Anaesthesia for Thoracic Surgery

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INTRODUCTION :

- Anesthesia for thoracic surgery requires careful preoperative evaluation to identify patients liable to develop post operative morbidity especially the need for continued mechanical ventilation

- Pulmonary function tests and ABG may be

useful to identify at risk patients

Preoperative Preparation :

- **Stop Smoking :**

For 2-3 month → improves in ciliary function,
→ improves closing volume, and
→ reduction in sputum production

For 4 - 6 weeks → decreases incidence of post-operative complications.

For 48 hours → decrease the level of CarboxyHemoglobin (CoHb)

- **Infection :** broad spectrum antibiotics.

Smoking Cessation :

Benificial effects of smoking cessation and time course

Time course	Benificial effects
12-24hr	Decreased CO and nicotine levels
48-76 hr	COHb levels normalised, ciliary function improves
1-2 week	Decreased sputum production
4-6 week	PFTs improve
6-8 week	Immune function and metabolism normalizes
8-12 week	Decresed overall postoperative morbidty and mortality

Preoperative Preparation :

- **Hydration and removal of Bronchial Secretions :**

▸ ↘ the viscosity of the bronchial secretions and facilitates their removal from the air ways.

- Acetylcysteine (Mucomyst)
- Potassium iodide
- (Chest Physiotherapy)Postural drainage, Vigorous coughing, Chest percussion

- **Wheezing :**

▸ The presence of acute wheezing represents a medical emergency, and elective surgery should be postponed until effective proper treatment has been instituted.

Preoperative Preparation :

- **Preparation of Bronchodilator drugs :**
  - ♦ Sympathomimetic Drugs (Albuterol, Salbutamol)
  - ♦ Phosphodiesterase Inhibitors (Aminophylline)
  - ♦ Steroids (Ipratropium , Prednisolone)

Effects of Anesthesia on lung volume and capacity :

- ↘ Total lung capacity (TLC) .
- Vital capacity is ↘ by 25% to 50% .
- Residual volume (RV) ↗ by 13% .
- Expiratory reserve volume ↘ by 25% and 60% .
- Tidal volume (VT) ↘ by 20% .

Intraoperative Monitoring :

- Precordial stethoscope
- Pulse oxymetry
- NIBP
- Capnography
- ECG
- ABG analysis
- Direct Arterial Catheterization
- CV Catheterization

Choices of Anesthesia for Thoracic Surgery :

- A choice of anesthesia for thoracic surgery depends on:-
  - The patient's cardiovascular & respiratory status
  - The particular effects of anesthetic drugs on CVS and RS & other organ systems.
- The ideal thoracic anesthetic technique would be:
  - Rapid in onset and offset and produce inhibition of airway reflexes and bronchodilation
  - It would allow the use of a high FiO2 without inhibiting hypoxic pulmonary vasoconstriction.
  - It would also produce no adverse cardiovascular effects.

Choices of Anesthesia for Thoracic Surgery :

◙ Before Induction :

♦ IV - lidocaine allow used to treated brochospasm occurring during anesthesia.

♦ Atropine - for antimuscarinic effects of acetylcholine & protect cholinergic induced bronchoconstriction .

◙ Induction :

♦ Propofol Satisfactory in most patients.

♦ Etomidate elderly or those with cardiovascular instability .

♦ ketamine may be the drug of choice for reactive airway .

♦ Halothane is preferable for inhalation induction as it is least pungent .

Choices of Anesthesia for Thoracic Surgery :

◙ Neuromuscular blockade :

- ♦ Consider suxamethonium for difficult intubation .
- ♦ Avoid drugs which have histamine release effect
- ♦ Use vecronium and pacronium

◙ Maintenance of anaesthesia :

- ♦ Isoflurance most suitable
- ♦ Avoid halothane: has marked inhibitory effect on hypoxic pulmonary vasoconstriction
- ♦ Nitrous oxide is contraindicated in patients with cysts or bullae because it can expand the air space and cause rupture.
- ♦ TIVA(propofol and fentanyl)

Fluid Management :

♦ There is an increased potential for pulmonary oedema to develop. Right pneumonectomy is associated with the highest risk of this complication.

♦ Pulmonary oedema may develop due to several factors.

- Raising pulmonary vessel hydrostatic pressures
- Loss of lymphatic drainage occurs.
- Decreased pulmonary capillary oncotic pressures
- No more than 10ml/kg of crystalloid in the first hour intraoperatively

♦ 1.5L in the first 24 hours postoperatively.

ONE LUNG VENTILATION :

One Lung Ventilation (OLV) is a technique that allows isolation of the individual lungs and each lung functioning independently by preparation of the airway under anesthesia.

Indication for one lung ventilation (OLV) :

Absolute indication

- Isolation of one lung from the other to avoid spillage or contamination
  - Infection
  - Massive hemorrhage
- Control of the distribution of ventilation
  - Bronchopleural cutaneous fistula
  - Surgical opening of a major conducting airway
  - Giant unilateral lung cyst or bulla
  - Life-threatening hypoxemia due to unilateral lung disease
- Unilateral bronchopulmonary lavage
- Video assisted Thoracoscopic surgery

Indication for one lung ventilation (OLV) :

Relative indications

- Surgical exposure — **high priority**
  - Thoracic aortic aneurysm
  - Pneumonectomy
  - Upper lobectomy
- Surgical exposure — **low priority**
  - Esophageal surgery
  - Middle and lower lobectomy

Physiology of OLV :

One-lung ventilation, anesthetized, paralyzed, chest open

- Two-lung ventilation in the lateral position: nondependent lung 40% C.O.P 60% dependent lung
- Shunt 5% in each lung
- C.O participating in gas exchange 35% nondependent 55% in the dependent
- Right-to-left transpulmonary shunt
- Active HPV, blood flow nondependent hypoxic lung will be decreased by 50%

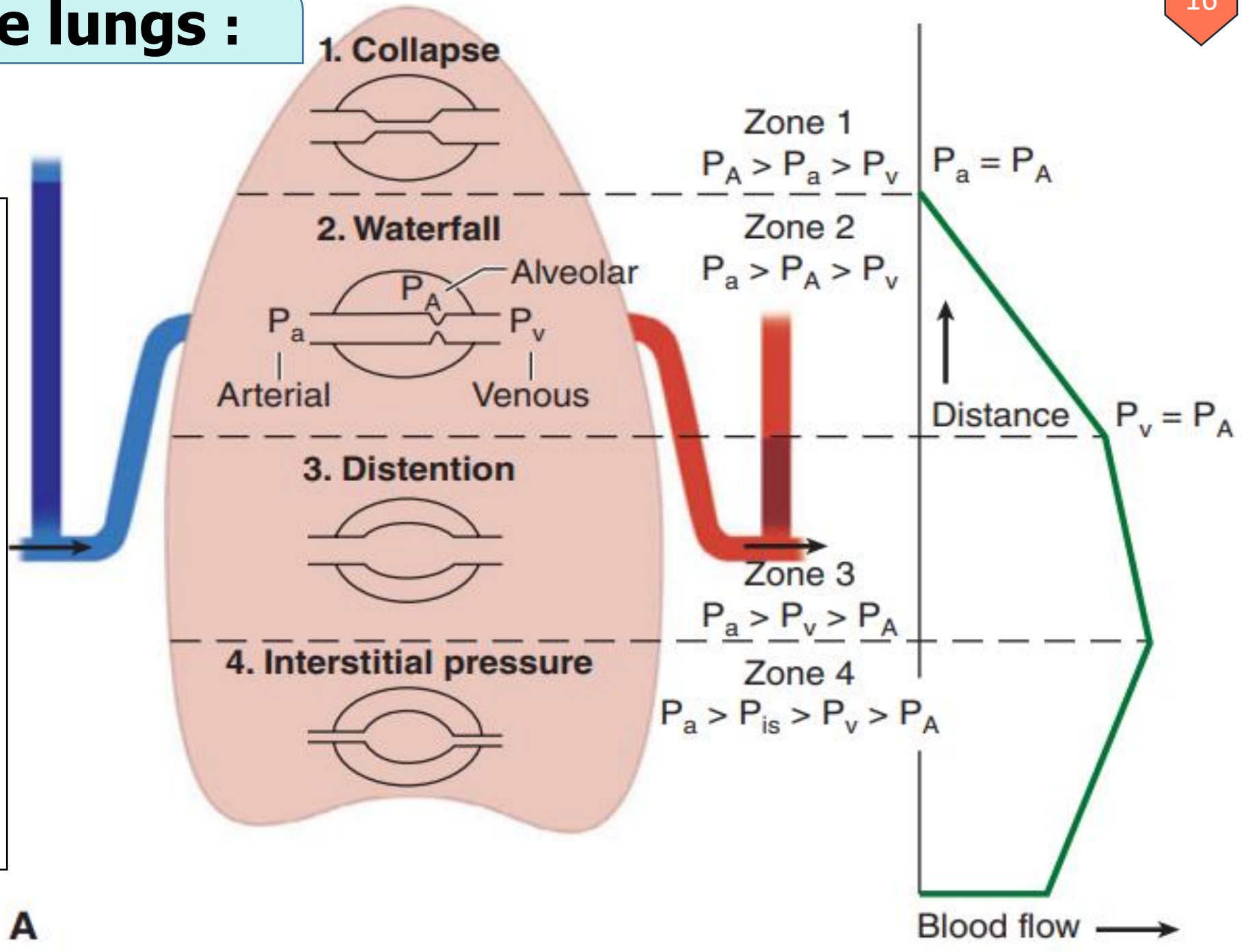
Blood flow in the lungs :

Up right position

Pulmonary blood flow distribution relative to the alveolar pressure (P A), the pulmonary arterial pressure (P a), the pulmonary venous pressure (P V), and the interstitial pressure (PiS) at various gravitation levels.

A: Classic West Zones of blood flow distribution in the

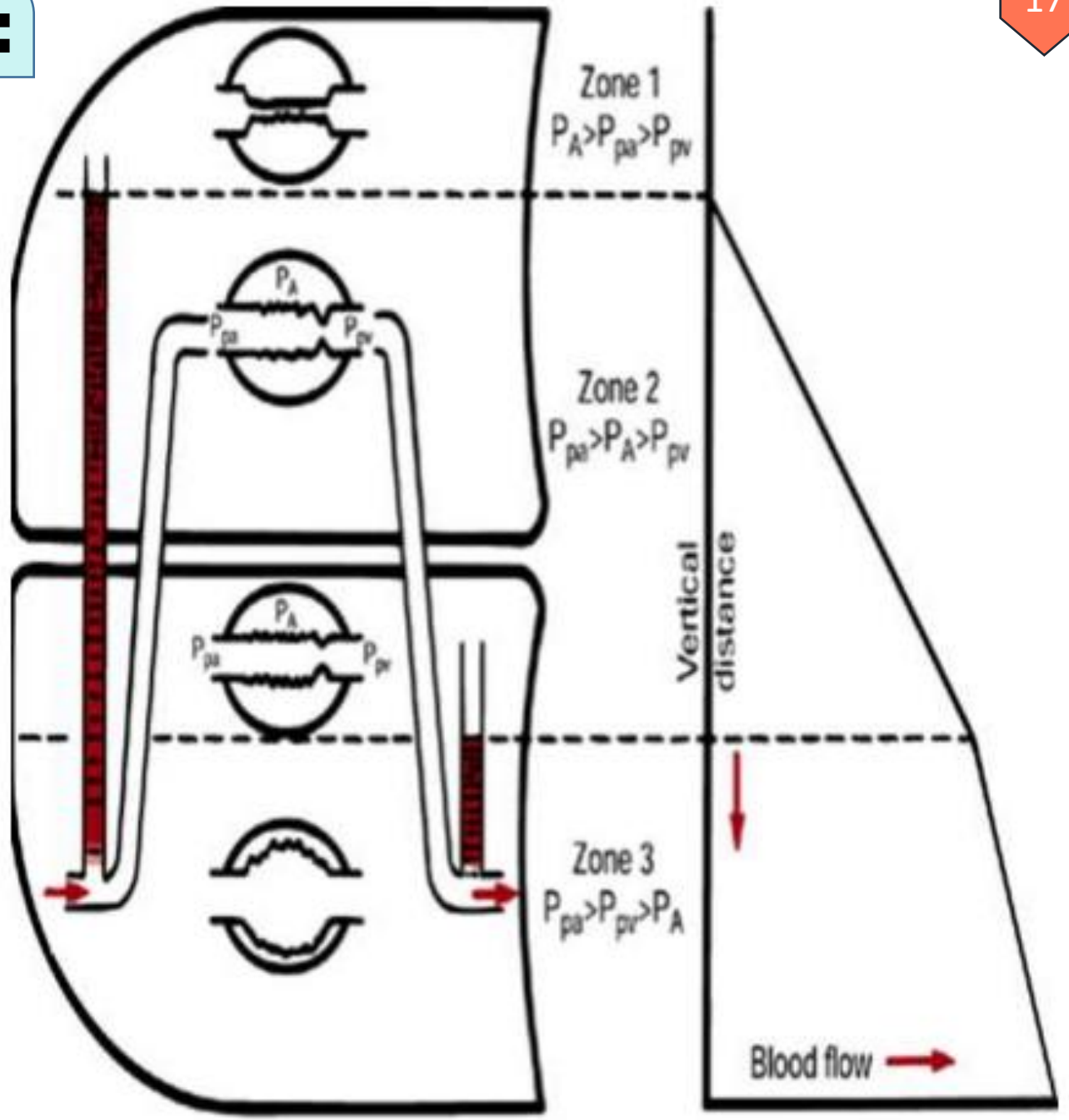
upright position



Blood flow in the lungs :

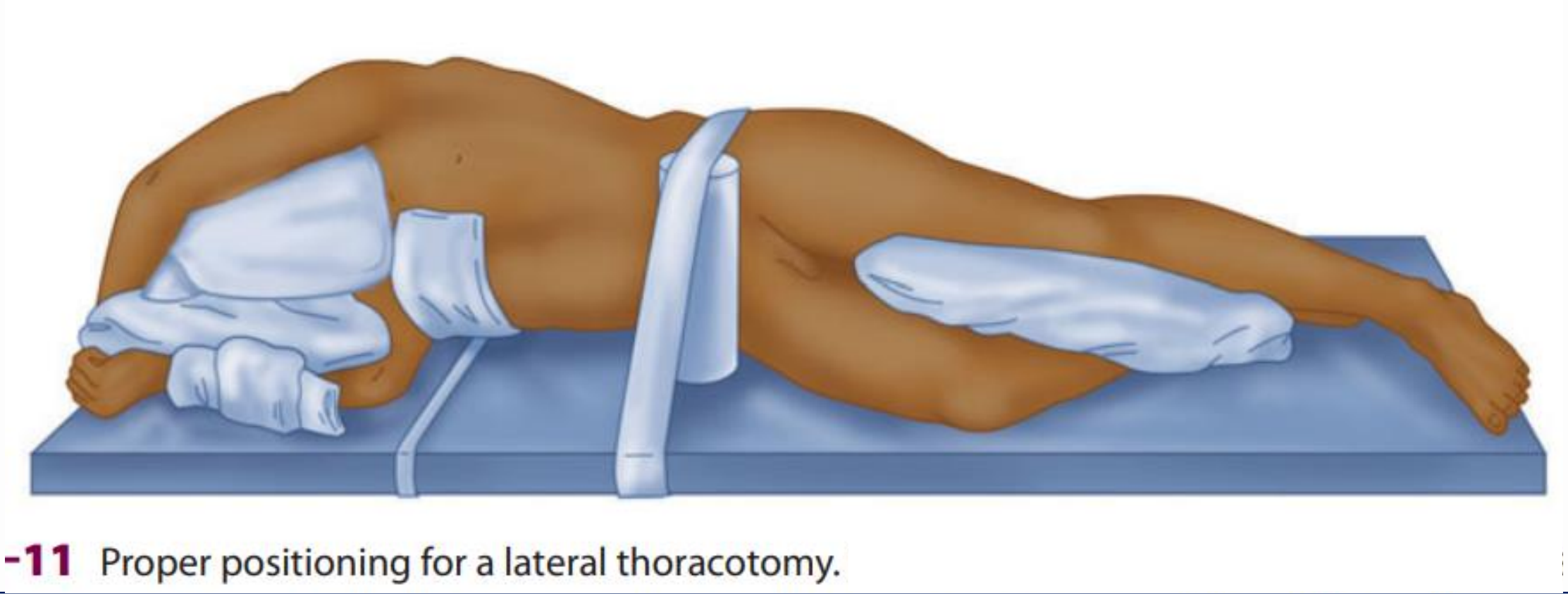
LD Position

Notes :



Physiology of the Lateral Decubitus Position :

In the lateral decubitus position, the distribution of blood flow and ventilation is similar to that in the upright position, but turned by 90 degrees.



-11 Proper positioning for a lateral thoracotomy.

Physiology of the LDP :

1) Lateral position, awake, breathing spontaneously, chest closed

- ♦ Vertical hydrostatic pressure gradient is smaller
- ♦ Dependent lung has ↑perfusion & ↑ventilation

2) Lateral position, awake, breathing spontaneously, chest open

Example: Thoracoscopy under intercostal block

♦ Two complications can arise from the patient breathing spontaneously with an open chest.

These are: A) Mediastinal shift

B) Paradoxical breathing

Physiology of the LDP :

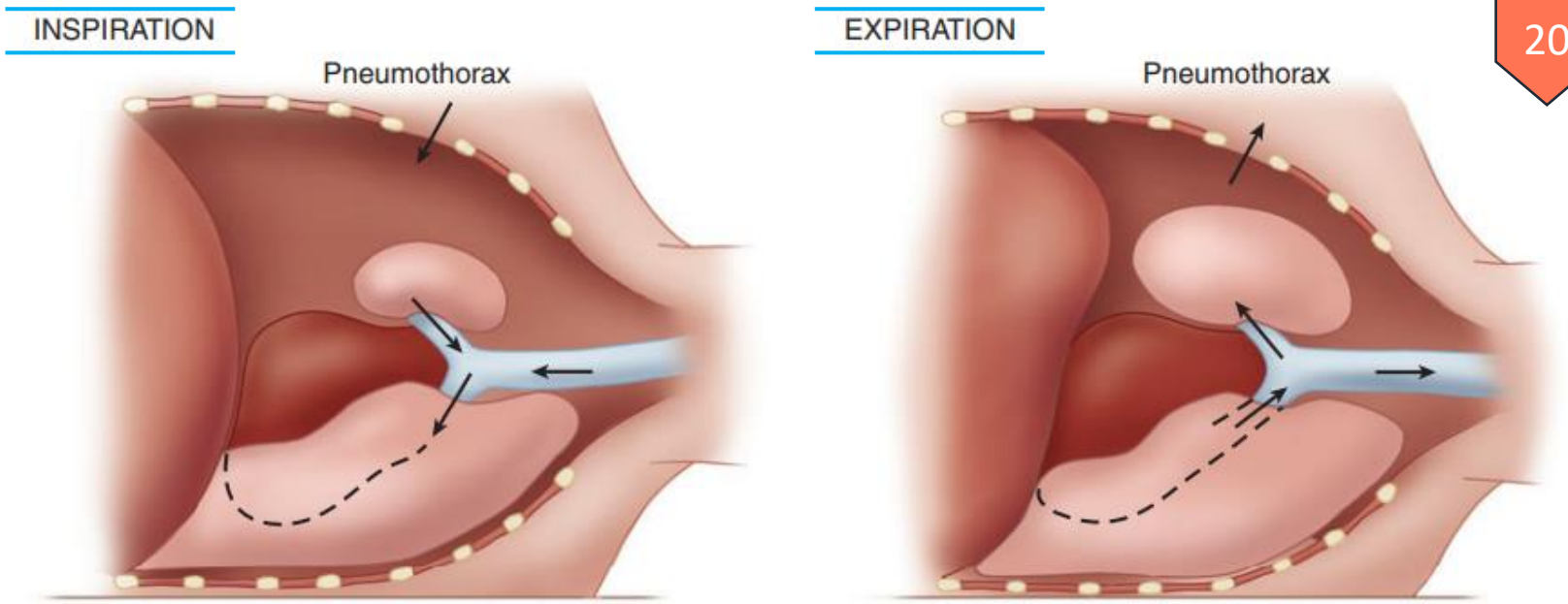


FIGURE 25–4 Paradoxical respiration in spontaneously breathing patients on their side. (Reproduced, with permission, from

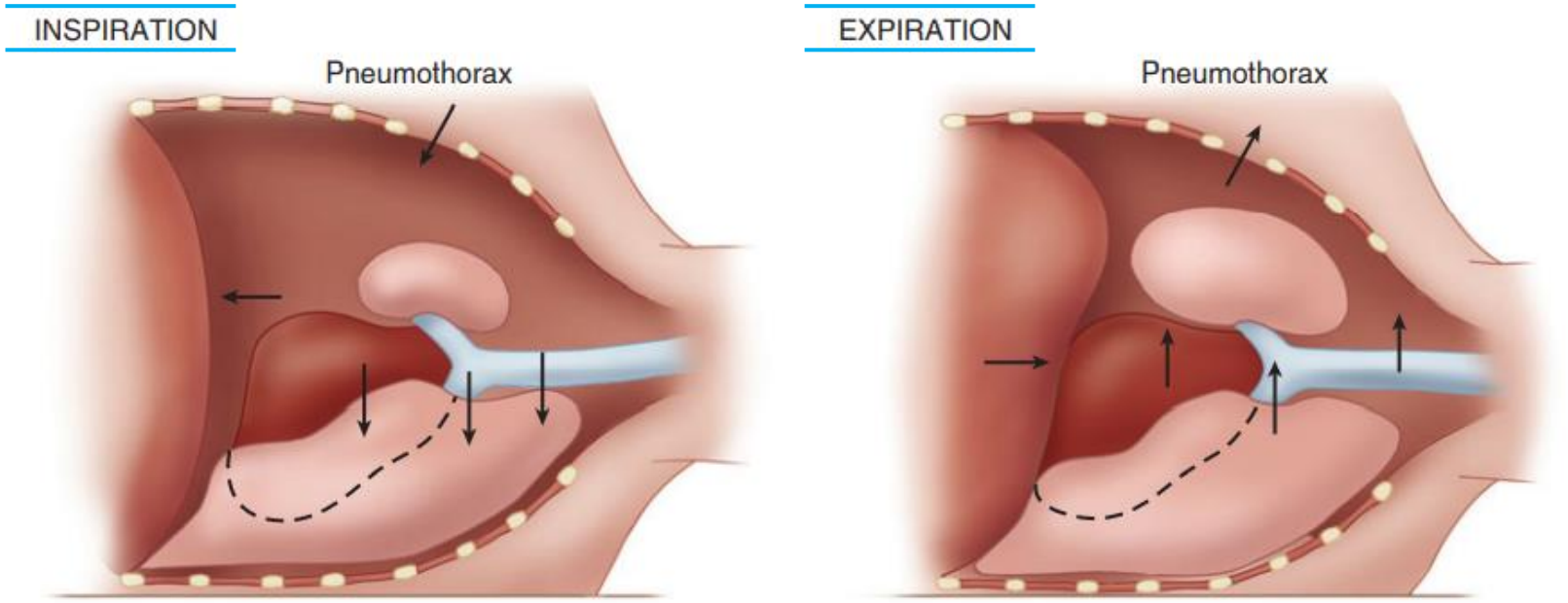


FIGURE 25–3 Mediastinal shift in a spontaneously breathing patient in the lateral decubitus position. (Reproduced, with

Neurovascular injury specific to LDP :

- Dependent eye
- Dependent ear pinna
- Brachial plexus (dependent and nondependent)
- Suprascapular nerve(dependent and nondependent)
- Sciatic nerve (nondependent)
- Peroneal nerve (dependent)

Hypoxic Pulmonary Vasoconstriction :

Hypoxic Pulmonary Vasoconstriction :

- HPV is a physiological response of the lung to alveolar hypoxia, which redistributes pulmonary blood flow from areas of low oxygen partial pressure to areas of high oxygen availability.

Mechanism of action :

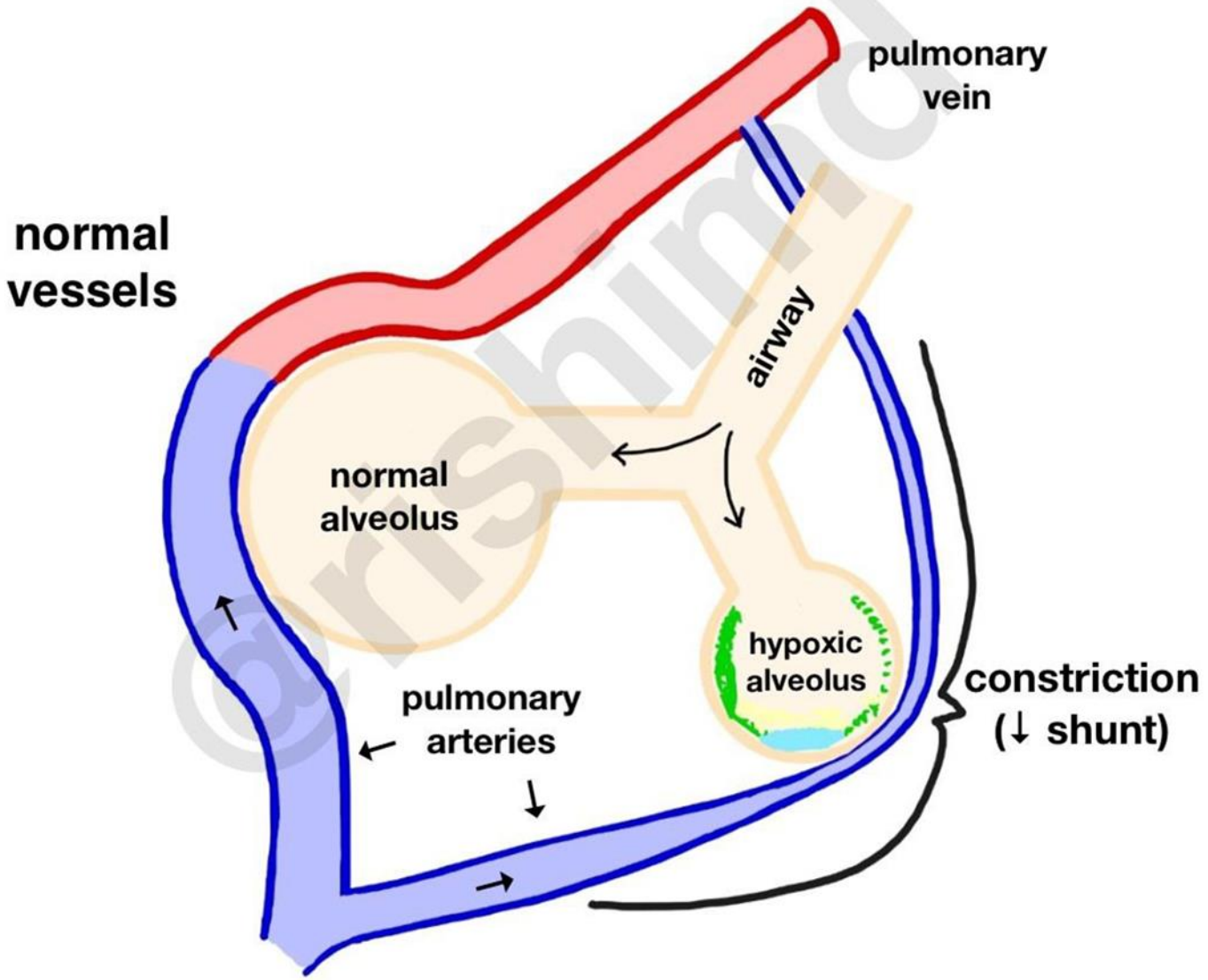
- HPV is graded and limited, of greatest benefit when 30% to 70% of the lung is made hypoxic.
- HPV is effective only when there are normoxic areas of the lung available to receive the diverted blood flow

Hypoxic Pulmonary Vasoconstriction :

- HPV is inhibited directly by volatile anesthetics (less with N2O), vasodilators (NTG, ß2-agonist), increased hypocapnia.

- HPV is indirectly inhibited by PEEP; vasoconstrictor drugs (epinephrine, norepinephrine, phenylephrine, and dopamine).

HYPOXIC PULMONARY VASOCONSTRICTION



Methods of Lung Separation :

OLV is achieved by either :

1) Double lumen ETT (DLT)

2) Bronchial blocker

- Single-lumen ET with a built-in bronchial blocker (univent tube)
- Single-lumen ET with an isolated bronchial blocker(ardnt, wire guided tube)

3) Endobronchial tube (ETT)

- Endobronchial intubation of a single-lumen ET

Double-Lumen Endobronchial Tube :

Are currently the most widely used. Types of DLT are :

A. Carlens Tube

- ♦ The first DLT used for OLV
- ♦ A left sided DLT with a carinal hook3) Endobronchial tube

B. White, a right-sided Carlens tube

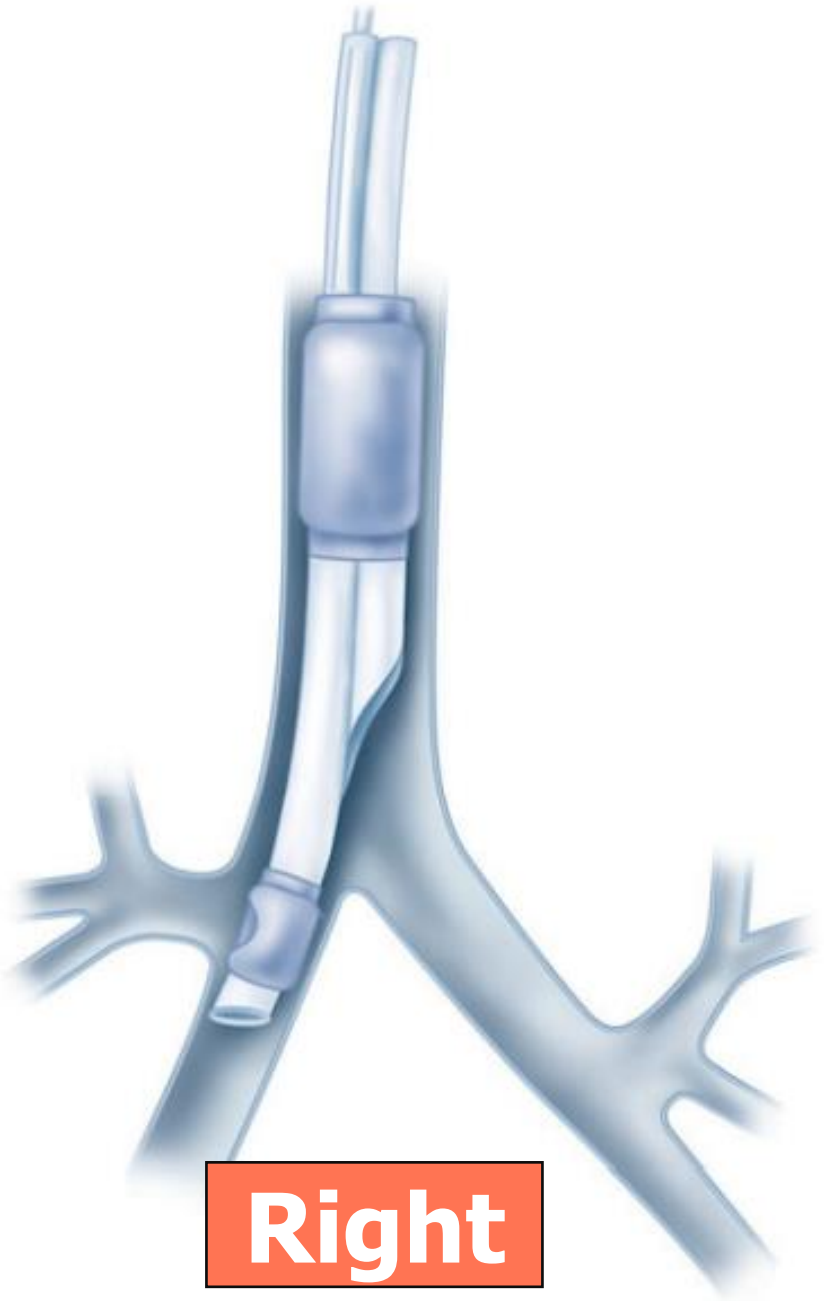
C. Robertshaw Tube

- ♦ All have two cuffs, one terminating in the trachea and the other in the mainstem bronchus
- ♦ Right-sided or left-sided available
- ♦ Available size: 41,39, 37, 35, 28 French (ID=6.5, 6.0, 5.5, 5.0 and 4.5 mm respectively)

Shapes :

Double lumen tube (DLT)

Left



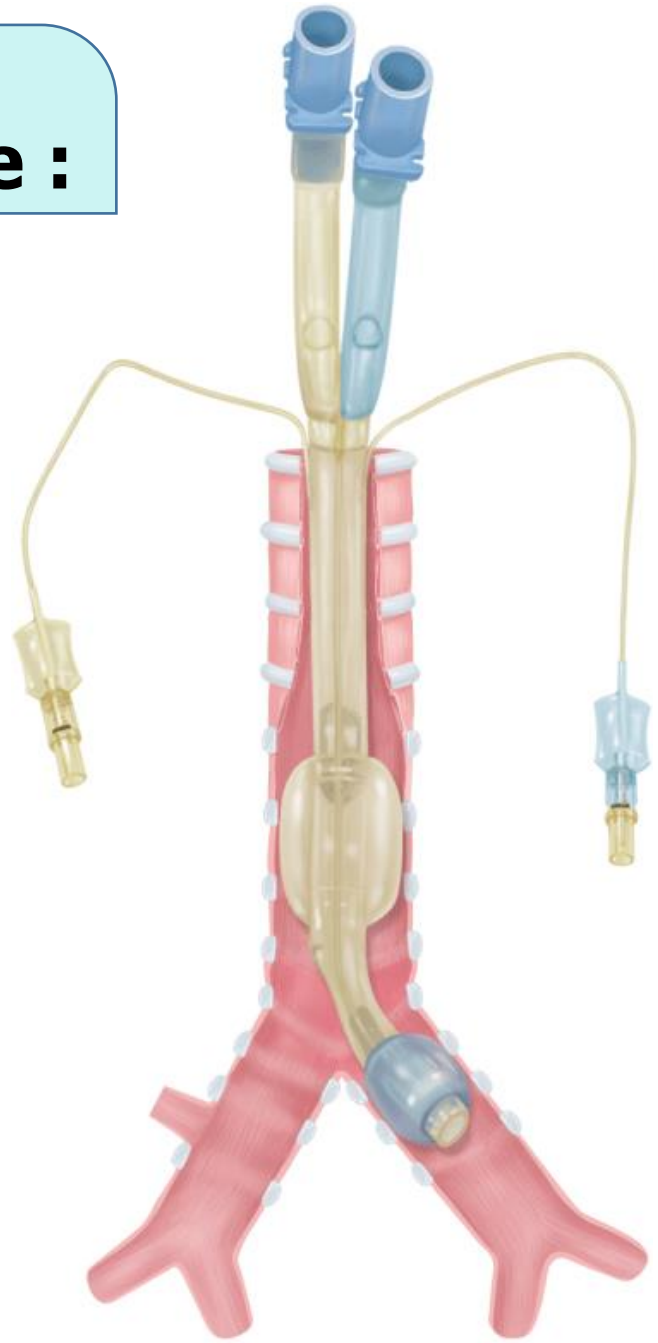
Right

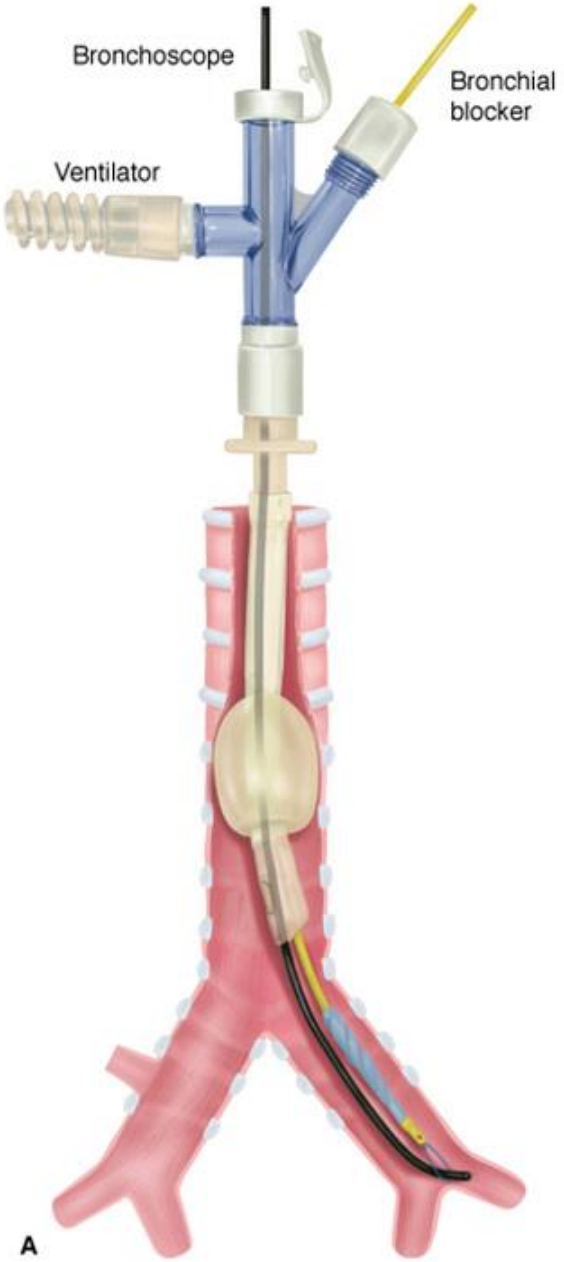
DLT Right Shape :

DLT Left Shape :

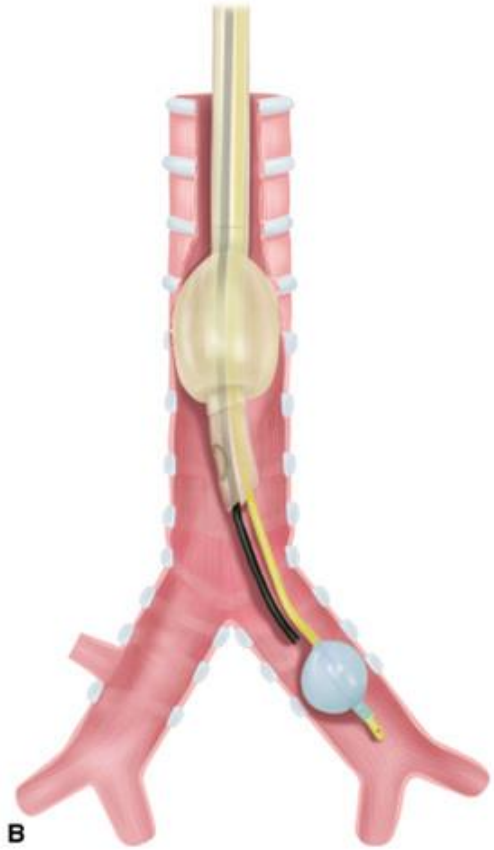
DLT Shape :

Endobronchial blocker Tube Shape :

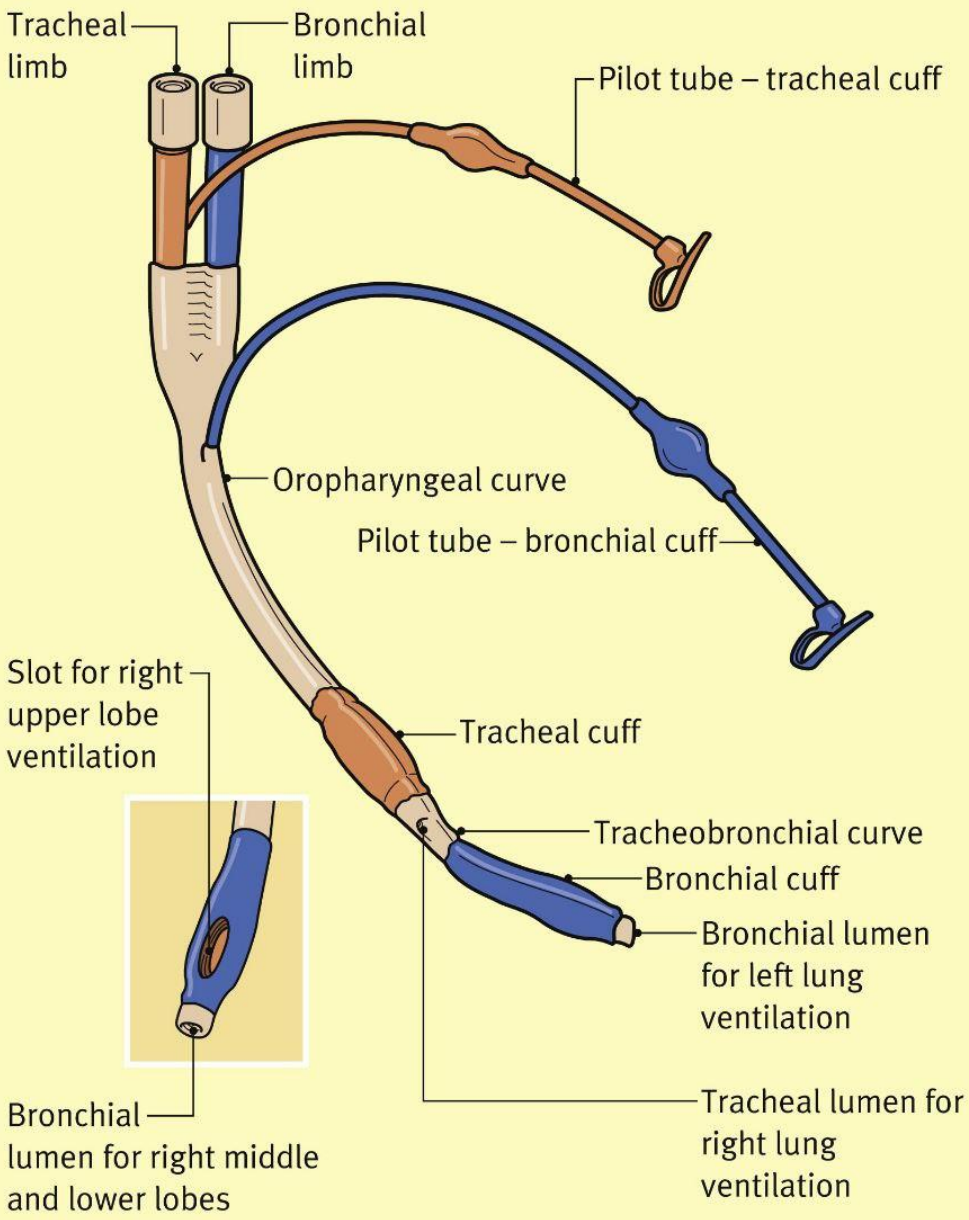




Coaxial Placement of Arndt Endo-Bronchial Blocker



Robertshaw Tube Shape :



Inset, tip of right-sided Robertshaw. Reproduced, with permission, from the Department of Medical Illustration, Wythenshawe Hospital, Manchester, UK.

Carlens Tube Shape :

DLT Placement :

1- Before insertion prepare &check the tube, stylate, FOB, 10ml syringe for tracheal cuff and 3ml syringe for bronchial cuff, connector

2- Use mackintosh blade 3

3- Lubricate tube

4- Insert tube with distal concave curvature facing anteriorly

5- Remove stylet once through the vocal cords

6- Rotate tube 90 degrees (in direction of desired lung)

7- Advancement of tube ceases when resistance is encountered.

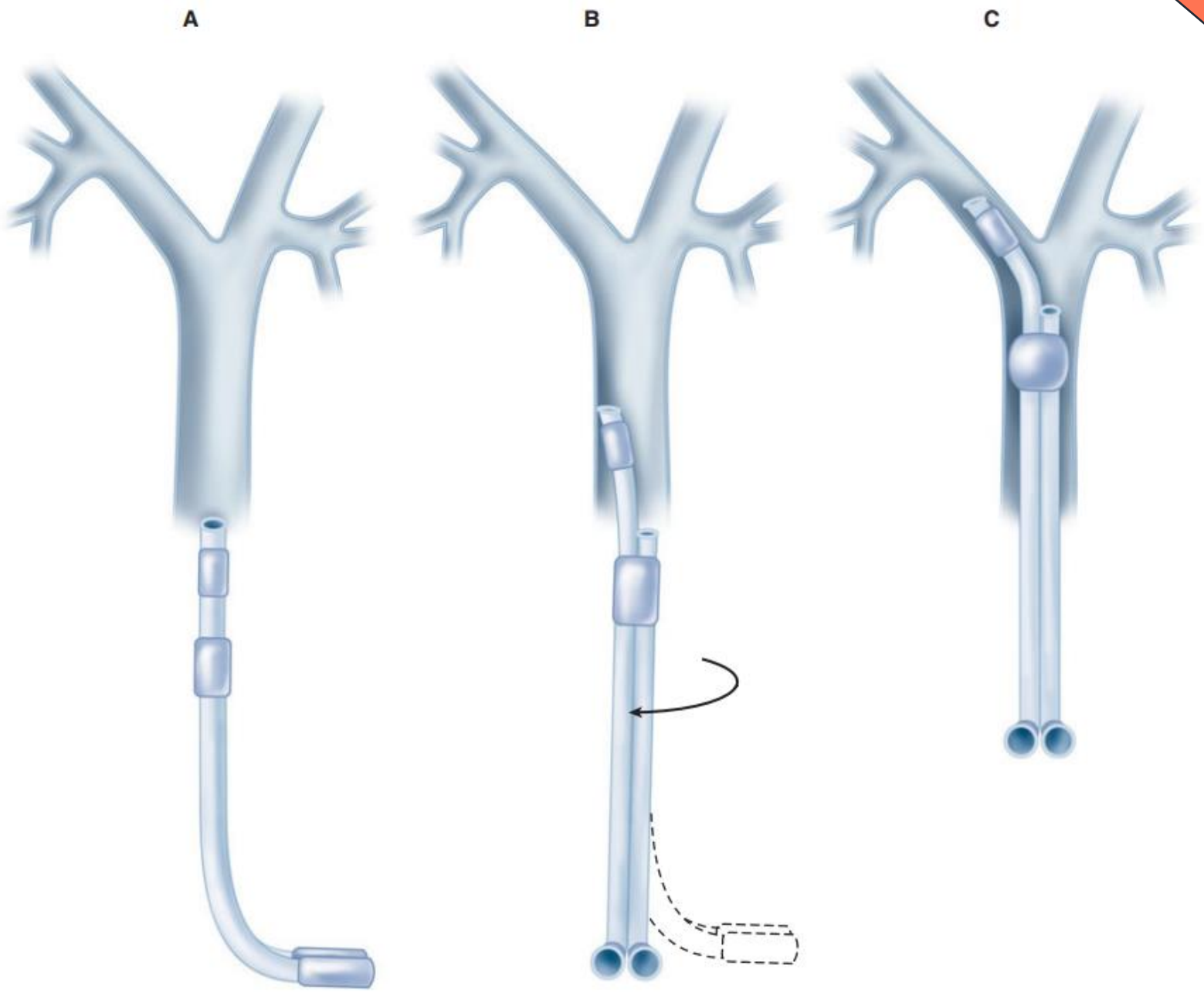
Placement of DLT :

Placement of a left-sided double-lumen tube. Note that the tube is turned 90° as soon as it enters the larynx.

A: Initial position.

B: Rotated 90°.

C: Final position.



DLT Placement :

Check its location

First step : the tracheal cuff –inflate &equal ventilation of both lungs

Second step : is to clamp the right side (in case of left sided tubes), inflate bronchial cuff slowly

Third step : remove the clamp & check both lungs are ventilated with both cuffs inflated.

Final step : selectively clamp each side &watch for absences of movement & breath sounds on the ipsilateral (clamped) side.

DLT Placement :

- Other methods to ensure position of a DLT :
  - Fluoroscopy
  - Chest x-ray
  - Selective capnography
  - Pediatric fiberoptic bronchoscope
  - Clinical observation
  - Surgeon; may be able to palpate, redirect or assist in changing DLT

position from within the chest (by deflecting the DLT away from the wrong lung, etc.).

Checking :

Left Side (DLT) Position .

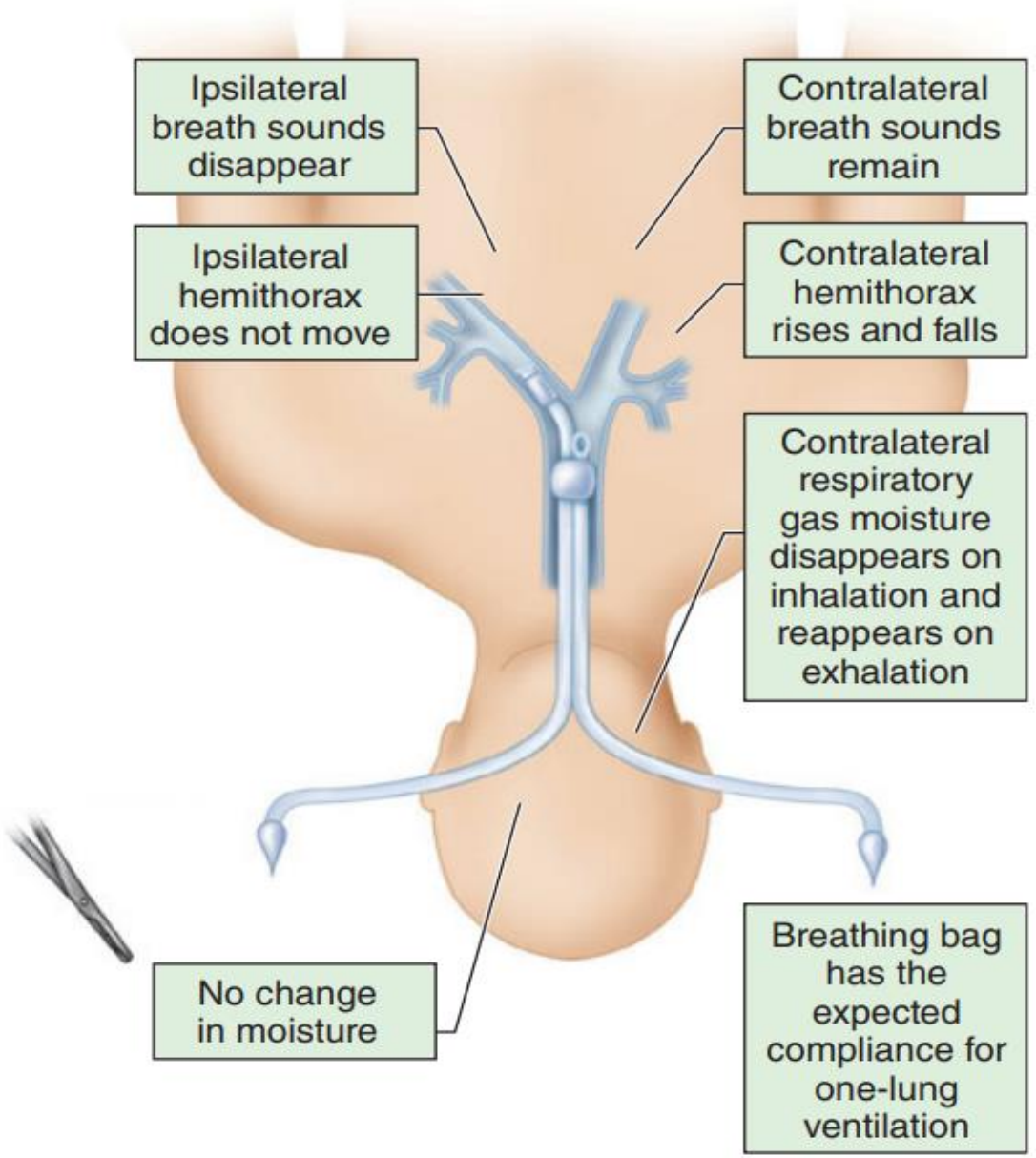


FIGURE 25–8 Results of unilateral clamping of the bronchial lumen tube when the double-lumen tube is in the correct position.

Protocol :

TABLE 25–2 Protocol for checking placement of a left-sided double-lumen tube.

1. Inflate the tracheal cuff (5–10 mL of air).
2. Check for bilateral breath sounds. Unilateral breath sounds indicate that the tube is too far down (tracheal opening is bronchial).
3. Inflate the bronchial cuff (1–2 mL).
4. Clamp the tracheal lumen.
5. Check for unilateral left-sided breath sounds.
   a. Persistence of right-sided breath sounds indicates that the bronchial opening is still in the trachea (tube should be advanced).
   b. Unilateral right-sided breath sounds indicate incorrect entry of the tube in the right bronchus.
   c. Absence of breath sounds over the entire right lung and the left upper lobe indicates that the tube is too far down the left bronchus.
6. Unclamp the tracheal lumen and clamp the bronchial lumen.
7. Check for unilateral right-sided breath sounds. Absence or diminution of breath sounds indicates that the tube is not far enough down and that the bronchial cuff is occluding the distal trachea.

Problems of Malposition of the Double-Lumen Tube :

1 - DLT in wrong bronchus

2 - DLT may be passes too far down either the right or left mainstem bronchus

3 - DLT not inserted for enough

4 - A right-sided DLT may occlude the right upper lobe orifice.

5 - The left upper lobe orifice may be obstructed by a left side DLT.

6 - Bronchial cuff herination & may obstruct the bronchial lumen

7 - Rare complication

- tracheal rupture .
- over inflation of the bronchial cuff .

Contraindications to Use of DLT :

- Full stomach
- Lesion (stricture, tumor) along pathway of DLT (may be traumatized);
- Patients, too small (<25-35kg) or too young (< 8-12 yrs.)
- Anticipated difficult intubation;
- Extremely critically ill patients who have a single-lumen tube already in place
- Under these circumstances, -using a single-lumen tube ,a bronchial blocker

Clinical Approach to OLV management :

- After positioning recheck the position of DLT
- Two-lung ventilation should be maintained for as long as possible
- Use FIO2 of 100 % .
- VT =Two strategies:
  - High tidal volume (10-12 ml/kg) without PEEP or
  - Moderate tidal volume (6-8 ml/kg) with PEEP
- Adjust RR to keep PaCO2 = 35+/-3 mmHg
- CPAP(5 to 10 cm H2O) keeps this lung "quiet" and prevents it from collapsing completely.

Management of hypoxemia during OLV :

- FiO2 = 1.0
- Intermittent two-lung ventilation
- Manual ventilation
- Check DLT position with FOB
- Check hemodynamic status
- CPAP (5-10 cm H2O, 5 L/min) to nondependent lung, most effective
- PEEP (5-10 cm H2O) to dependent lung, least effective
- Clamp pulmonary artery

Termination of surgery and Anesthesia :

- Placed in supine position before extubation.
- Both lumens of the DLT should be suctioned to remove any mucus, blood, or debris from each lung.
- Reinflating the collapsed lung; Hyperinflation of the lungs is an important maneuver to remove air from the pleural space at the site of thoracic surgery.
- The surgeon pours warm saline into the pleural cavity while the anesthesiologist applies increasing levels of inflation pressures (up to 30–40 cmH2O) by manually compressing the reservoir bag .

Termination of surgery and Anesthesia :

- Both lungs must be fully re-expanded and the mediastinum must be midline at the completion of one-lung ventilation.
- If mechanical ventilation of the lungs must be continued into the postoperative period, it will be necessary to replace the DLT with a single-lumen tube.
- Anesthesia is lightened &spontaneous ventilation reestablished.
- Place-sitting position after removal of DLT allowed to breath O2 enriched air.

Complications and their management Following Thoracic Surgery:

- Atelectasis (most common).
- cardiovascular herniation.
- hemorrhage from a major vessel.
- Pneumothorax .
- Dysrhythmias.

Postoperative Analgesia :

- Thoracotomy is among the most painful of all operative procedures. Good analgesia is essential hypoventilation due to pain may increase the risk of postoperative pulmonary complications

- **Systemic opioids :** Systemic opioids remain the mainstay of post-thoracotomy analgesic techniques.

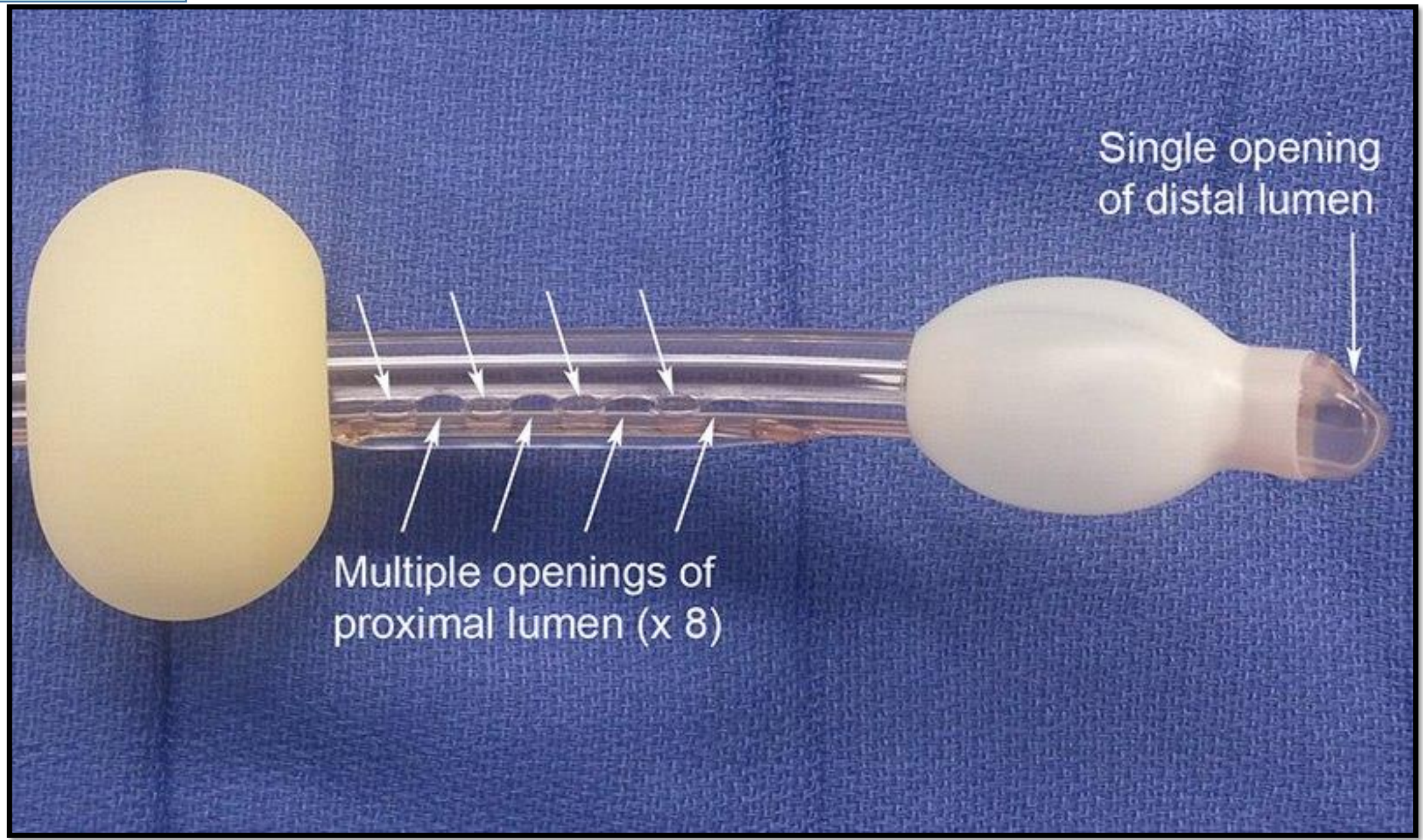
- Their major clinical limitation is a narrow therapeutic window.

- Well-controlled opiate infusion may provide comparable analgesia.

Postoperative Analgesia :

- NSAIDS : NSAIDs have opioid-sparing benefits when commenced Postoperatively. They do not produce respiratory depression
- Epidural analgesia : Thoracic epidural infusions of opiates appear to be more effective than lumbar
- Intercostal nerve blocks : Intercostal nerve blocks performed intraoperatively are of benefit for a short period immediately postoperatively.
- Interpleuaral analgesia : Interpleural analgesia is performed by directly infusing local anaesthetic into the pleural cavity.

Combi Tube :


Single opening
of distal lumen
Multiple openings of
proximal lumen (x 8)

Combi Tube :

Rigid bronchoscopy :

Procedure	Endoscopic inspection of tracheobronchial tree—± biopsy, stents, removal of foreign body
Position	Supine with head and neck extended
Practical techniques	TIVA with propofol, remifentanil, intermittent suxamethonium. IPPV through bronchoscope with oxygen via Venturi needle and Sanders injector

Rigid bronchoscopy / Preoperative :

- Check for airway obstruction—stridor, tracheal tumour on CT scan, or foreign body.
- Warn about postoperative coughing, haemoptysis, and suxamethonium myalgia.
- Often combined with mediastinoscopy to assess suitability for lung resection.
- The airway will be unprotected so patients at risk of regurgitation (omeprazole 40mg

Rigid bronchoscopy / Perioperative :

- Give full preoxygenation.
- Confirm surgeon is in the theatre before induction the GA .
- Boluses of midazolam (2–3mg) and Remifentanyl or Fentanyl
- A preinduction ‘taming’ dose of non-depolarising relaxant

(e.g. vecuronium 0.5mg) can reduce suxamethonium pains.

- Give suxamethonium just prior to bronchoscopy.

Rigid bronchoscopy / Perioperative :

- If there is potential airway obstruction (foreign body or tracheal compression) inhalation induction in theatre with sevofl urane in oxygen is recommended until airway is secure.
- Co-ordinate ventilation with surgical activity.
- Suction upper airway and confi rm adequate muscle power before removing the scope.

Rigid bronchoscopy / Postoperative :

- Turn patient biopsied side down to avoid bleeding into normal lung.
- Sit fully upright as soon as awake.
- Blood clot can cause severe lower airway obstruction requiring immediate intubation, suction, and repeat bronchoscopy.

Rigid bronchoscopy / Special considerations :

- The procedure is very stimulating and can generate a marked hypertensive response.
- Vocal cords can be sprayed with local anaesthetic (4% topical lidocaine), but this will not prevent carinal reflexes and may impair postoperative coughing.
- Rarely, biopsy can precipitate a life-threatening airway bleed.
- Stent insertion can be technically difficult and may involve periodic loss of airway control.

Rigid bronchoscopy/ Special considerations :

- Bradycardias caused by repeat doses of suxamethonium are rarely seen during rigid bronchoscopy in adults. Atropine should be drawn up, but routine administration is not recommended since this will exacerbate any tachycardia.

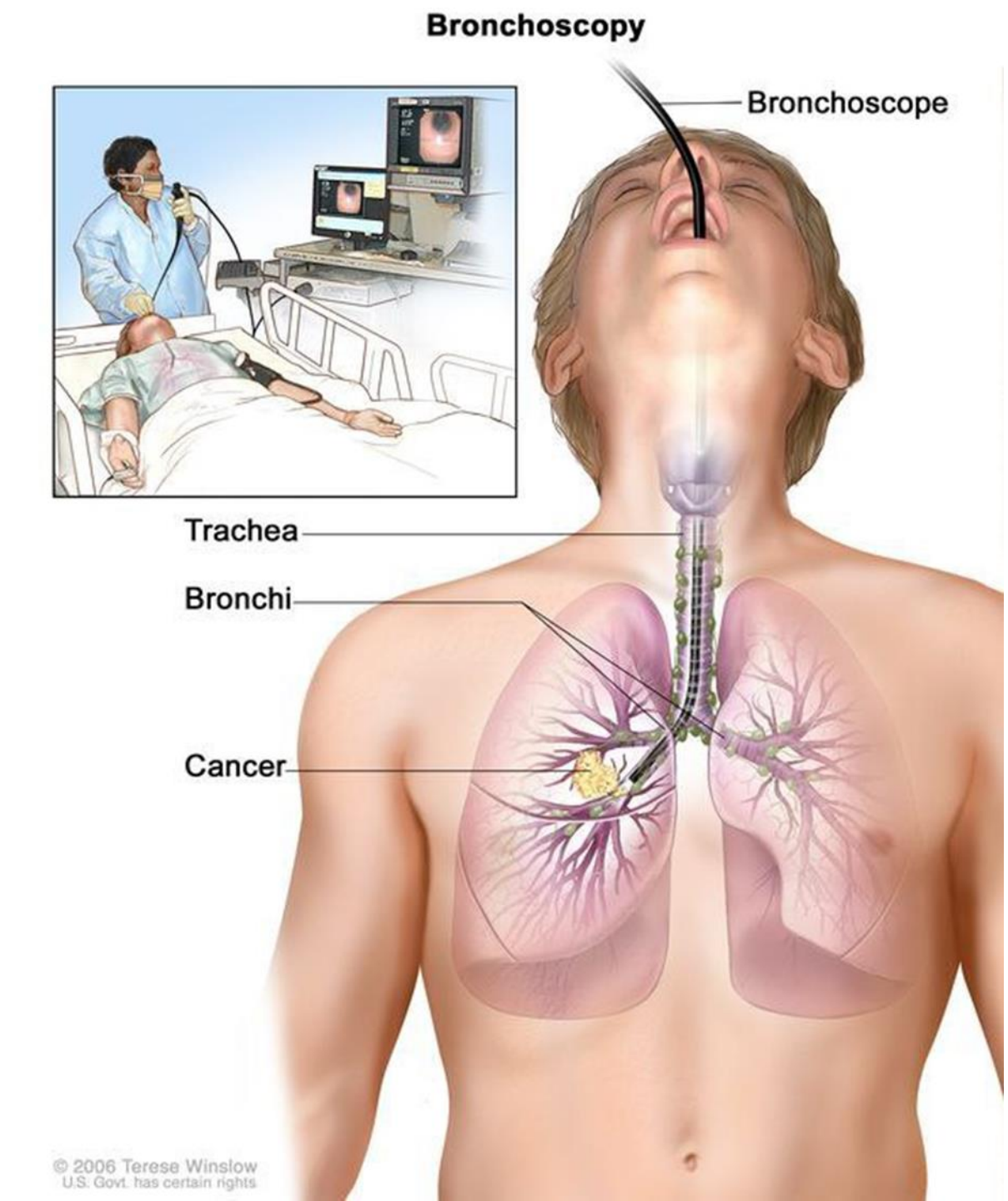
- Use of rocuronium followed by reversal with sugammadex may be an alternative.

Rigid bronchoscopy

Shape :


Aspiration probe
Rigid optic
Axial entrance
Lateral entrance
Lateral entrance for ventilation


KARL
STOR
DASORB
SMALL CHILD


Bronchoscopy
Bronchoscope
Trachea
Bronchi
Cancer
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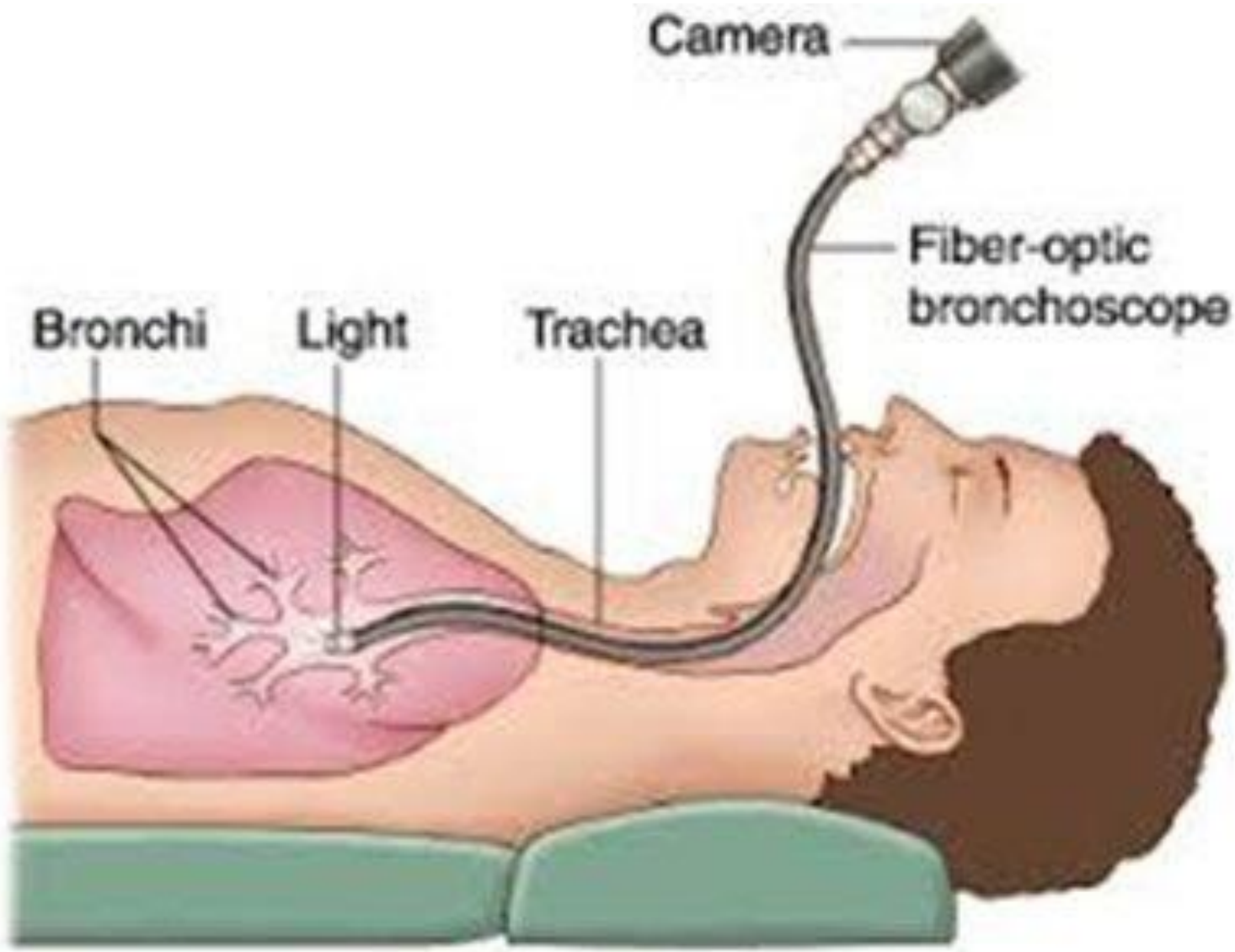
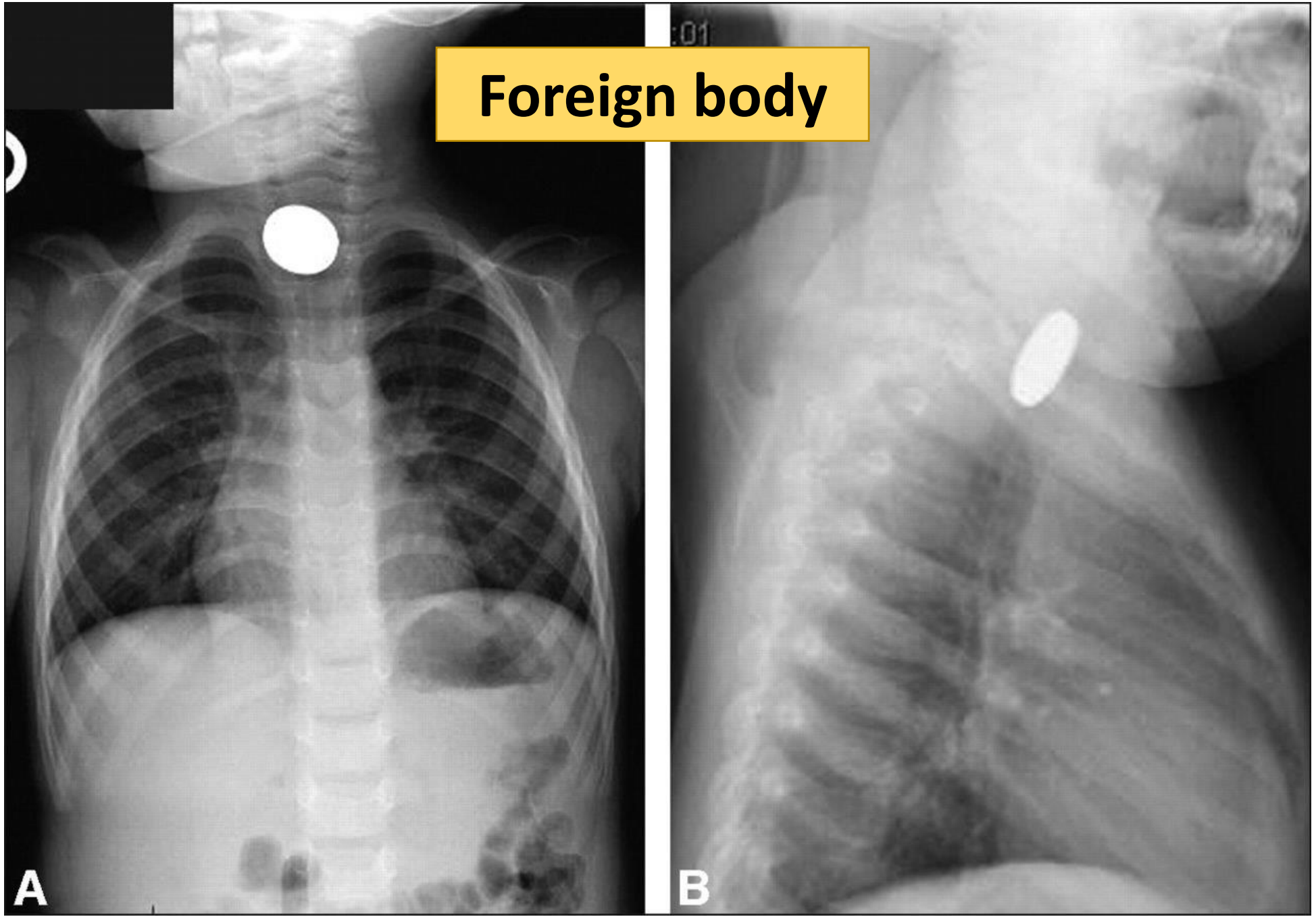
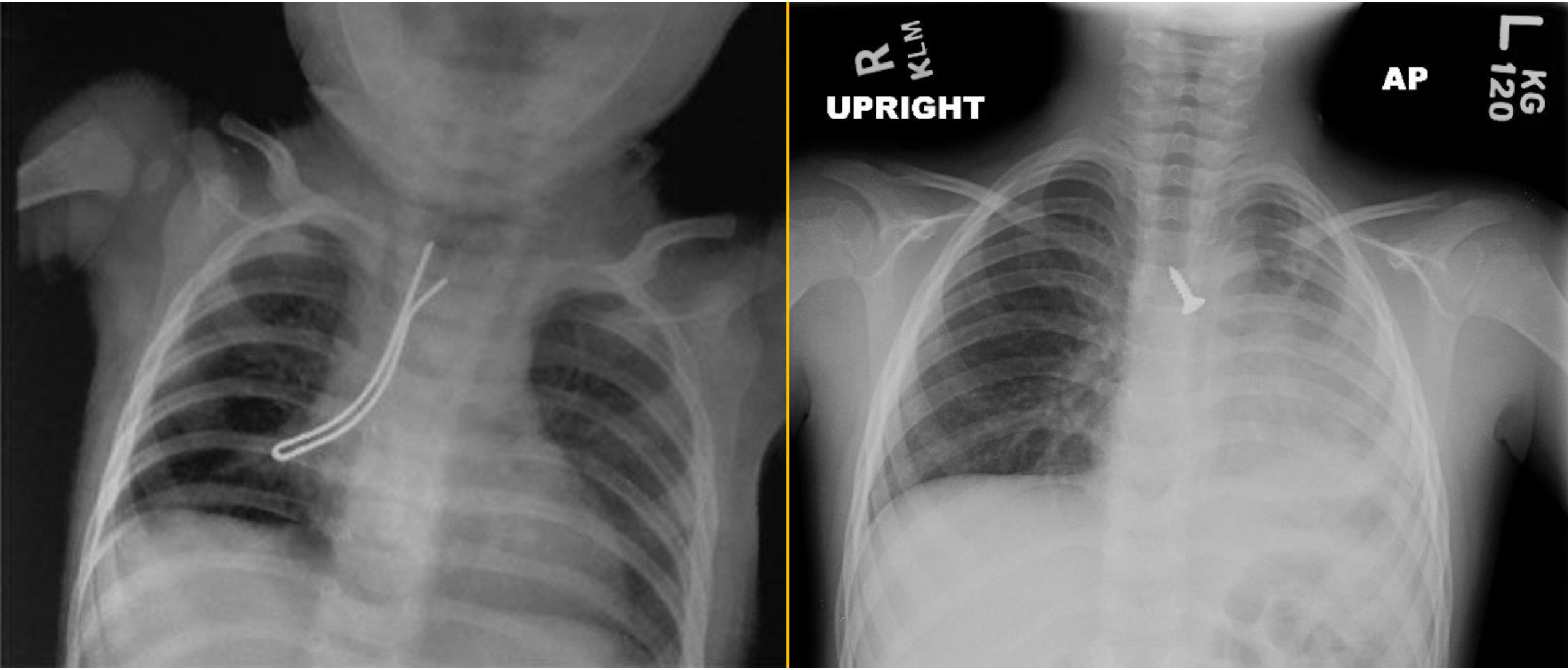

Camera
Fiber-optic bronchoscope
Bronchi
Light
Trachea

Foreign body



Foreign body



Thank You

End of lecture