ANAESTHESIA FOR THORACIC SURGERY IN CHILDREN -PARTICULARITIES-

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NEONATAL SURGERY

Most common thoracic non-cardiac surgical conditions:

- Oesophageal atresia, with or without tracheo-oesophageal fistula
- Congenital diaphragmatic hernia

Anesthetic techniques must be tailored to child and surgery, but the key principles of management are similar

Differencies in anatomy, physiology, pharmachology in neonates

- Oxigen consumption is twice that of an adult 7 ml/kg/ hour
- Hypoxia develops quickly
- Diaphragmatic breathing is important. Abdominal distension may compromise
- Thermolability – warming fluids and active warming strategies
- Response to hypoxemia is temperature dependent

Differencies in anatomy, physiology, pharmachology in neonates

- Haemoglobin 20 g/dl but fetal Hb, poor tissue oxygen delivery.
- Postoperative apnea, mostly in prems and anaemia
- Vitamin K dependent clotting factors are low at birth. Vitamin K 1 mg IM
- Adequate analgesia! nociceptive pathways develop and vulnerable long term consequences
- Hypoglycemia

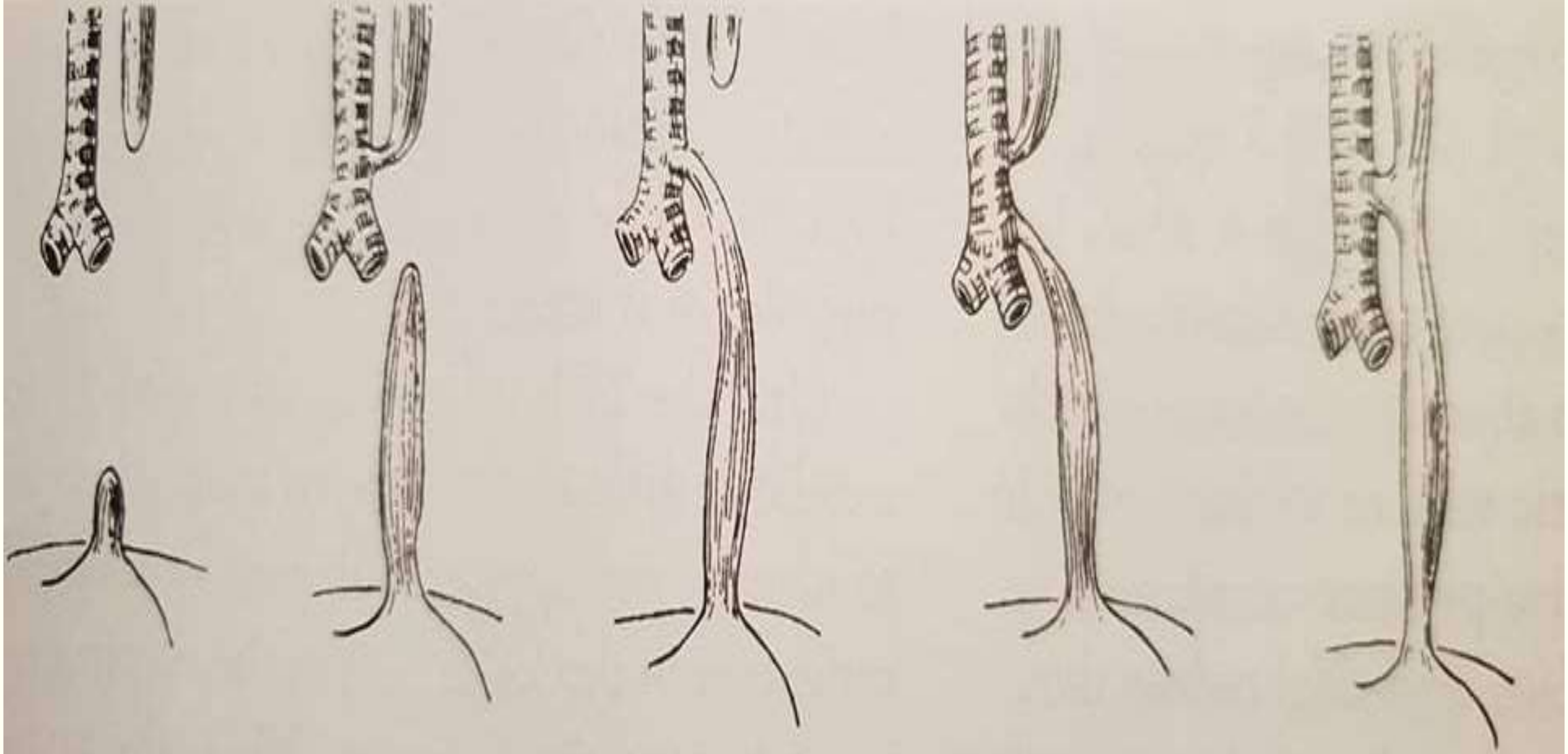
- Congenital heart disease
- Echocardiography preoperatively
- Prostacyclin infusion for patency of ductus arteriosus. Low pulmonary lung perfusion may need systemic to pulmonary artery shunt

ANESTHESIA

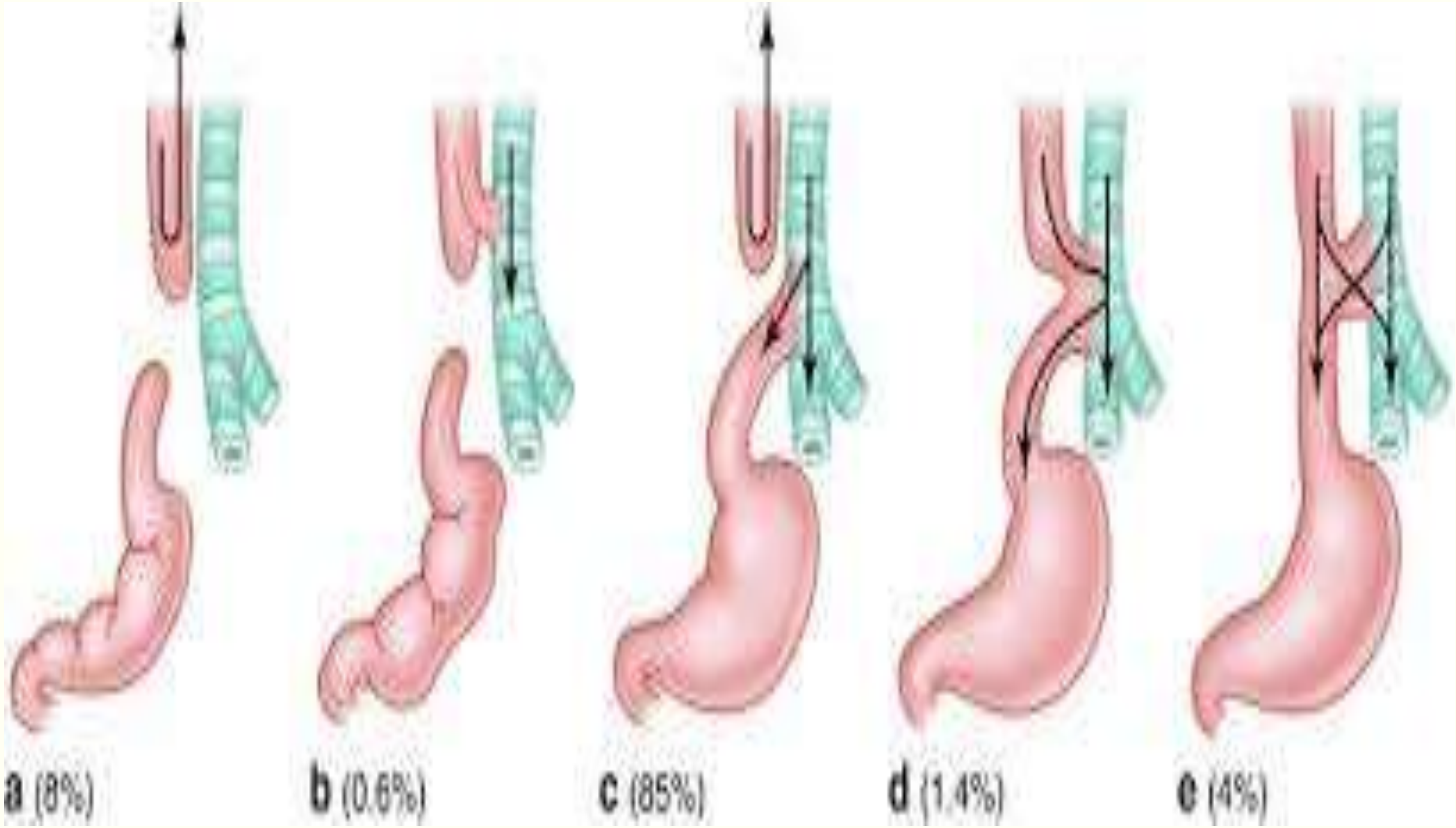
- Fasting 6 hours (formulas), 3-4 hours (breast- fed), 2 hours (clear fluids)
- Tracheal intubation. Laringeal mask size 1 <
- MAC higher
- Myocardium sensitive to depression and vagotonic action of volatile agents – Atropine 0.02 mg/kg
- Sevo for induction, Sevo, Iso or Desflurane for maintenance
- Opioid- based techniques when postop ventilation
- Venous capacitance is relatively low
- Maintaining normothermia

OESOPHAGEAL ATRESIA AND TRACHEO-OESOPHAGEAL FISTULA

- Several variants
- 5 types classification; with or without fistula
- Type C distal tracheao-oesophageal fistula
- Polyhydramnios, malformations, anomalies
- First feed – no passage of a nasogastric tube
- Chest X ray - coiled tube
- Aspiration
- Chronic lung disease
- continuous low level suction
- gastrointestinal ventilation, distension, respiratory compromise
- Gentle gas induction



A B C D E


a (8%)
b (0.6%)
c (85%)
d (1.4%)
e (4%)

OESOPHAGEAL ATRESIA

No nitrous oxide

Gentle epigastric pressure by the assistant

Intubate deep and withdraw to block the fistula

Rigid bronchoscopy

If gastric distension – disconnect and decompress the stomach via the tracheal tube. Urgent gastrostomy is not useful

Fogarty catheter to block the fistula

Right thoracotomy, right lung retracted, gentle hand ventilation

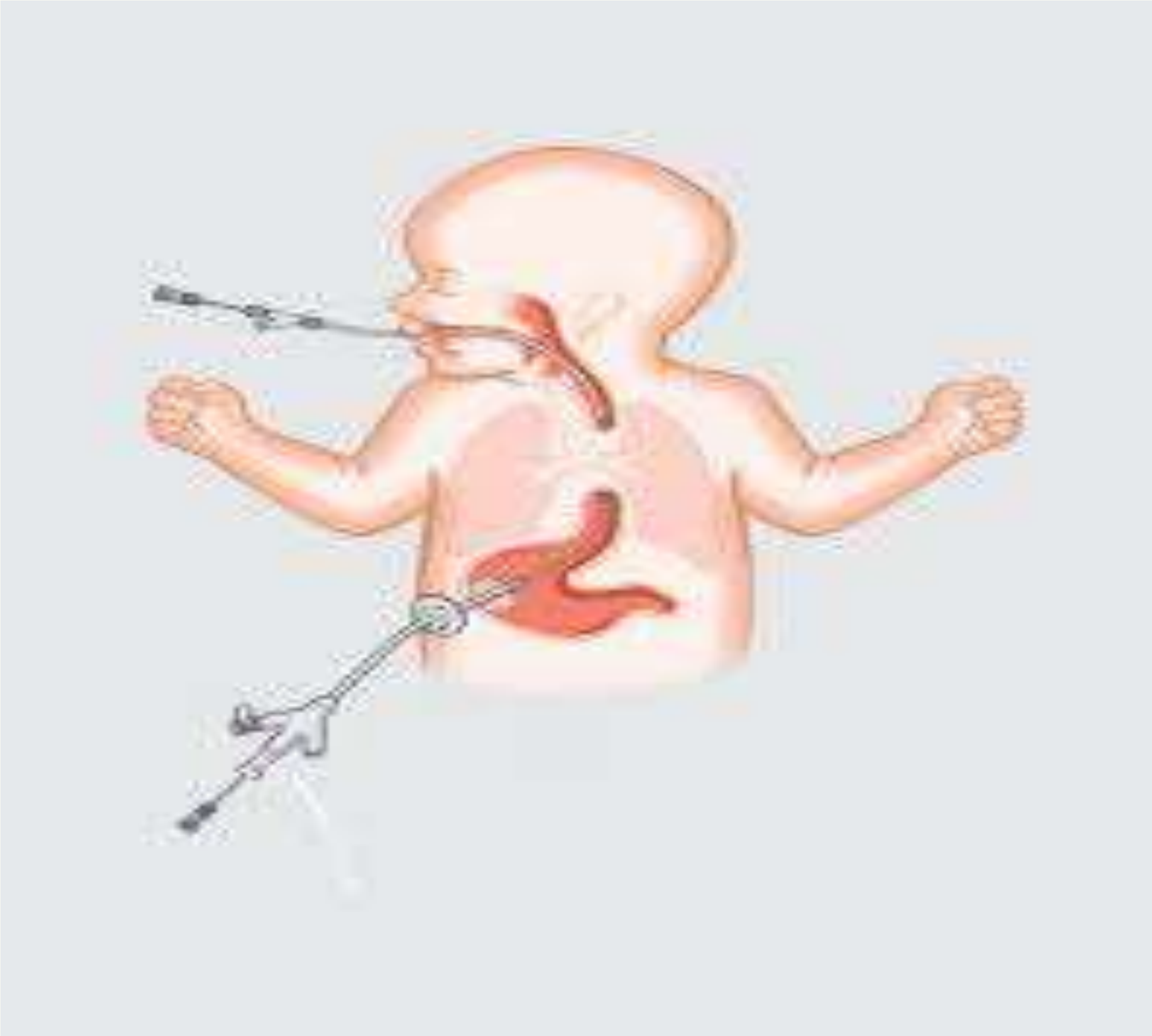
Unstable, desaturations, re-ventilation of the compressed lung

Ligation, anastomosis, labeled transanastomotic tube.

OESOPHAGEAL ATRESIA

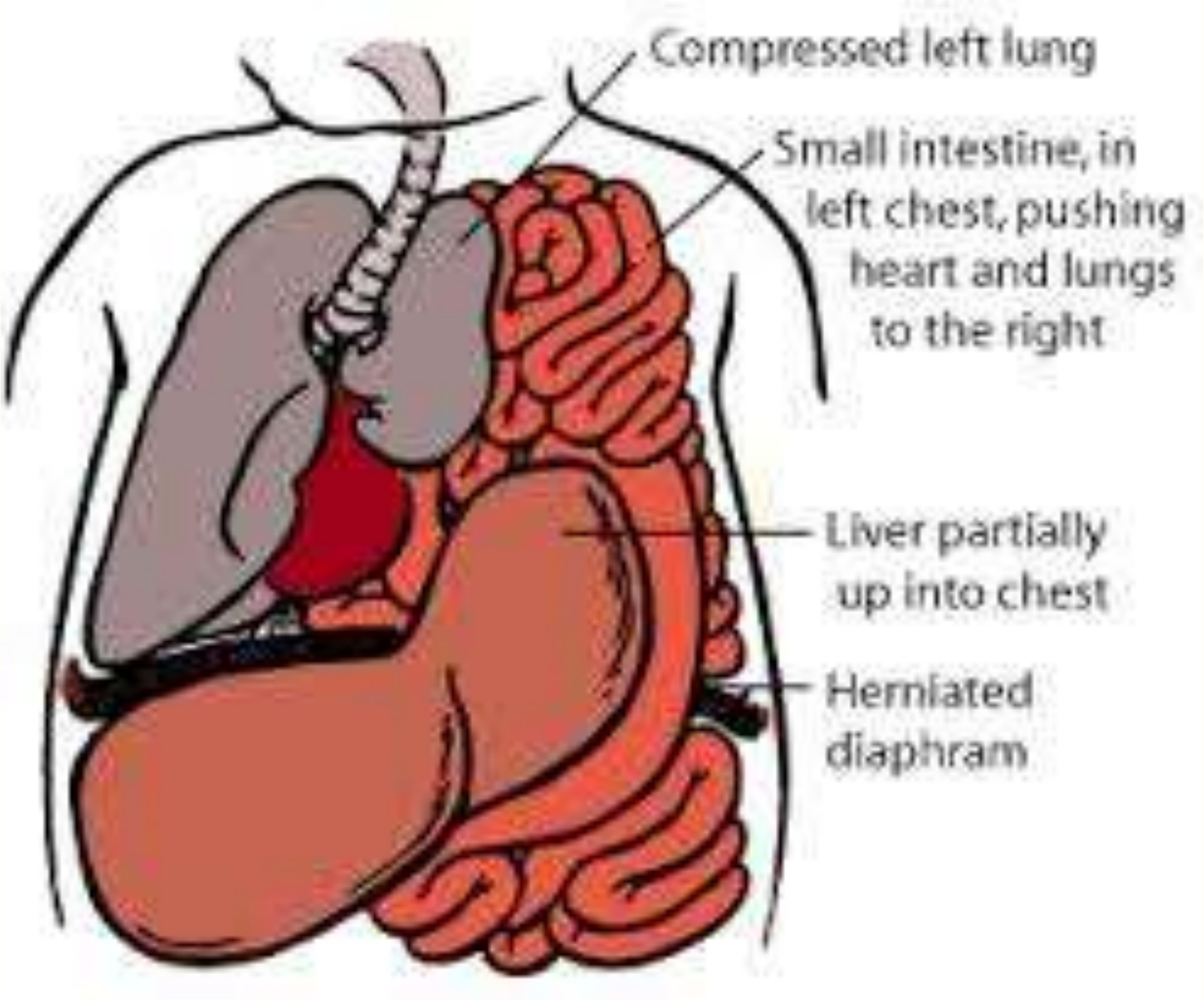
- Oesosophagostomy
- Gastrostomy
- Extubate vs postop ventilation (curare)

- Gastrooesophageal reflux
- Tracheomalacia – aortopexy
- Strictures. Dilations of oesophagus



CONGENITAL DIAPHRAGMATIC HERNIA

- 1 / 5000 live births
- Left hand side
- Antenatal diagnosis
- Lung underdeveloped, abdominal viscera cranial migration, pushed mediastinum
- Respiratory distress
- HFOV or ECMO
- Pulmonary hypertension
- Nitric oxide


Compressed left lung
Small intestine, in left chest, pushing heart and lungs to the right
Liver partially up into chest
Herniated diaphram

CONGENITAL DIAPHRAGMATIC HERNIA

- Surgical closure – stable, conventional ventilation, off inotropic support
- CHD 98% left posterolateral (Bochdalek), 2% retrosternal
- Primary closure/ patch (anterior abdominal wall scaphoid)
- Derotation and fixation of the abdominal content
- Elective appendicectomy

- Postoperatively - hypoxia ongoing – pulmonary hypertension, right to left shunting through ductus arteriosus

CONGENITAL ABNORMALITIES OF THE LUNG
CONGENITAL LOBAR EMPHYSEMA

- Due to bronchial cartilaginous dysplasia
- Valve effect, emphysematous accumulation of air, poor deflation of the lobe
- Left upper lobe
- Incidental X ray finding, to acute distress
- Lobectomy

CONGENITAL CYSTIC ABNORMALITIES OF THE LUNG

- **Cystic adenomatous malformation**

- **Pulmonary sequestration**

- **Bronchogenic cysts**

Symptoms caused by mass effect or secondary infection

- **Congenital cystic adenomatous malformation**

- Local arrest of maturation of fetal lung
- Filled cysts non communicating
- Resection to relieve compression / infection, malignant change

- **Pulmonary sequestration**

- Separate bronchopulmonary mass or cyst disconnected from the bronchial tree
- but separate blood supply from the aorta

- From a supernumerary lung bud

- **Bronchogenic cysts**

- Solitary, unilocular, mucus filled

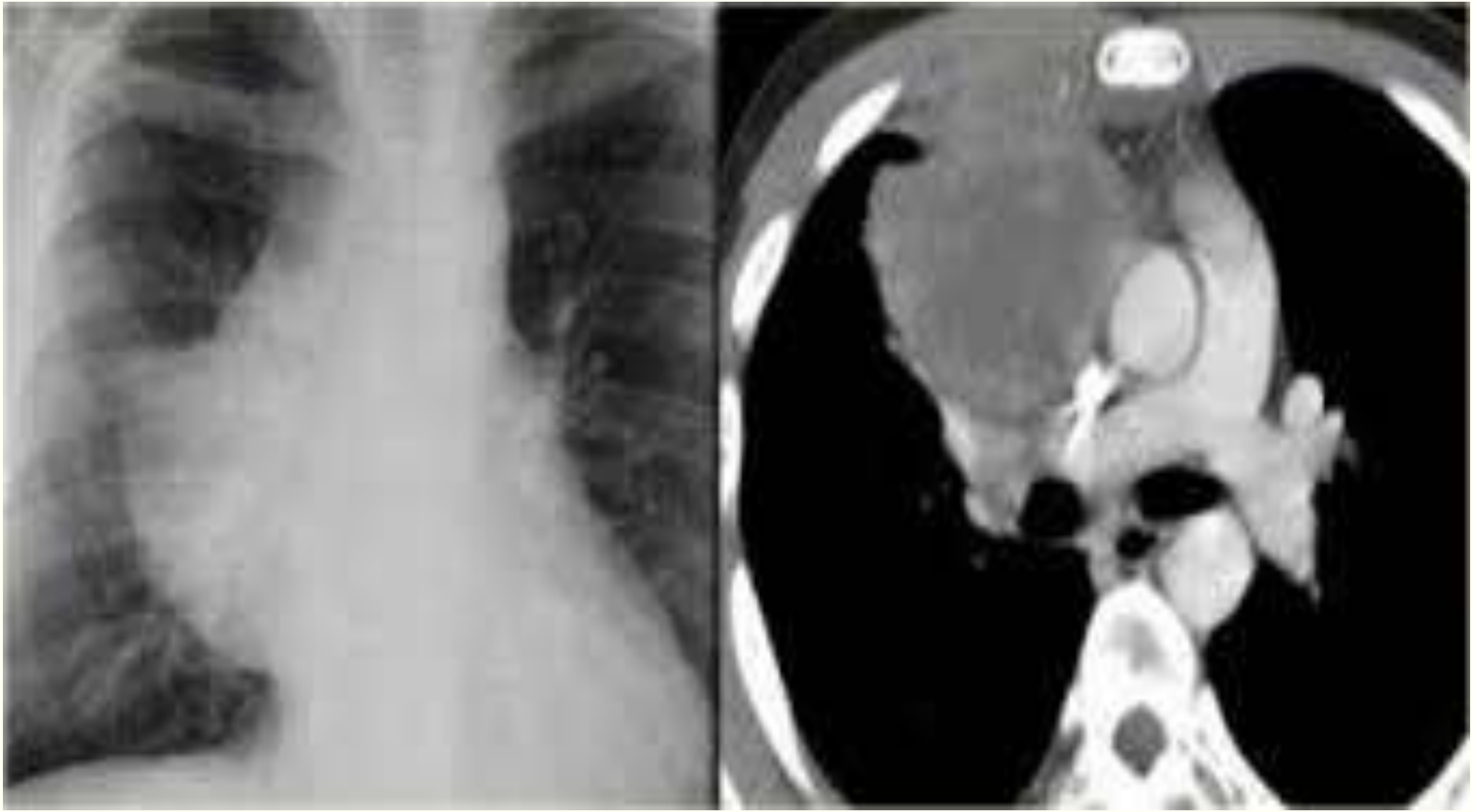
- May become infected


A
B

ACQUIRED PATHOLOGY
THORACIC TUMOURS IN CHILDREN

- **Primary lung**
- **Thoracic** – neuroblastoma
- **Metastases**

- **Anterior mediastinal mass**
- Hematological malignancy ex lymphoma, or primary malignancy
- Compression, airway obstruction, venous return
- Risc with relaxation and changing position
- Rigid bronchoscope, or prone position.
- Cardiopulmonary bypass



PLEURAL COLLECTIONS EMPYEMA

- Bacterial pneumonia – pneumococcal
- Purulent pleural effusion
- Broncho pleural fistula
- Surgical decortication, on a small thoracotomy incision
- Bacteriemia and haemodinamical compromise
- Treat anaemia. Blood loss!
- Stabilise. Possible postoperative ventilation

LUNG ABCESSES

- Primary infection
- Foreign body

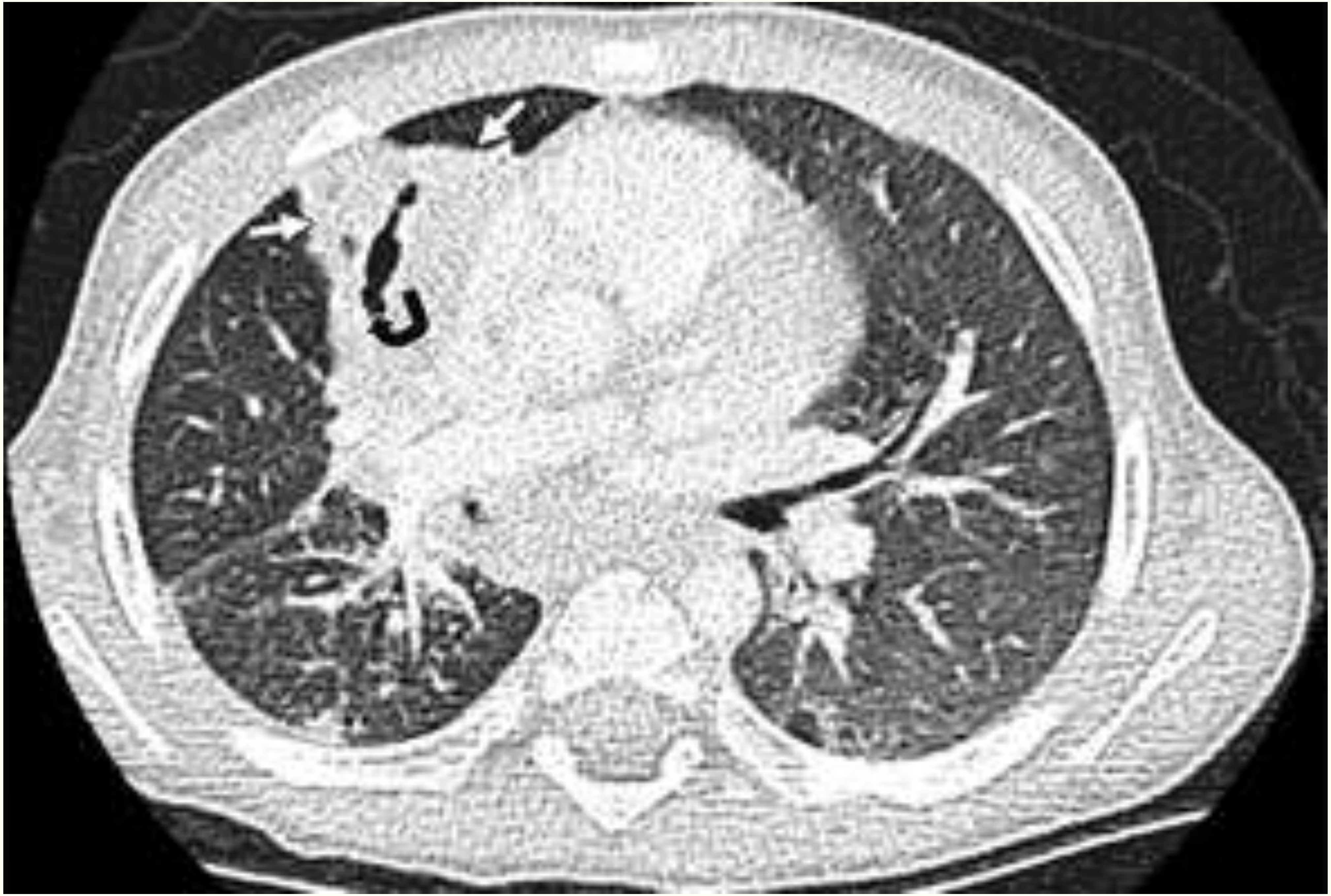
- Lung resection
- Bronchopleural fistula

- Protective one lung ventilation

BRONCHIECTASIS

- Damaged and dilated bronchi
- Cystic fibrosis
- Associated with immune compromise

- Surgical resection with single lung ventilation



CHEST WALL DEFORMITY

- Pectus escavatum. Pectus carinatum
- Ravitch,   Nuss procedure

- Thoracoscopy with CO_2

- Pain; epidural

ANAESTHESIA FOR THORACIC SURGERY
SPECIFIC CONSIDERATIONS

Hypoxic pulmonary vasoconstriction

- Limites blood flow through unventilated or hypoxic areas of lung
- Inhibitory effects of inhalational anaesthetic agents on HTP – debatable

LATERAL DECUBITUS POSITION

- Ventilation/perfusion mismatch may result in hypoxaemia
- More marked in infants
- FRC increases when moved from supine to lateral
- Opening pleura, than retracting the lung decrease FRC with 50 %
- FRC returns to baseline on completion of surgery

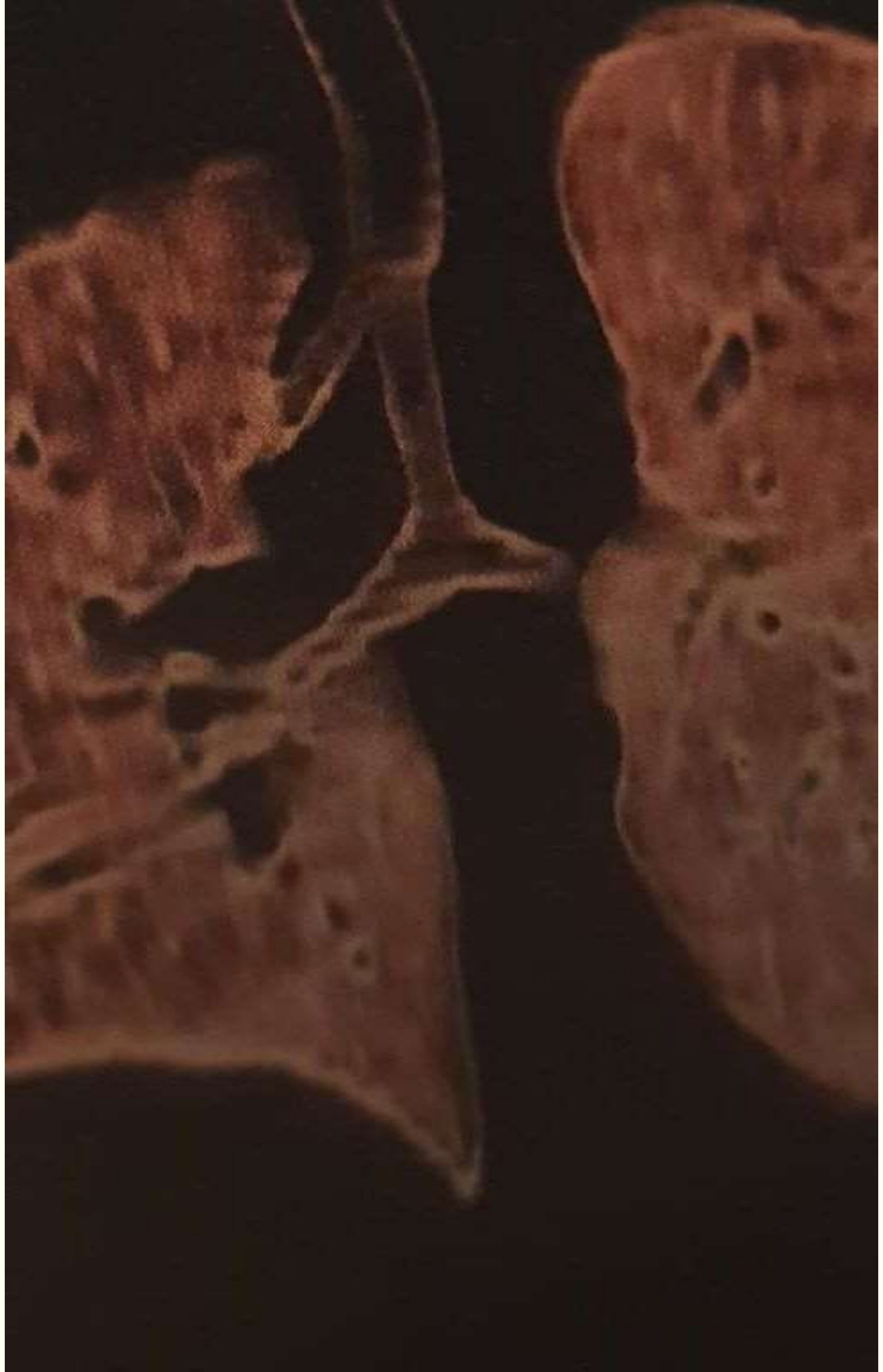
LUNG RETRACTION

- When single lung ventilation is not possible
- Low compliance
- Saturation 85 – 90 %
- Avoid lung contusion and mediastinal compression – occlude venous return to the hearth.
- Use PEEP during thoracotomy

SINGLE LUNG VENTILATION

Single lumen tube

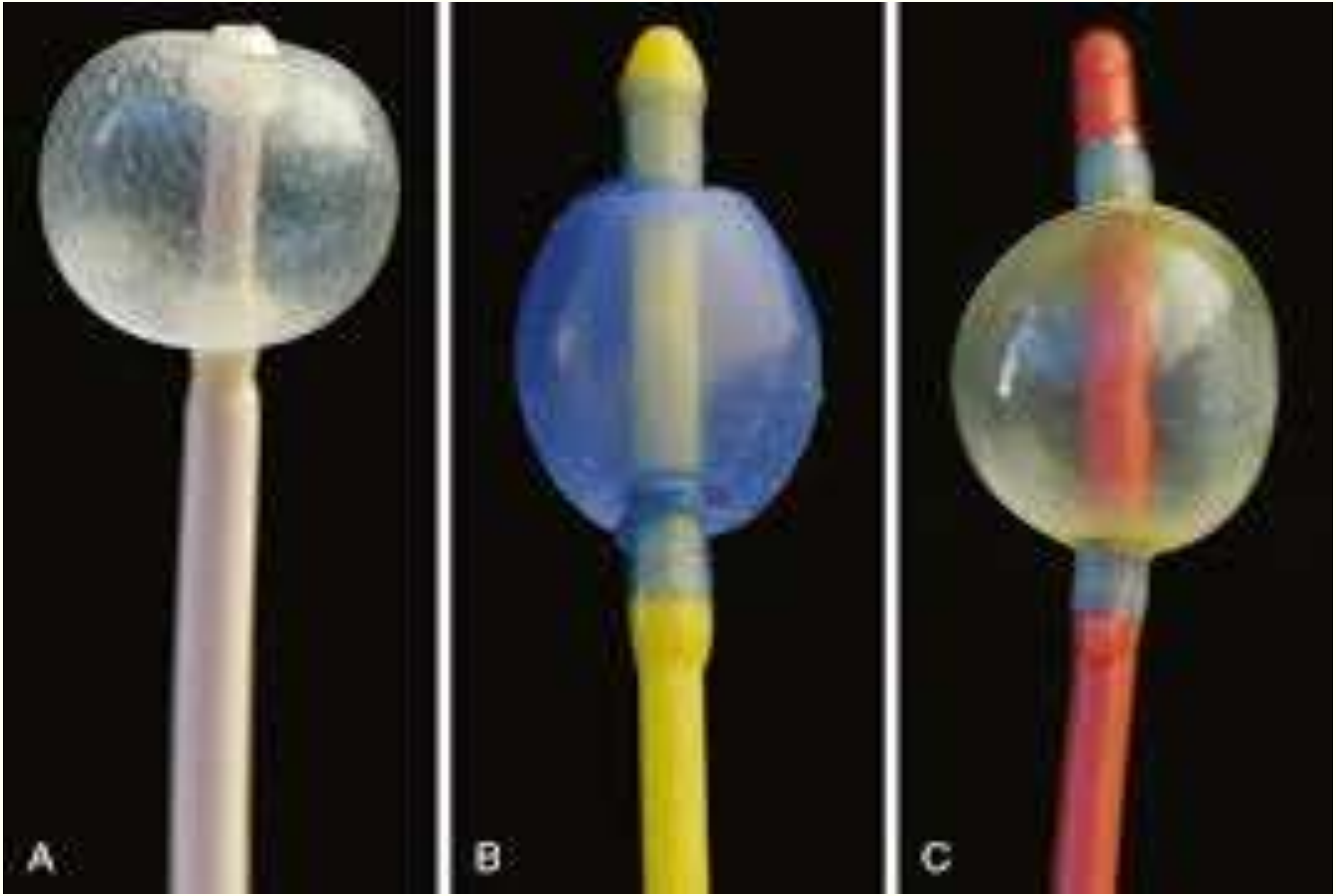
- The mainstem bronchus of the nonoperative side is intubated with a tube 0.5 mm smaller than normal; usually the right main bronchus
- For left, raise the right shoulder and turn the head towards the right
- Fiber-optic bronchoscope passed through the tube, than advancing the tube over the bronchoscope
- Movement tolerance in small children is 2-3 mm, ! upper lobe ventilated
- The upper right bronchus can arise from the carina , or directly from the trachea
- Auscultation, when moving the child.
- Sealing the bronchus with an uncuffed tube
- Cuff can occlude the upper lobe bronchus



SINGLE LUNG VENTILATION

Baloon-tipped bronchial blockers

- Baloon, central lumen which the lung deflates
- End hole balloon wedge catheter
- Fogarty embolectomy catheter
- Wire guided endobronchial blockers WEB; 5 Fr, outher diameter 1.7 mm; passed through bronchoscopy
- 2.2 bronchoscope admit a 4.5 mm internal diameter tracheal tube. 9.7 kg child


A
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SINGLE LUNG VENTILATION

- *Univent tube*
- Conventional tracheal tube with a second lumen through which a bronchus blocker is advanced
- 3.5 mm internal, same as a 5 mm tracheal tube; children > 2 years.

- *Double lumen tubes*
- Two inequal length tubes moulded together. Left / right sided
- Adolescence

INDICATIONS FOR SLV IN CHILDREN

Strong indication

- major gas trapping in one lung or pleural space
- lobectomy to prevent airway soiling by blood or pus
- minimally invasive thoracic surgery

Moderate indication

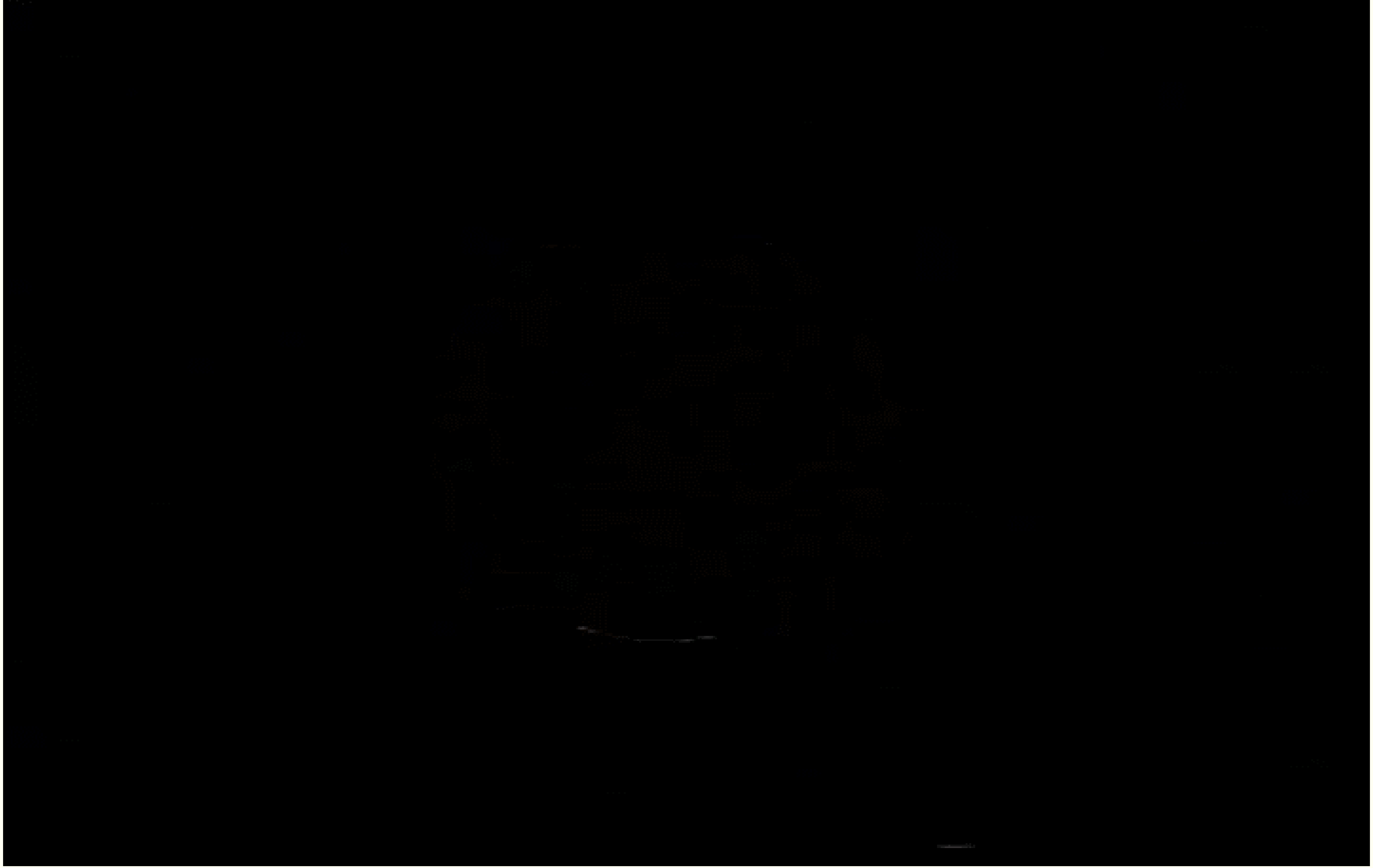
- lobectomy or pneumectomy for cystic malformations and tumour
- anterior spine surgery
- oesophageal or aortic surgery

Contraindication SLV

- unacceptable hypoxia after institution of SLV
- safe isolation of the lung impossible

BRONCHOSCOPY

- Rigid and flexible
- Prior to intubation
- Lung isolation, variants, microbiological tests
- Stridor, infections, trauma, tracheomalacia, stenosis, extrinsic compression …
- Smallest flexible 2.8 mm; without succion 2.2 mm
- Through laryngeal mask or transnasally
- Rigid; can ventilate if attaching a open circuit to the side arm of a Storz bronchoscope
- Inhalational agents, or I.V.

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DR RIZESCU
Facility:

VIDEO ASSISTED THORACOSCOPIC SURGERY

- Minimally invasive surgery
- Intrapeural insufflation of carbon dioxide; venous return !

Pleural drains

- Tube + one way valve + collecting chamber
- Different suction sources for different tubes
- Not clamped or occluded in IPPV – tension pneumothorax!

PRINCIPLES OF ANAESTHESIA FOR THORACIC SURGERY

- Topical local anaesthetic
- Nitrous oxide - contraindicated

Vascular access

- Bleeding, plasma losses
- Peripheral and central venous access
- CVP monitoring can be misleading in lateral decubitus
- Invasive arterial pressure monitoring

VENTILATION STRATEGIES

- No spontaneous ventilation
- Muscle relaxation and IPPV
- Sever congenital lobar emphysema; spontaneous vent until the chest wall is opened, or slow respiratory rate without PEEP, SLV when possible
- Tailoring the ventilation
- Spirometry
- Manual ventilation
- Permissive hypercapnia
- Compliance monitoring
- End tidal capnography may underestimate $PaCO_2$, in SLV

POSTOPERATIVE MANAGEMENT AND ANALGESIA

Postop analgesia in neonates

- IV nurse controlled **morphine**
- Boluses 10 mcg/ with 20-30 min lockout, no background infusion.
- **Paracetamol**
- Prems 45 mg/kg/ day
- 32 weeks postmenstrual age to 3 months 60 mg/kg
- Ibuprofen – not licenced below 3 months
- **Epidurals**
- Levobupivacaine plain 0.125 %, up to 0.3 ml/kg/h

POSTOPERATIVE ANALGESIA IN CHILDREN

- Intensive therapy

- Pain management, physiotherapy, CPAP

- Most intense pains
- Combination of regional + systemic analgesia (opioid and non steroid).

POSTOPERATIVE ANALGESIA IN CHILDREN

- Regional anaesthesia
- Intercostal nerve blocks
- Subpleural space catheter, blocking also the paravertebral space
- Epidural analgesia - catheter at the op level , or caudally inserted
- Intrapleural instillation of LA;   toxicity!

POSTOPERATIVE ANALGESIA IN CHILDREN

- Systemic analgesia
- Opioid infusion, NCA or PCA boluses, 48 hours after thoracothomy, in addition to RA
- Paracetamol
- NSAID

THANK YOU!