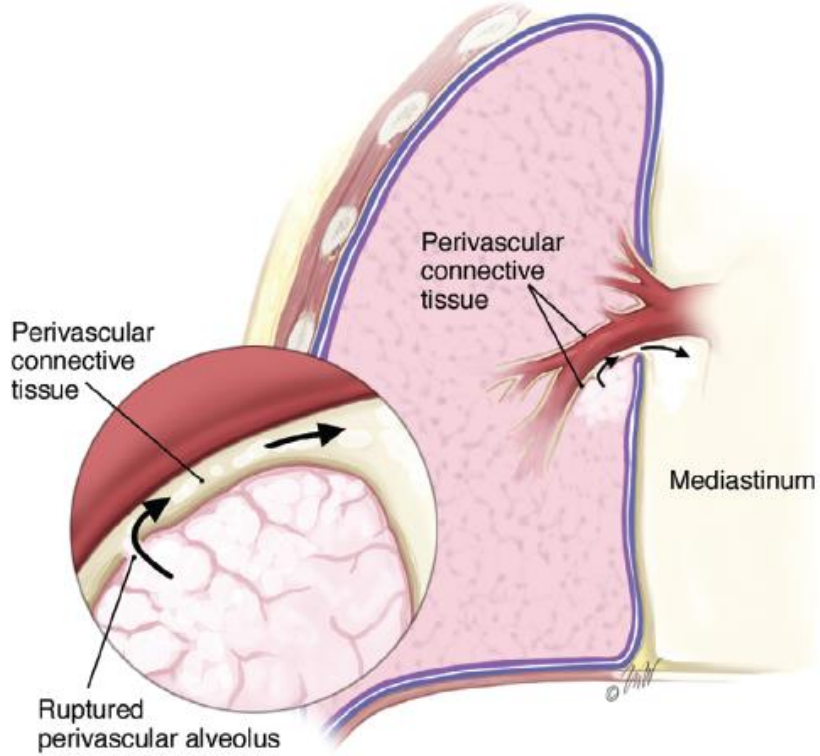
Postop. 2 year PFT

FVC 2.85 (77%)
FEV1 0.79 (31%)
FEV1/FVC 28%

Pneumomediastinum

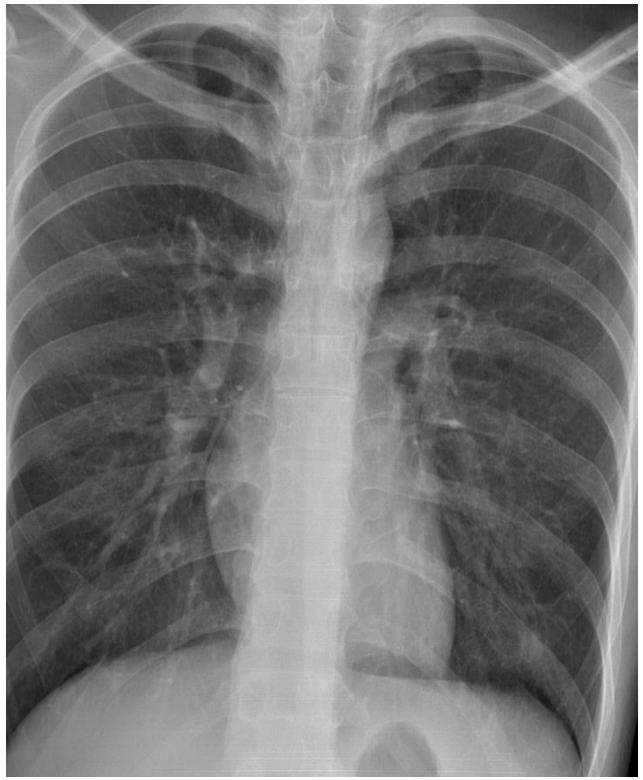


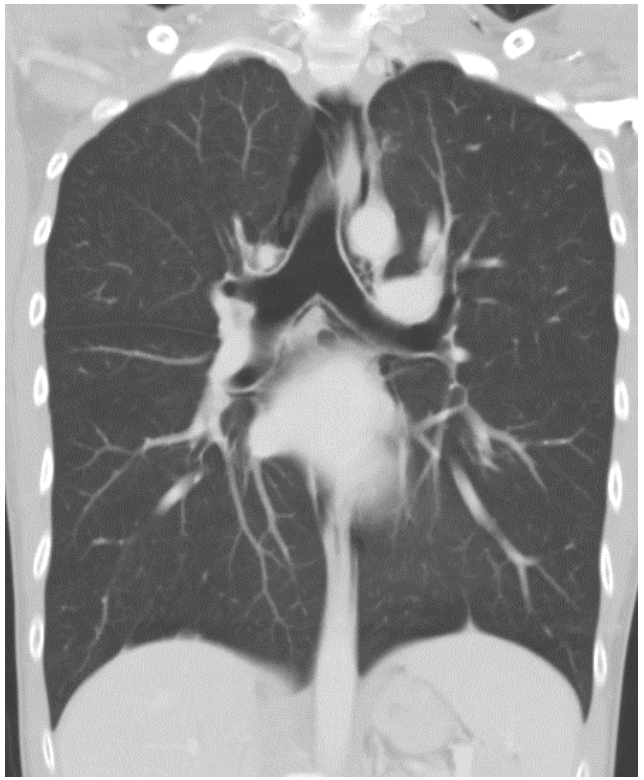
Mechanism of Pneumothorax

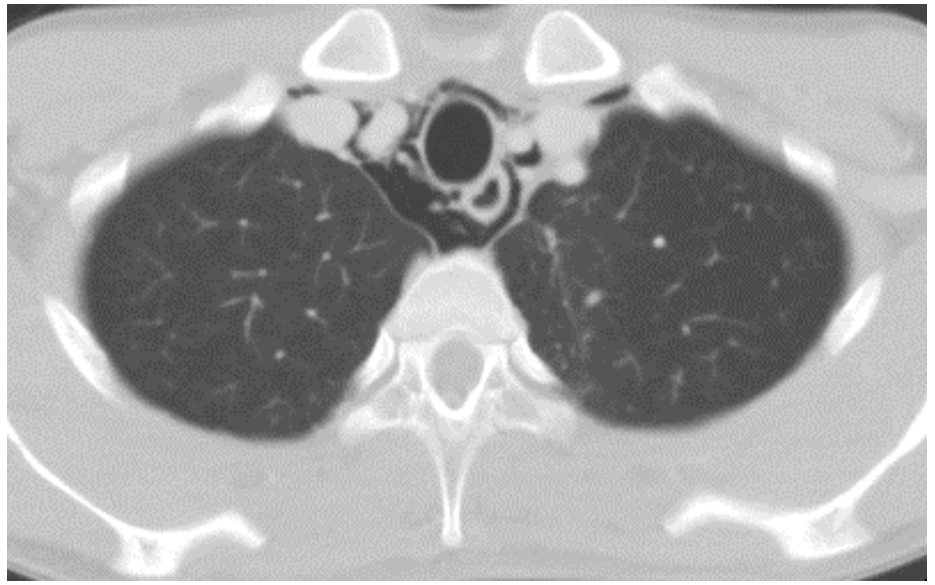


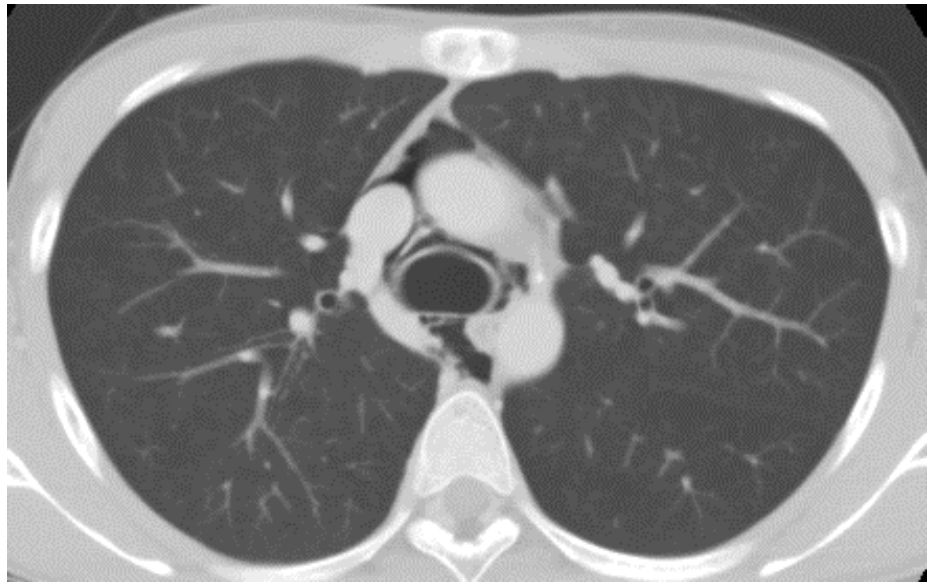
Mechanism of Spontaneous Pneumomediastinum

Pneumomediastinum





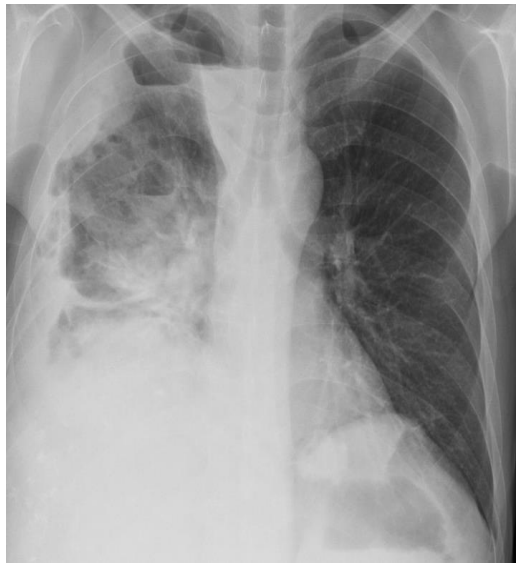


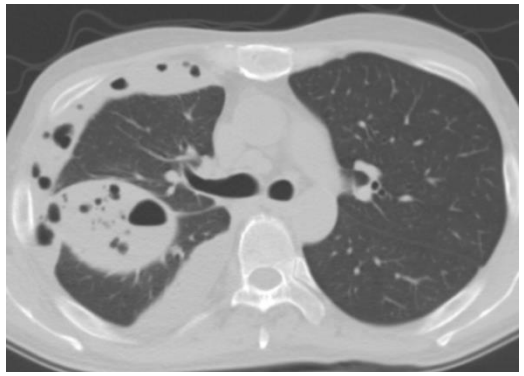
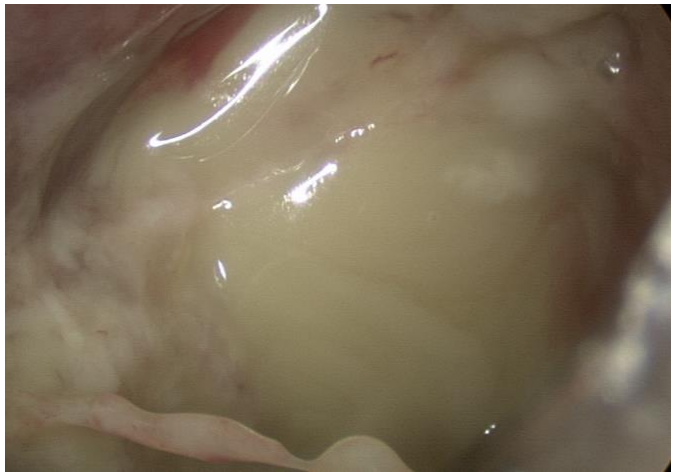


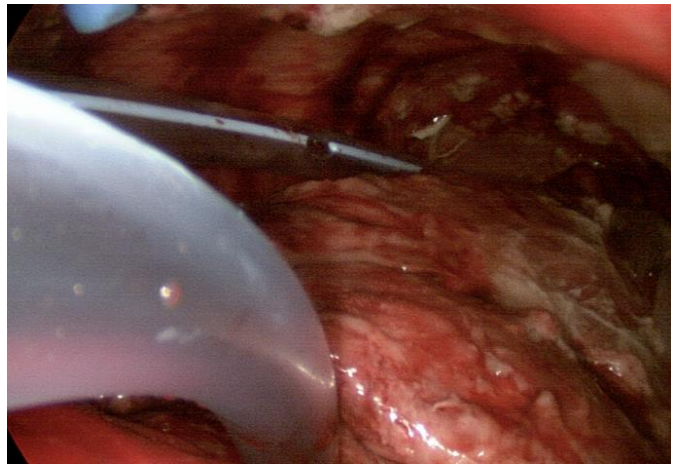
- Usually self-limiting
- Rule out serious causes such as esophageal perforation, tracheobronchial rupture

Pleural effusion

VATS drainage for parapneumonic effusion




Preoperative course

- CT; fissure, air bubble, septation
- PCD → pus, CXR; no change→ VATS

Intraoperative findings

pleural fibrin, pus, loculation, multiple drains, good position well expansion

Physiology of the thoracic duct

- Flow : 1.38 mL/kg/hr (varying 30~190ml/hr)
- Flow increases
  - after ingestion of food and water
  - During abdominal massage
- Flow upward by
  - Negative transdiaphragmatic pressure gradient
  - Muscular contractions of the duct wall (m/i)
  - Thoracic duct’s valves, mostly in the upper portion

Diagnosis

- Rate of accumulation: > 700~1200 mL/day in a 70kg adult
- Abrupt increase in chest tube drainage

- **Lymphangiography**
  - Provides useful information regarding the lymphatic anatomy and fistula site
  - Reserved for refractory chylothoraces that have failed initial surgical closure

- Preoperative subcutaneous injection of 1% Evans blue dye in the thigh
- Enteral administration of a fat source like cream or olive oil.

Medical management

- Useful as an initial strategy

- Components
  - Drainage of the pleural space
  - Reduction of Chyle flow
  - Maintenance of hydration
  - Provision of adequate nutrition
  - Obliteration of pleural space

By tube thoracostomy
Provides lung reexpansion
Continuous drainage
Accurate measurement of chyle flow
Infection from the indwelling tube is uncommon

MCT diet
Transported directly into the **portal system**, bypassing lymphatic pathways
→ diminish lymph flow through the thoracic duct

Antibiotics (Tetracycline, doxycycline)
Antineoplastic agents (Bleomycin)
Biologic modifiers (OK-432, interferon, and interleukins)
Talc

Medical management

- Somatostatin
  - Inhibitory effects on GI and endocrine function
  - Decreases the volume of foregut secretions
  - Act directly on the splanchnic circulation to reduce lymph
  - As an adjunct in initial conservative management
  - Octreotide(a synthetic somatostatin analogue) : 1 to 4 *μ*g/kg/hr

Surgical management

- Indications
  - loss of > 1,500mL/day in adults, or >100mL/day in children over 5–day period
  - **Persistent leak for > 2 weeks despite conservative management***
  - Nutritional or metabolic complications
  - If the lung is entrapped or pleural symphysis cannot be achieved

    → early surgical intervention is indicated

* However, earlier is better

Surgical management methods

- **Direct ligation of the thoracic duct**
  - If the leak can be identified
  - Direct ligation with nonabsorbable ligatures

- **Mass ligation of the thoracic duct**
  - If the leak cannot be identified, extensive dissection should be avoided
  - Mass ligation of all tissue between aorta, spine, esophagus, azygos vein, pericardium
  - Above the diaphragmatic hiatus via the right pleural space
  - Rt. Thoracotomy with 6^{th} or 7^{th} intercostal space
  - Division of the inferior pulmonary ligament
  - Particular care following esophagectomy

Surgical management

- **VATS ligation of the thoracic duct**
  - Enteral administration of a fat source (50ml of heavy cream, 100ml of olive oil)
  - Rt. 6^{th} or 7^{th} intercostal space in the midaxillary line

- **Parietal pleurectomy**
  - May provide pleural symphysis
  - Should be considered when control of the duct is uncertain

- **Prophylactic ligation of the thoracic duct**
  - Cannot conclude that routine duct ligation is beneficial
  - It does not appear detrimental and therefore should be considered whenever concern exists

Postpneumonectomy chylothorax

- **Tension chylothorax**
- **Very rapid accumulation** of postoperative pleural fluid
- No reliable way to measure
- Short trial of conservative therapy may be appropriate
- **Successful conservative management factor**
  - Absence of contralateral mediastinal shift and symptoms
  - Drainage < 300ml/day
  - Presentation after the first postoperative week
  - Absence of a demonstrable leak on lymphangiography

Empyema

Empyema

- ddx from lung abscess
  - Air-fluid level extends to the chest wall
  - Its border tapers near the mediastinum or chest wall
  - The air-fluid level crosses the fissure

- CT
  - Thin, uniform, smooth wall along the exterior surface
  - Split sign; separated visceral and parietal pleural surfaces

Incidence of empyema

- Pneumonia→parapneumonic effusion : 40%
- Parapneumonic effusion→empyema : 10%

  **anaerobe infection : 30%

- Tbc effusion → tuberculous empyema :16%
- Postoperative empyema :1-5%

  **post pneumonectomy empyema : 10%

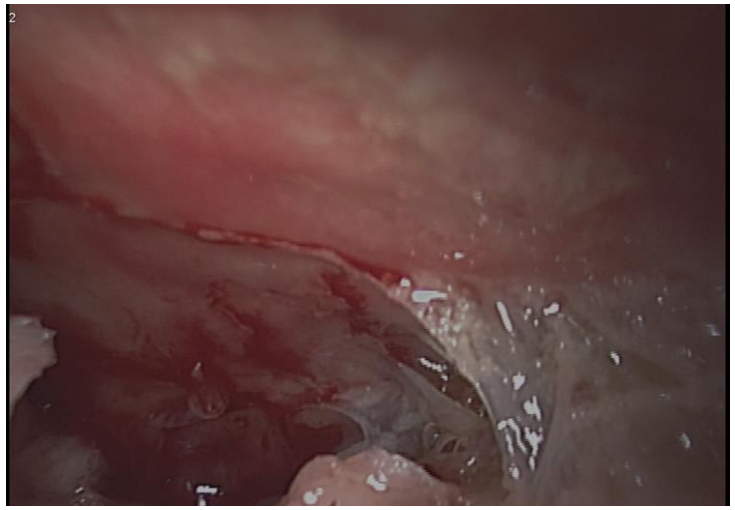
Complication of empyema

- Pulmonary fibrosis
- Contraction of the chest wall
- Spontaneous drainage through the skin: empyema necessitatis
- Spontaneous drainage through the bronchus: bronchopleural fistula
- Others
  - Osteomyelitis (rib, spine)
  - Pericarditis
  - Mediastinal abscess
  - Subphrenic abscess

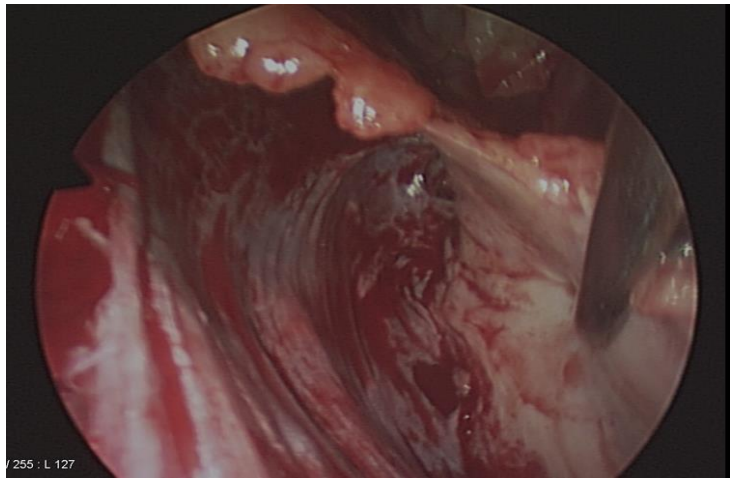
Goal of Therapy of Empyema

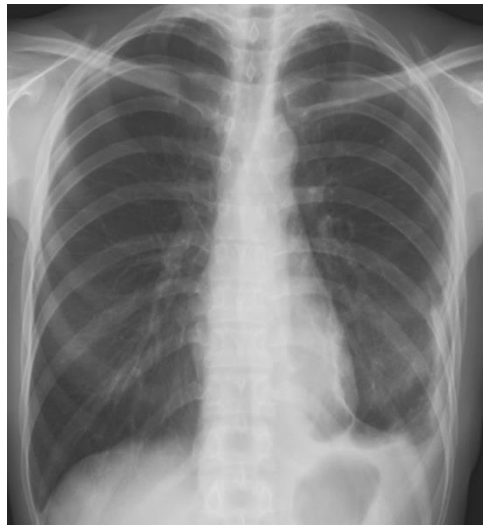
- Control of local & systemic infection : antibiotics
- Evacuation of empyema : tube drainage, open thoracotomy
- Re-expansion of the lung ± obliteration of pleural dead space:
  Decortication, thoracoplasty, Clagett's procedure

VATS decortication, 25/F, AntiTb-medication, 5 weeks later



Well

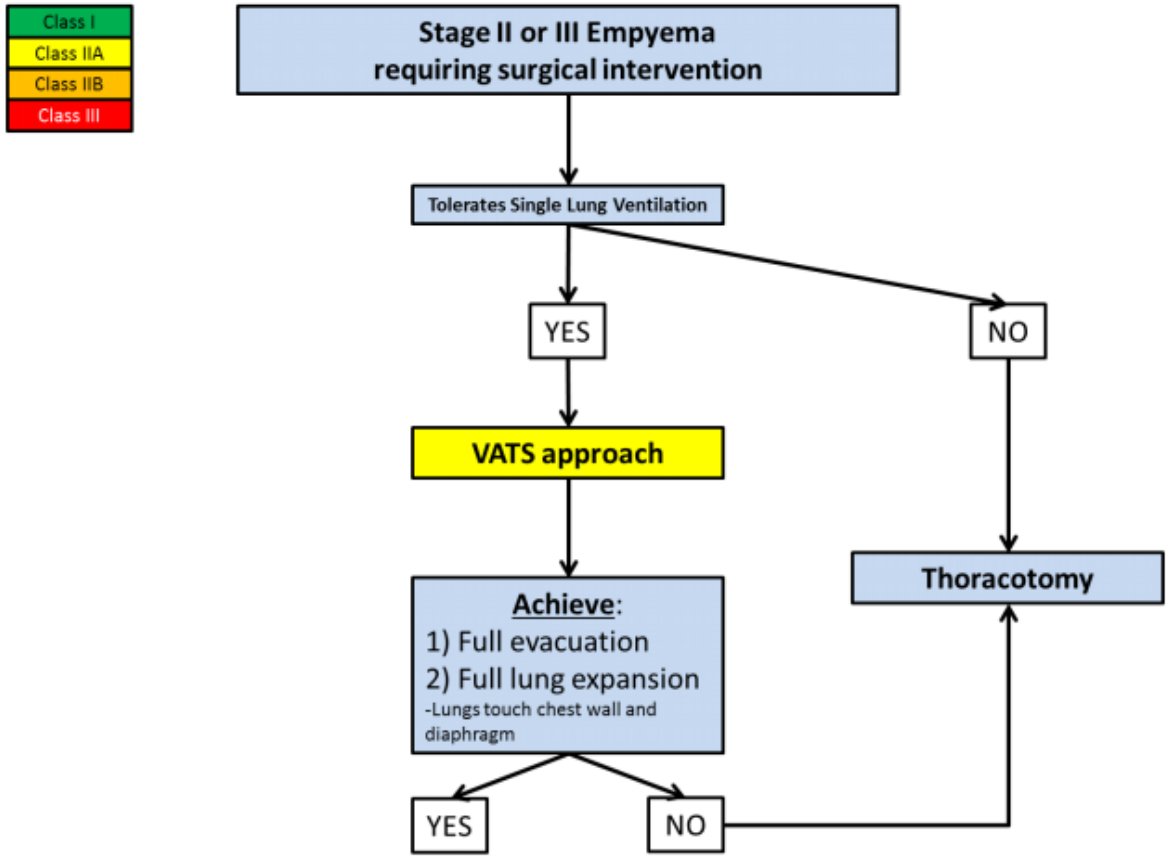




POD #2month

Best surgical approach to manage stage II empyema?

- **Class IIa:** VATS should be the first line approach in all patients with stage II acute empyema (LOE B)



Postpneumonectomy empyema (PPE)

- 5% incidence
- 50% mortality
- Risk factors; Rt pneumonectomy, CCRT, DM, Long stump…
- 80% accompanied by BPF
- Management
  - Tube thoracostomy drainage
  - Flexible bronchoscopy
  - Open drainage

Tumor

Incidence of MPM

백만명당

Country	IR	Main source of the data	References
Australia	30	Mesothelioma Registry	10, 11)
Great Britain	30	Mesothelioma Mortality Registry	12)
Belgium	29	Researchers estimates	3)
The Netherlands	23*	Mortality data	13)
Italy	17*	Mortality data	14)
Norway	16*	Cancer Registry	15)
New Zealand	15	Cancer Registry	16)
Denmark	13	Cancer Registry	17)
Germany	13	Various	18)
Sweden	12*	Cancer Registry	13)
France	10–13*	Mesothelioma Surveillance Program	19)
Finland	>10*	Cancer Registry	20)
Canada	9	Cancer Registry	21)
Cyprus	9	Researchers estimates	†)
United States	9*	SEER Program	22–24)
Hungary	8	Mesothelioma Registry	25)
Turkey	7.8	Researchers estimates	‡)
Croatia	7.4*	Cancer Registry	26, 27)
Japan	7	Mortality data	28)
Romania	6	Researchers estimates	3)
Austria	5.6*	Cancer Registry	29)
Poland	4*	Mortality data	30)
Slovakia	4	Researchers estimates	3)
Slovenia	4	Cancer Registry	31)
Spain	4*	Mortality data	32)
Estonia	3	Researchers estimates	3)
Israel	3	Cancer Registry	33)
Latvia	3	Researchers estimates	3)
Lithuania	3	Researchers estimates	3)
Macedonia	3	Researchers estimates	3)
Portugal	2–3	Researchers estimates	3)
Argentina	2.2*	Health Ministry Statistics	34)
Singapore	2	Cancer Registry	35)
South Korea	1–2	Cancer Registry	36)
Morocco	0.7	Researchers estimates	37)
Tunisia	0.6	Researchers estimates	37)

Clinical staging of MPM

T

T1	Tumor involves ipsilateral parietal or visceral pleura only
T2	T1 + Invasion of diaphragmatic muscle, lung parenchyma
T3	T1 + Invasion of endothoracic fascia, mediastinal fat, solitary focus of chest wall
T4	T1 + chest wall, peritoneum, contralateral pleura, mediastinal organs, vertebra

Surgical candidates

N

N0	No metastasis to lymph nodes
N1	Metastases to ipsilateral intrathoracic lymph nodes
N2	Metastases to contralateral intrathoracic lymph nodes, ipsilateral or contralateral SCN

8th Edition of TNM of MPM

INTERNATIONAL ASSOCIATION FOR THE STUDY OF LUNG CANCER

8th Edition of the TNM Classification for Malignant Pleural Mesothelioma

T – Primary Tumour

T1	Tumour involving the ipsilateral parietal or visceral pleura only
T2	Tumour involving ipsilateral pleura (parietal or visceral pleura) with invasion involving at least one of the following: • diaphragmatic muscle • pulmonary parenchyma
T3[1]	Tumour involving ipsilateral pleura (parietal or visceral pleura) with invasion involving at least one of the following: • endothoracic fascia • mediastinal fat • chest wall, with or without associated rib destruction (solitary, resectable) • pericardium (non-transmural invasion)
T4[2]	Tumour involving ipsilateral pleura (parietal or visceral pleura) with invasion involving at least one of the following: • chest wall, with or without associated rib destruction (diffuse or multifocal, unresectable) • peritoneum (via direct transdiaphragmatic extension) • contralateral pleura • mediastinal organs (oesophagus, trachea, heart, great vessels) • vertebra, neuroforamen, spinal cord or brachial plexus • pericardium (transmural invasion with or without a pericardial effusion)

N – Regional Lymph Nodes

NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastases
N1	Metastases to ipsilateral intrathoracic lymph nodes (includes ipsilateral bronchopulmonary, hilar, subcarinal, paratracheal, aortopulmonary, paraoesophageal, peridiaphragmatic, pericardial, intercostal and internal mammary nodes)
N2	Metastases to contralateral intrathoracic lymph nodes. Metastases to ipsilateral or contralateral supraclavicular lymph nodes

M – Distant Metastasis

M0	No distant metastasis
M1	Distant metastasis present

[1]T3 describes locally advanced, but potentially resectable tumour.

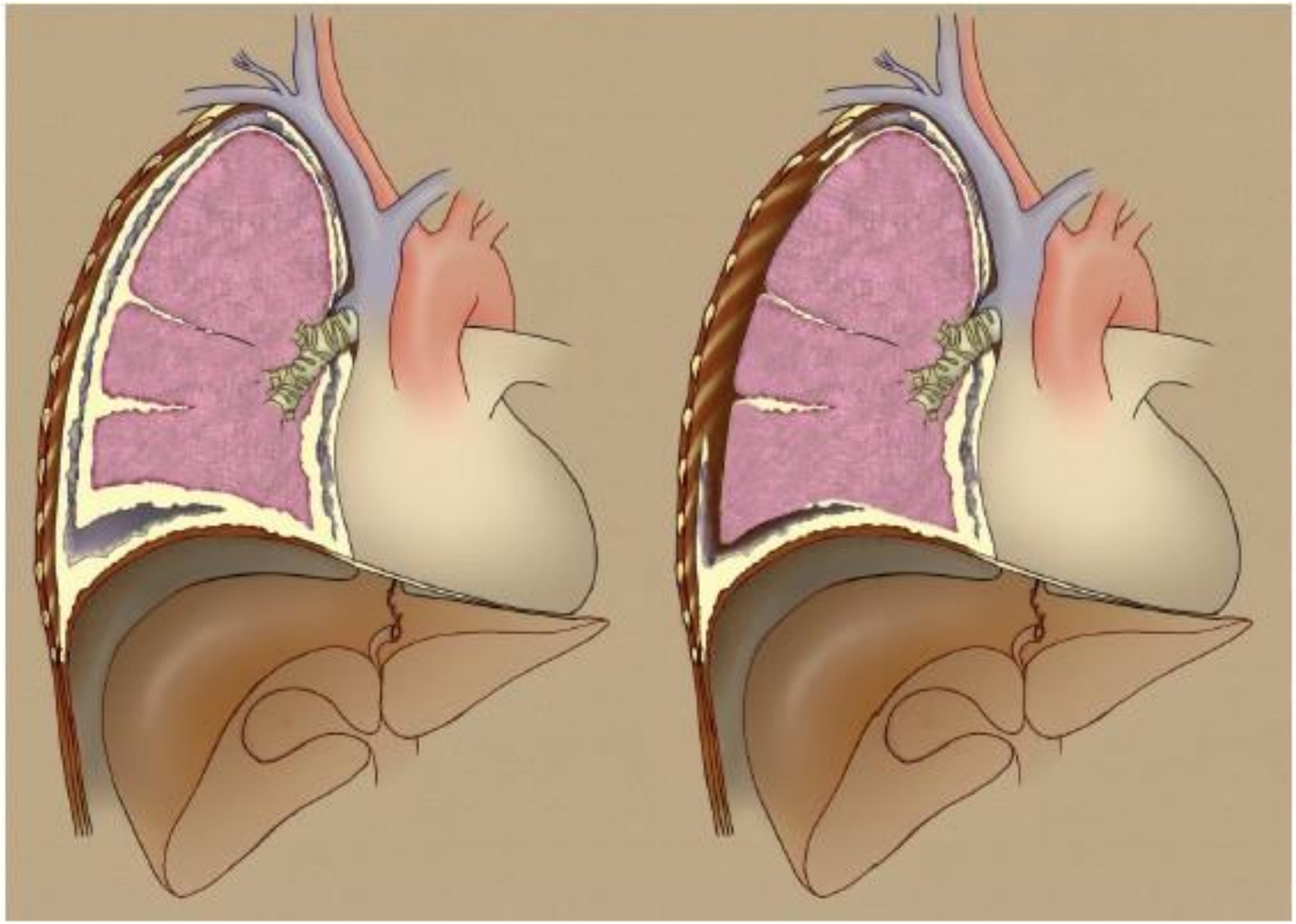
[2]T4 describes locally advanced, technically unresectable tumour.

INTERNATIONAL ASSOCIATION FOR THE STUDY OF LUNG CANCER

Stage Grouping for the 8th Edition of the TNM Classification for Malignant Pleural Mesothelioma

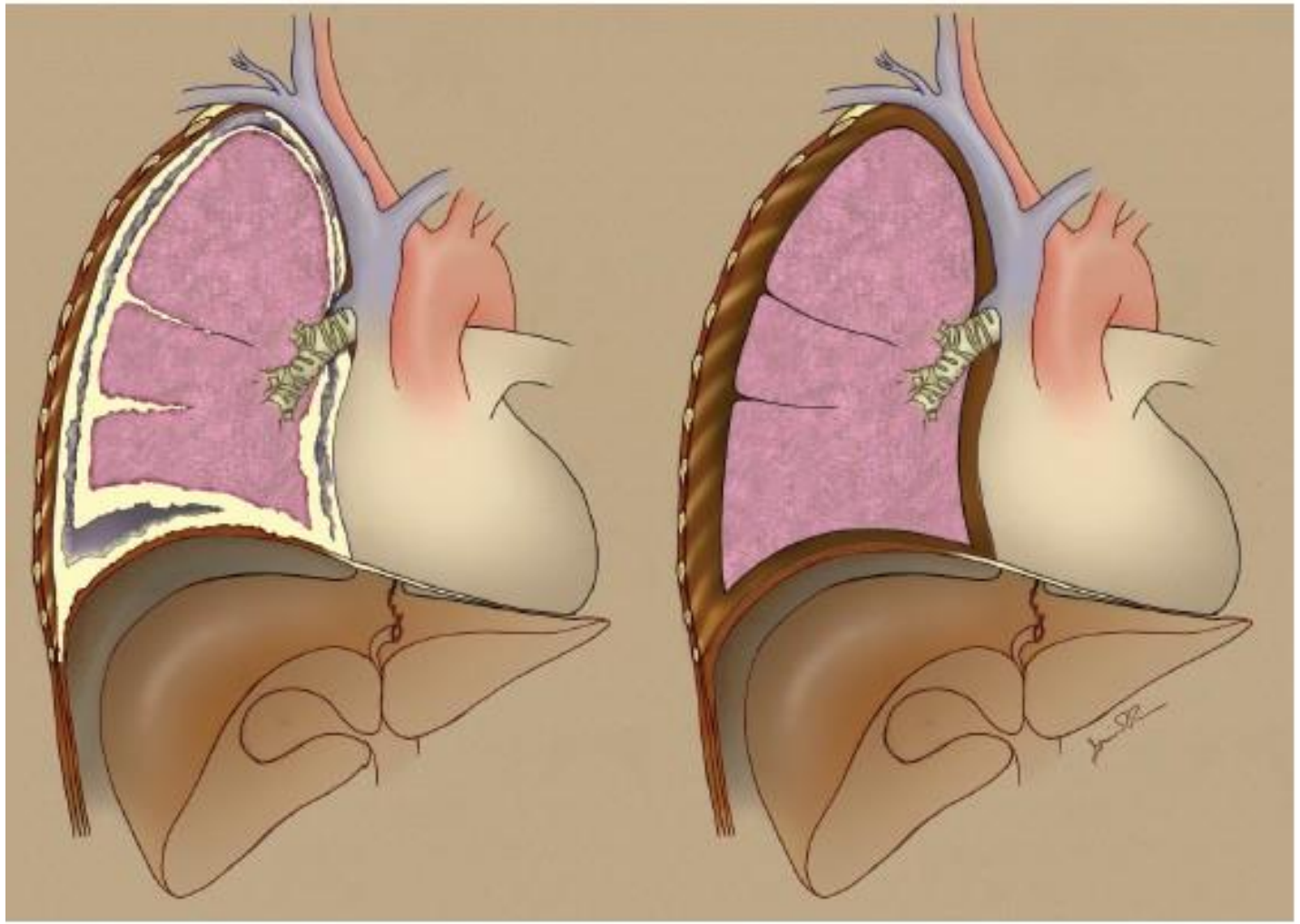
STAGE	T	N	M
IA	T1	N0	M0
IB	T2, T3	N0	M0
II	T1, T2	N1	M0
IIIA	T3	N1	M0
IIIB	T1, T2, T3	N2	M0
	T4	N0, N1, N2	M0
IV	Any T	Any N	M1

Partial Pleurectomy



Palliative purpose
- pain relieve

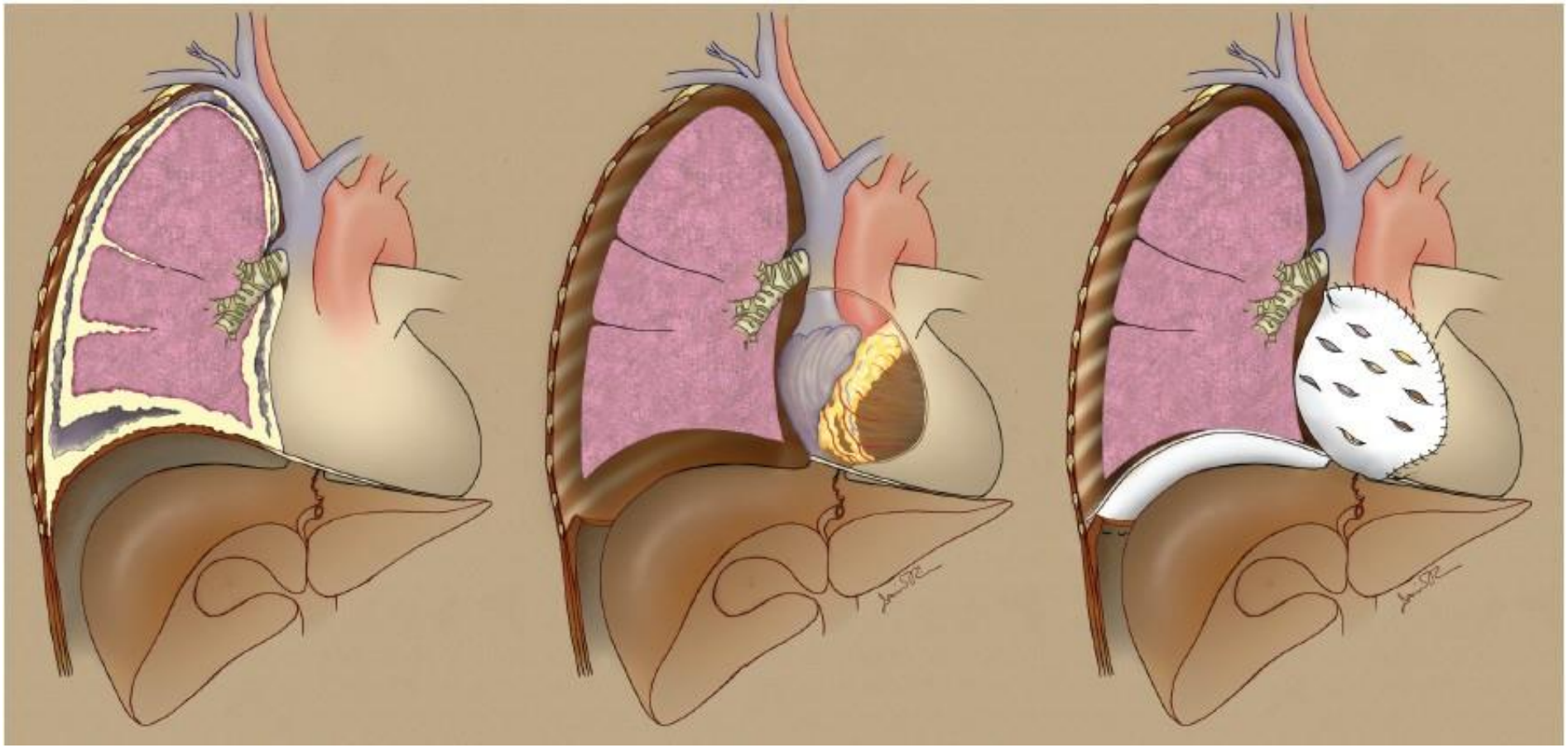
Pleurectomy/Decortication (P/D)



- Parietal, visceral pleurectomy
- No resection of the diaphragm or pericardium
- Early disease;
  - confined to the pleural envelope
  - no N2 LN
  - favorable histology (epithelioid)

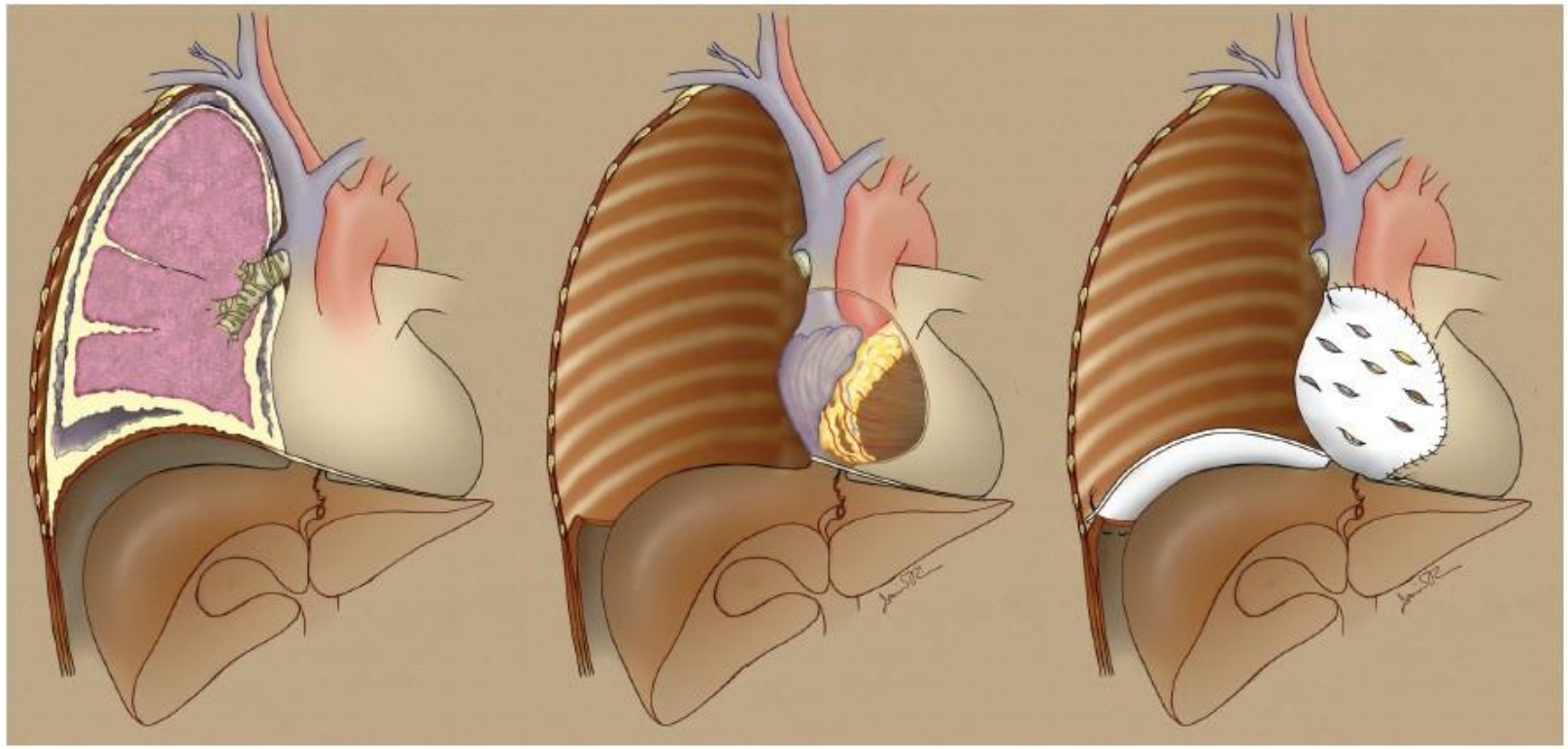
  -> first option

Extended P/D (pleurectomy/decortication)



- Parietal and visceral pleurectomy
- Resection of the diaphragm and/or pericardium

Extrapleural pneumonectomy (EPP)



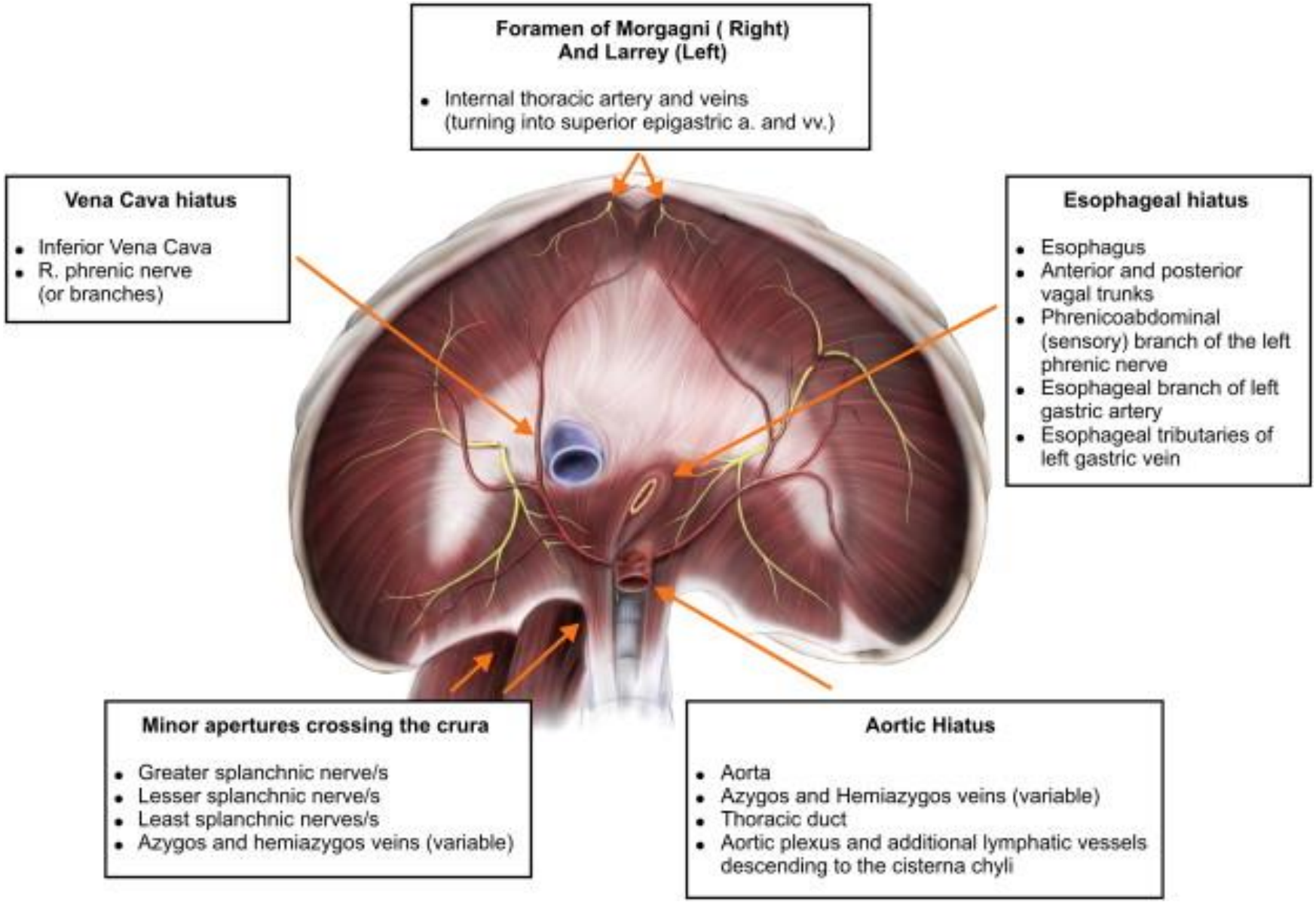
- En bloc resection; parietal and visceral pleura with ipsilateral lung, pericardium and diaphragm
- Mediastinal node sampling

NCCN guidelines 2017

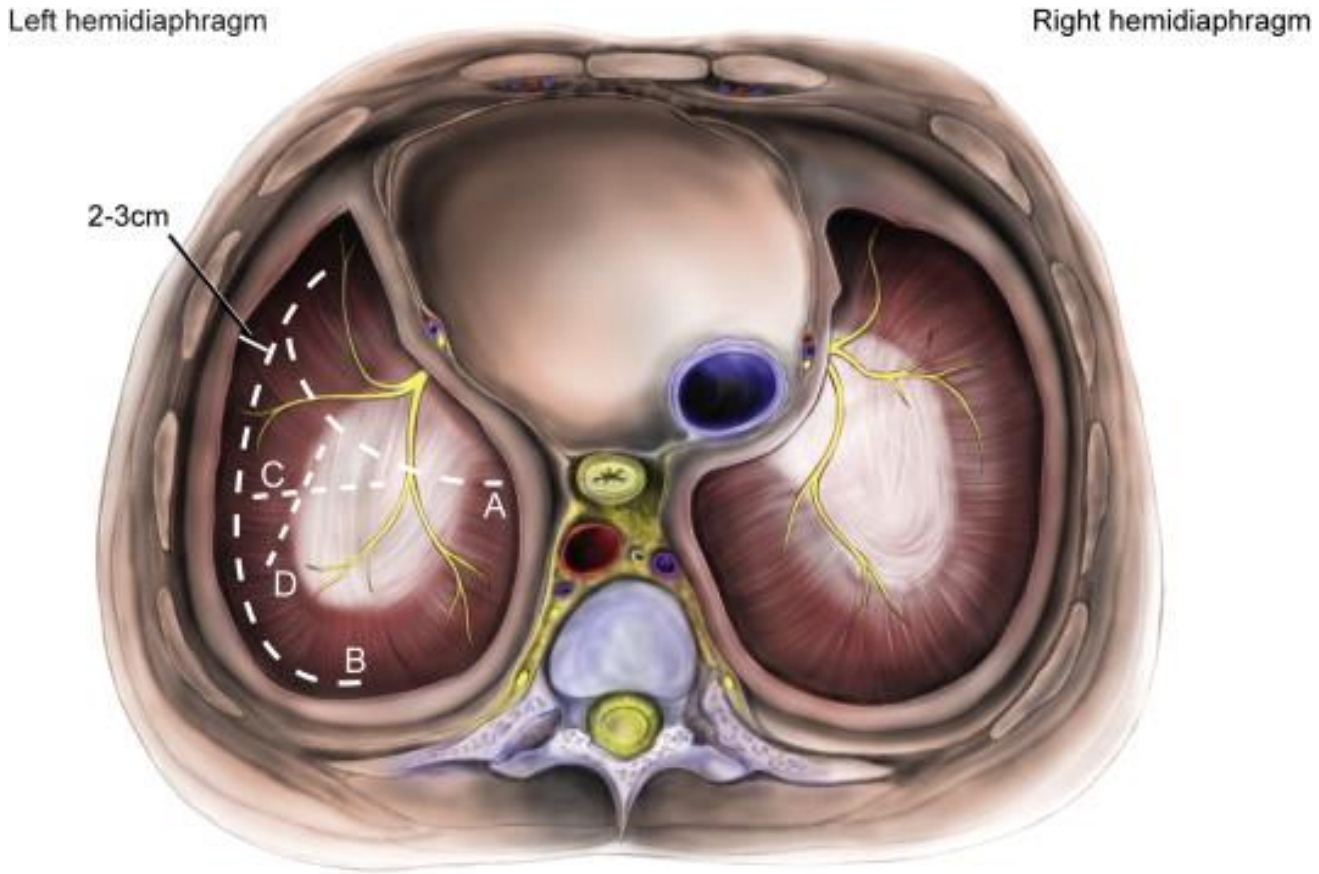
1.	**Early stage (stage I, N0–1) with epithelioid histology?**	P/D is first choice
2.	**Stage IV MPM or sarcomatoid histology?**	Surgery is not recommended
3.	**In case of N2 disease or mixed histology?**	Surgery only in high volume centers
4.	**Pleurodesis and debulking P/D?**	are palliative to limit pleural effusion and to relieve pain
5.	**VATS?**	Palliative role (e.g., pleurodesis), but it is not accepted to perform the P/D

Diaphragm

Structures passing through the diaphragm



Surgical incisions on the diaphragm



(A) An incision with a risk of total paralysis of the diaphragm.
(B) A preferred incision with minimal risk of nerve injury.
(C, D) Incisions in safe areas, but with small risk of nerve injury.

GOOD LUCK