Lobectomy

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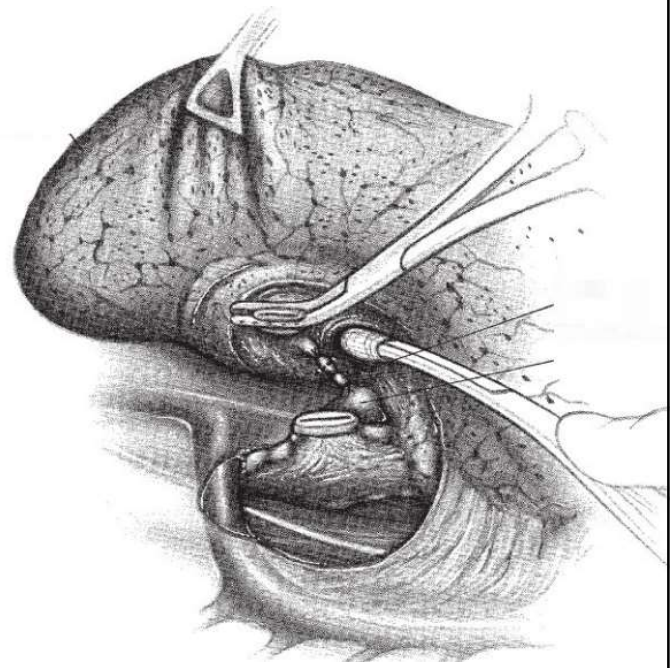


Introduction

- pediatric lobectomy is challenging
  - small rigid cavity
  - expanded lobe/cyst prevents the creation of a work space for VATS
    - VATS used if over-inflation is mild or after effective endoscopic decompression
  - inability to collapse the involved lung for the operation.
  - lung and mediastinum move continuously due to the beating heart
  - pulmonary arteries are thin walled and prone to unintentional injury.

    **Simultaneous traction and countertraction should be avoided

Outline

1. Anesthetic considerations
2. General principles
3. Right lung lobectomy
4. Left lung lobectomy

1. Anesthetic considerations

General Pediatric Considerations

- **Temperature** – need thermo-neutral environment
  - Weight inc by 20x but length will only inc by 3.5x (higher BSA:vol)
  - Less subcutaneous, Immature musculature (inability to shiver)
- **Airway** – difficult intubation
  - Large head, short neck
  - large tounge, larynx higher (C3), epiglottis floppy & horseshoe, cricoid narrowest point
- **Ventilation** – can't tolerate increased work of breathing (apnea as baby tires)
  - abdomen large, reduce FRC
  - ribs more horizontal & elastic and lack of type 1 (slow) fibers in diaphragm
  - metabolic rate is higher (2x oxygen consumption and CO2 prod)
- **Other systems**
  - **Pulmonary vasculature** liable to hypoxia (may develop reverse shuntinig through PDA or PFO)
  - **Fetal hemoglobin** allows neonate to tolerate desaturation but can't offload oxygen
  - **Immature kidneys** (inability to conc. urine) so can't compensate for change in hydration status
  - **Immature liver** (can't metabolized drugs) and glycogen storage is poor

Ventilation

- Positioning in lateral decubitous causes V/Q mismatch
  - Dependent lung compressed by mediastinum but more perfused due to gravity
  - Exacerbated by anesthesia (diaphragmatic relaxation + abdominal content push to thorax)
  - increased compliance of the child's chest wall allows further compression of the dependent lung and a greater reduction in that lung's FRC
  - **Use less volatile agents (more opioids) b/c they interfere with HPV of the dependent lung
- hypoxic pulmonary vasoconstriction (HPV) – is what allows single lung ventilation (SLV)
  - infants don't tolerate SLV well but lesions such as CLE produce alterations in the V/Q r/n ship
- In CLE there is hyperinflation of the lobe that may impair cardiac output.
  - Positive pressure ventilation should be used with caution
  - Nitrous oxide is often avoided

Single lung Ventilation

- **Double lumen tube** for older children
- **conventional ETT** pushed to the non operated side for smaller children
  - ventilation and isolation not reliable
  - May lead to inadvertent extubation when pulling tube back up to trachea
  - May lead to leak if smaller size needed for bronchial intubation
  - Intubate main bronchus with 3.0 micro cuffed ETT with fluoroscopy guidance
- **bronchial blocker tube** (balloon tipped embolectomy catheter may be used)
  - provide reliable lung isolation
  - If incorporate a central lumen, can use gentle suction to aid lung deflation.

Pain

- CNS is functionally immature, but despite immaturity pathways for noxious stimuli (pain are present)
- increased **blood–brain barrier permeability** to drugs
- tendency to **apnea** at times of stress
- greater risk of local anesthetic toxicity because of reduced protein binding and **immature metabolic pathways**.
- **dural sheath extends down** to the L4–5 level at birth, meaning that even low level epidural insertion has risk of cord injury
- hypotension with epidural less likely b/c lower resting sympathetic tone

Pain control

**pain will lead to an inadequate depth of breathing and reluctance to cough and must be avoided*

- intercostal nerve blocks (percutaneously or under direct vision): For few hours (adjunct)
- Epidural analgesia
  - at dermatomal level of incision (T4-T8)
  - Can also be advanced from caudal approach to minimize cord injury
  - Combination of dilute local anesthesia and opioids (bupivacaine-fentanyl)
- Paravertebral local anesthetics
  - placed in the paravertebral space (percutaneously or under direct vision)
  - similar analgesia to an epidural **on the side of the operation**
- IV opioids (morphine) – mainstay if epidural contraindicated
- Adjuncts (NSAIDs) – IV acetaminophen, diclofenac, ibuprofen

2. General principles of lobectomy

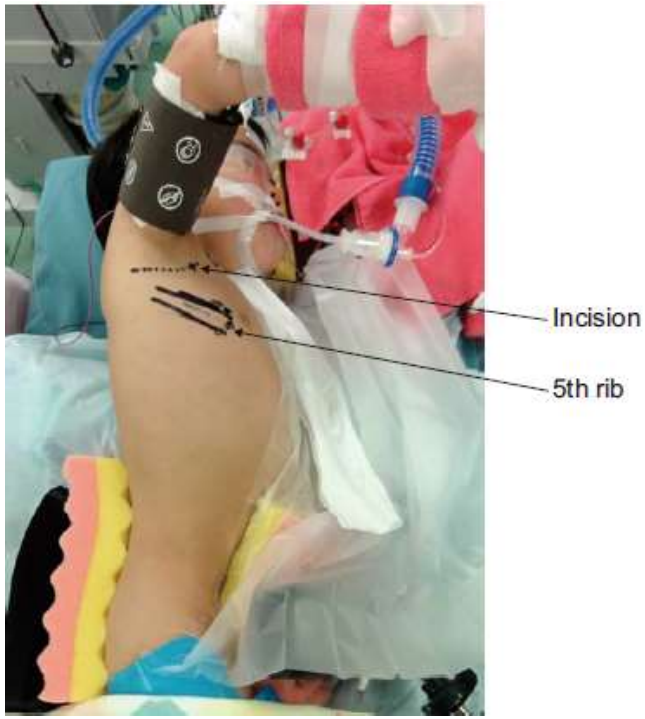
General principles of lobectomy

- principles of lobectomy are similar in children and adults
- **The most important consideration is adequate exposure of hilar structures**
  - Usually divide artery>>vein>> bronchus.
  - Divide bronchus first if purulent infection

General principles of lobectomy

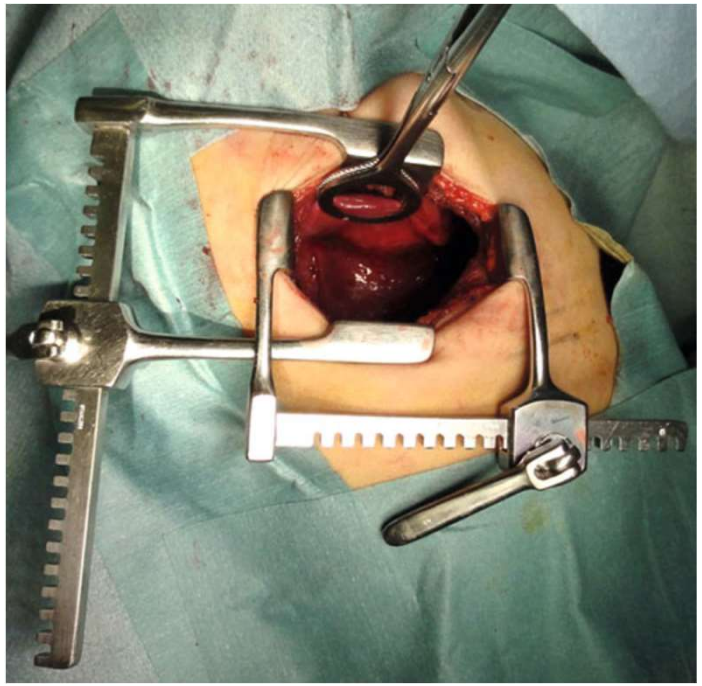
- Single lung ventilation preferred.
- position lateral decubitus with slightly prone (axillary roll and padding of legs)
- Posterolateral thoracotomy (muscle sparing mini thoracotomy) and divide adhesions between lung and pleura
- perforation of visceral pleura to decompress the lobe prior to lobectomy
- **Remove lobe** once completely isolated
- **Test** for air leak (uncommon if using staplers for non anatomic resection)
- 12 Fr **chest tube**

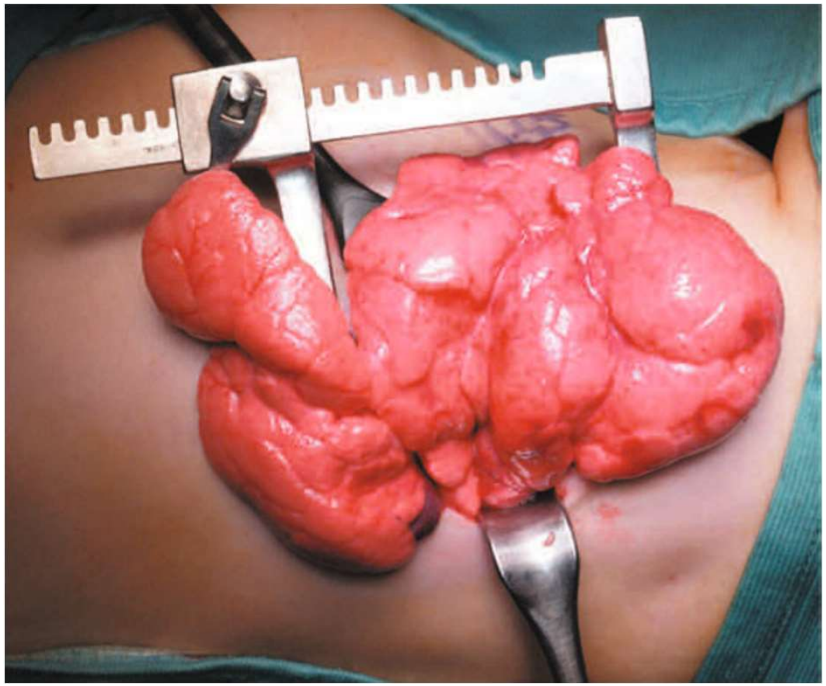
General principles of lobectomy



- axillary skin crease incision - pec major and latismus are spared. Serratus anterior Is split. Intercostal muscles above rib are cut to enter the thorax (5th ICS for upper lobectomy & central lesions, 6th ICS for lower lobectomy & peripheral lesions)

General principles of lobectomy



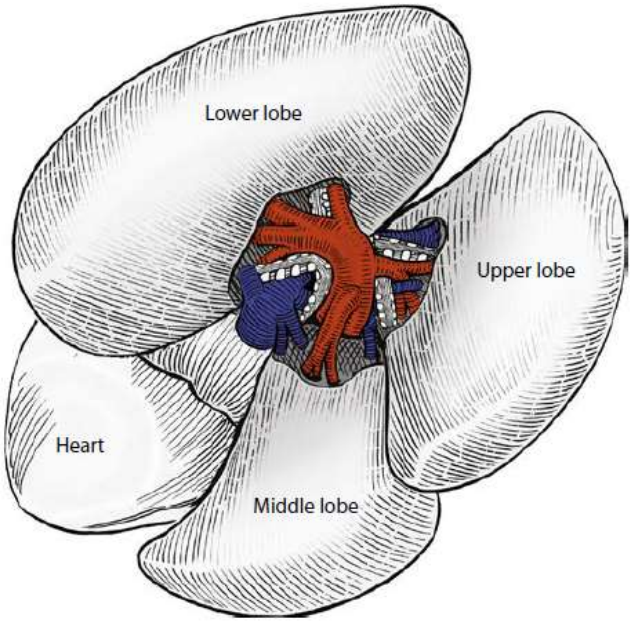


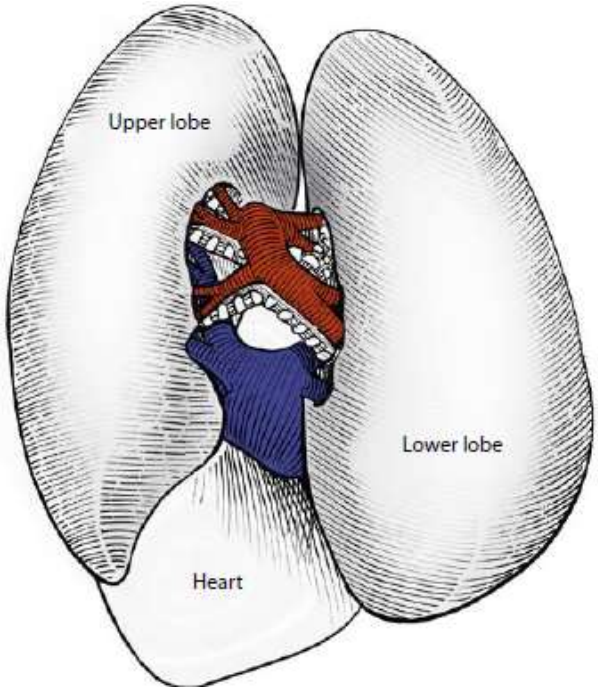
- visual field for lobectomy with **2 rib spreaders** inserted at right angles. Surgeon puts on **headlights** .Affected lobe is held by a gripping **forceps**. normal lobe is spread by **spatula** gently. affected may be eviscerated to the wound

General principles of lobectomy

- Handling of the major fissure
  - **Clarify directions of PA** branches to the lobes
  - **Separate fused lung tissue** if fissure incomplete (carefully with cautery or forceps with 4-0 prolene/cutting stapler)
- **dissection and control of major Vasculature**
  - Ligate Pulmonary artery branches by 2-0 or 3-0
    - *Double ligation, non absorbable, surgical square knots
  - Ligate pulmonary vein tributaries with 2-0 or endostapler
- **dissection and control of major bronchus**
  - Ligate bronchus with a 4-0 or 5-0 prolene or endostapler.
    - 1-2cm from mainstem to avoid long stump).
  - Care on dissecting hilar nodes to avoid investing fascia/ blood supply

General principles of lobectomy





- Visualization of **structures within the main fissures** of the lung from anterior to posterior (artery>bronchus>vein)

Post op care

- usually don’t require ICU after undergoing a VATS lobectomy.
- Pain control
- Chest drainage usually under water seal b/c suction prolongs air leaks.
- Early ambulation and pulmonary toilet

Outcome

- Generally good
- Majority are successfully treated with conservative
- Long term pulmonary growth after lobectomy is excellent

3. Right lung lobectomy

Right lung lobectomy

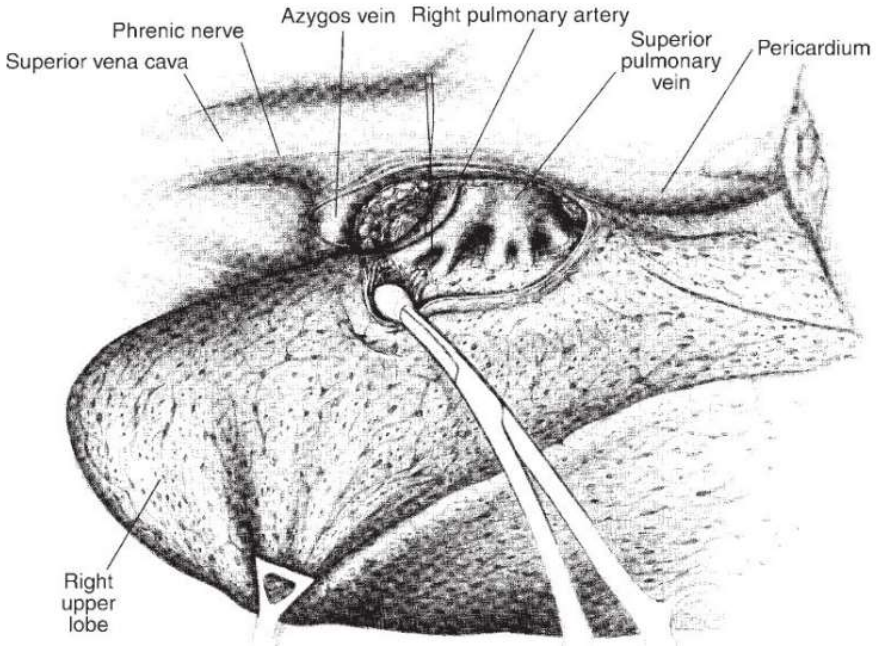
- Right lung larger than the left
- Contains 3 lobes (10 segments)
- **Upper or middle lobectomy is complicated** because the minor (horizontal fissure) is commonly incomplete (80%) and absent in 10%
  - Usually at least a partially developed fissure on the lateral surface
  - usually divided last (after vessels and bronchus)
- Right hilum
  - *Superiorly = RUL bronchus (branches outside the lung)*
  - *Posteriorly = main bronchus*
  - *Anterior= Right PA (divides immediately), superior PV (most ant)*
  - *Inferiorly = inferior PV (apex of pulmonary ligament)*

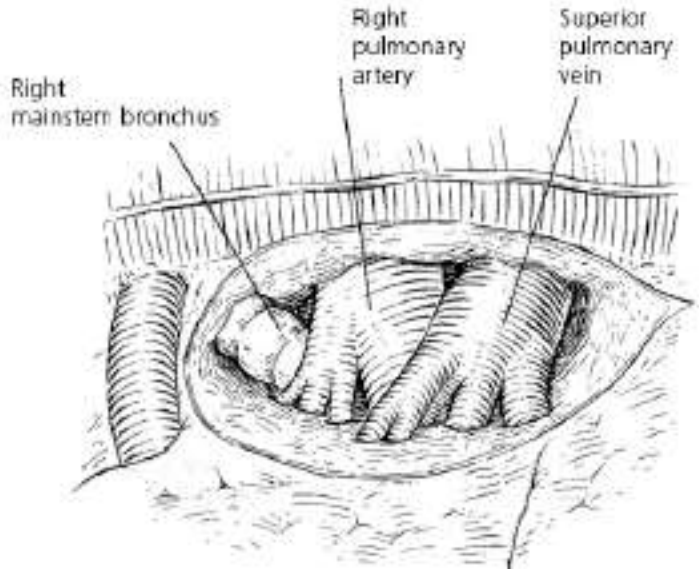
3.1 Right upper lobe lobectomy

Right upper lobe Lobectomy

- **Anatomy**
  - Bronchus = branches right angle a few cm from carina
    - variations (3%) - Directly from trachea in 1.4%, Absent in1.1%
  - Arterial supply = superior trunk but Posterior segment gets ascending branches from inferior trunk (90%)
  - Venous drainage = superior trunk (same with middle lobe)
- **Technique** (approach is consistent b/c anatomy consistent)
  - Divide **venous tributaries** **sparing veins of middle lobe**
  - Open **horizontal fissure** and divide (with cutting stapler if incomplete)
  - Divide **anterior trunk** (directly behind vein)
  - Divide **posterior ascending artery** (anterior, through fissure or retrograde approach)
  - Divide **RUL bronchus** and close flush with bronchus intermidius
  - Divide inferior pulmonary ligament to **allow lower lobe elevation**
  - If oblique fissure is complete, suture middle & lower lobe to **prevent volvulus**

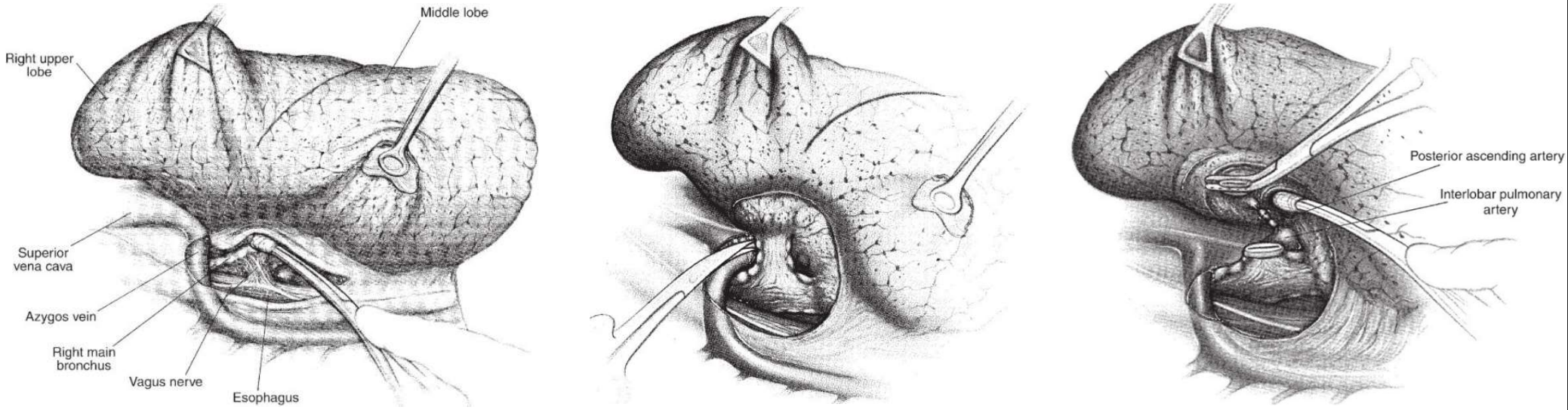
Right upper lobe Lobectomy





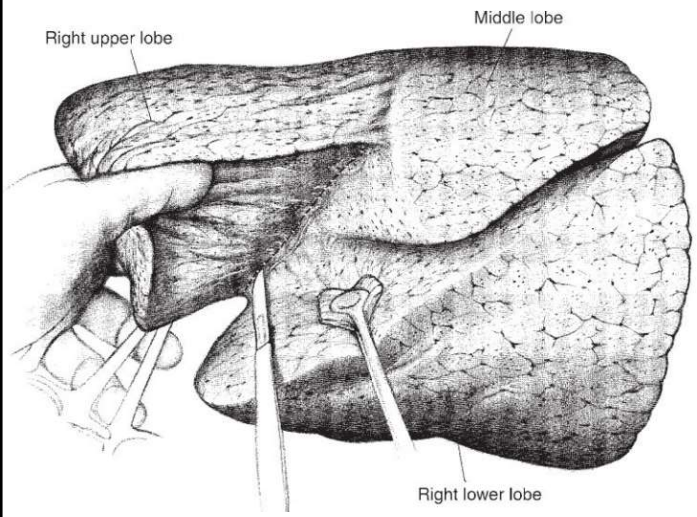
- Anterior mediastinal pleural opened lateral to SVC, inferior to azygus, posterior to phrenic nerve (care not to injur). **First structure exposed is superior pulmonary vein**. Spare middle lobe veins entering superior pulmonary vein. Ligation of the apical & anterior segment veins **exposes superior pulmonary artery trunk.** Segmental arterial branches are individually ligated.

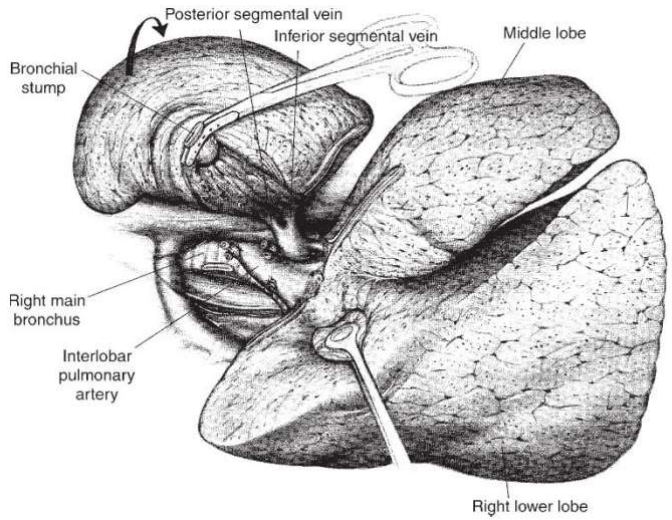
Right upper lobe Lobectomy

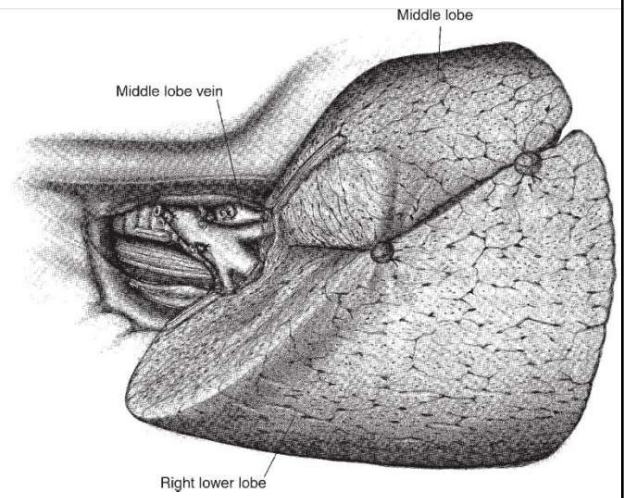


- Division of posterior mediastinal pleura anterior to vagus to expose posterior hilum followed by **division of RUL bronchus**

Right upper lobe Lobectomy







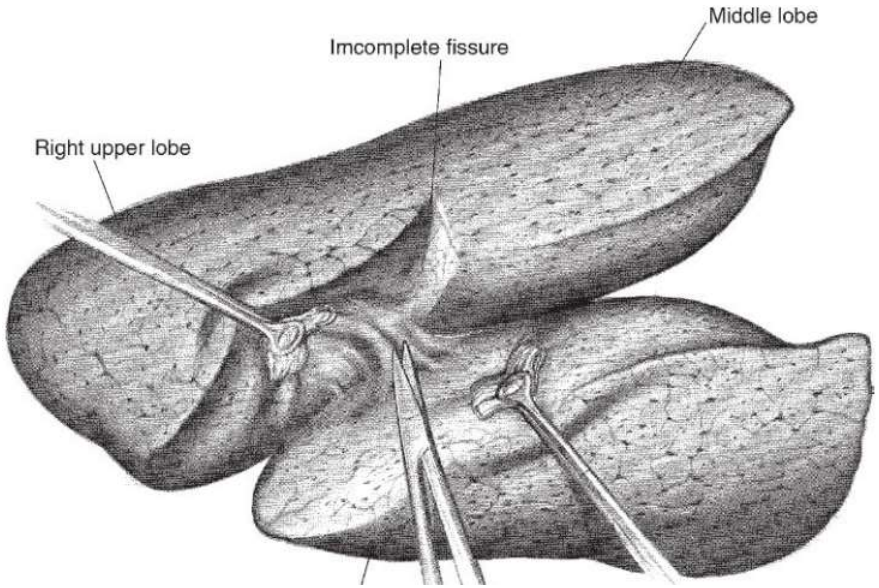
- Partial inflation to aid completion of oblique fissure with combined sharp and blunt dissection. This **exposes posterior ascending artery** which comes off pulmonary artery after middle lobe branches**.** Finally **approximation of RML & RLL** to prevent volvulus

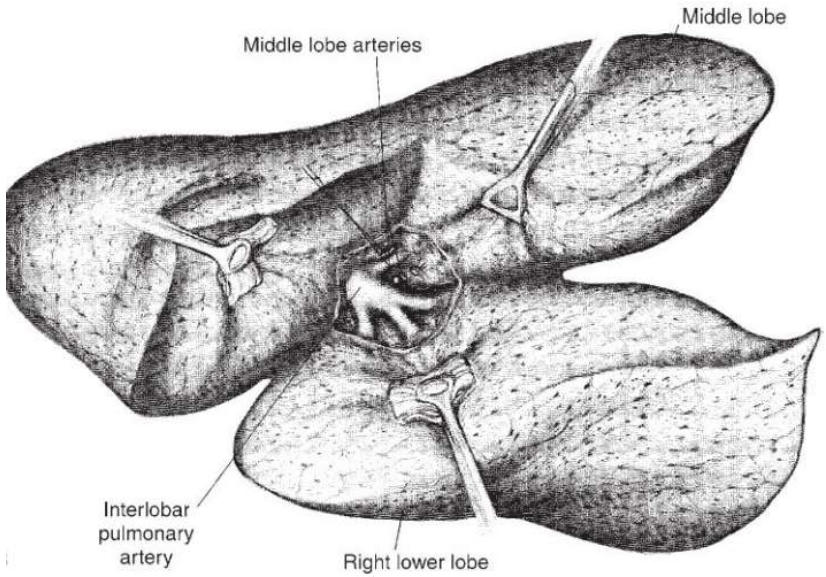
3.2 Right middle lobe lobectomy

Right middle lobe Lobectomy

- **Anatomy**
  - Bronchus = continuation of main bronchus after branching of RUL
  - Arterial supply = inferior trunk (run in horizontal fissure)
    - Medial lobe branches arise directly opposite to superior segment branches (like their bronchus)
  - Venous drainage = superior PV (same with upper lobe)
- **Technique (most difficult lobectomy)**
  - Open horizontal fissure to identify inferior PA and divide avoiding branches to lower lobe superior segment
  - Open pleura over hilum to identify superior PV
  - Divide bronchus flush with bronchus intermedius avoiding narrowing lower lobe superior segment
  - ***if doing bilobectomy with RLL divided bronchus intermidius but with RUL divide each bronchus separately*

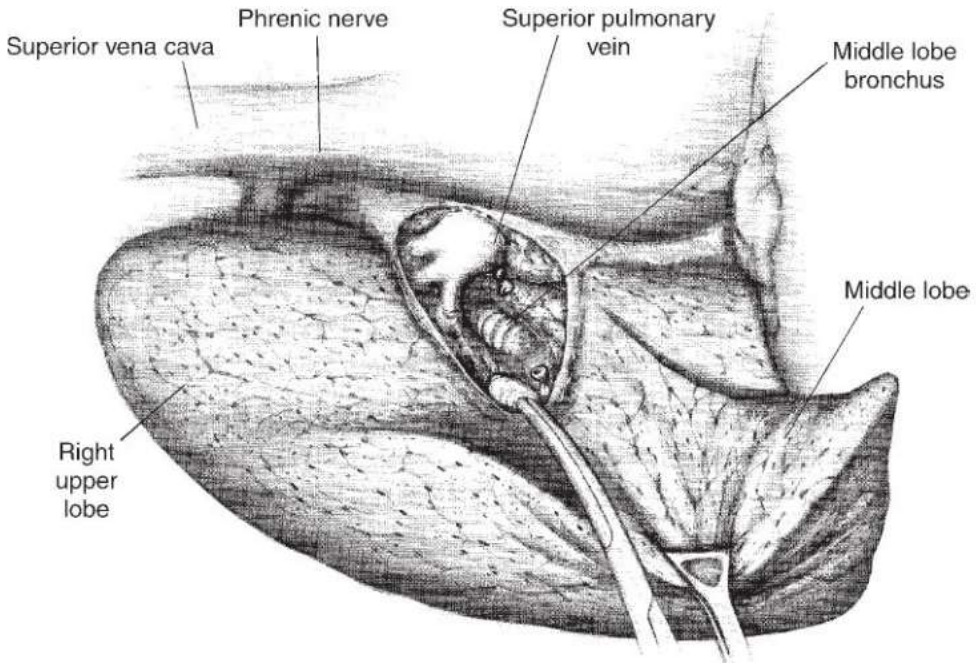
Right middle lobe Lobectomy





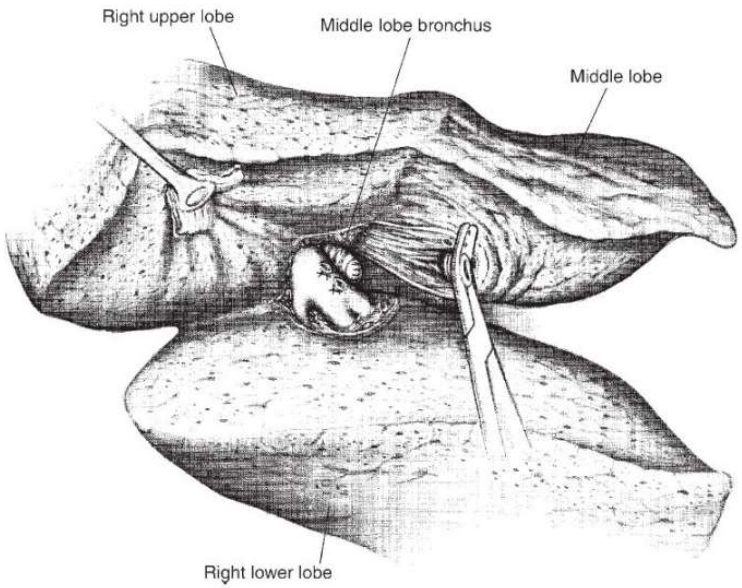
- Lung retracted posteriorly and oblique fissure dissected **expose interlobar artery** and its branch to middle and lower lobe (usually near posterior aspect of fissure at junction with horizontal fissure)

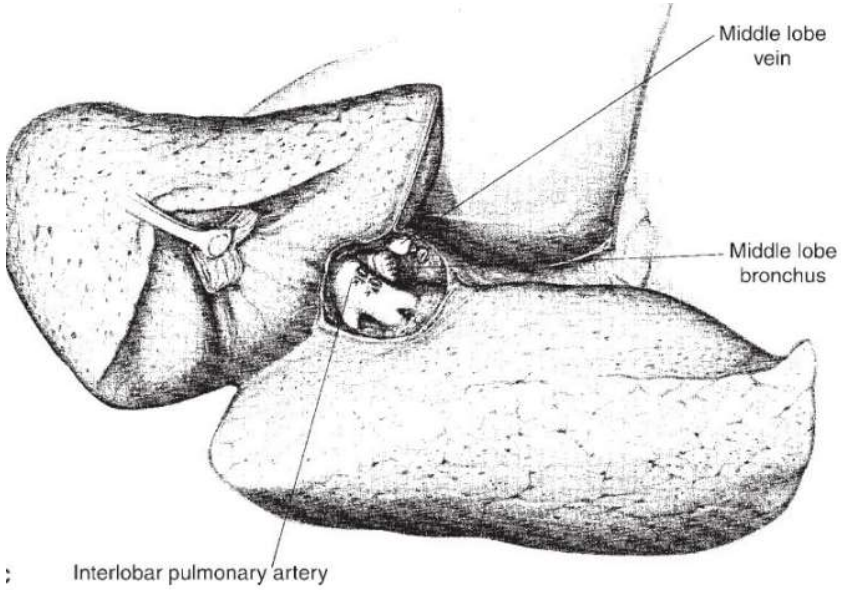
Right middle lobe Lobectomy



- Division of anterior mediastinal pleura to **expose middle lobe vein tributary** to superior vein.

Right middle lobe Lobectomy





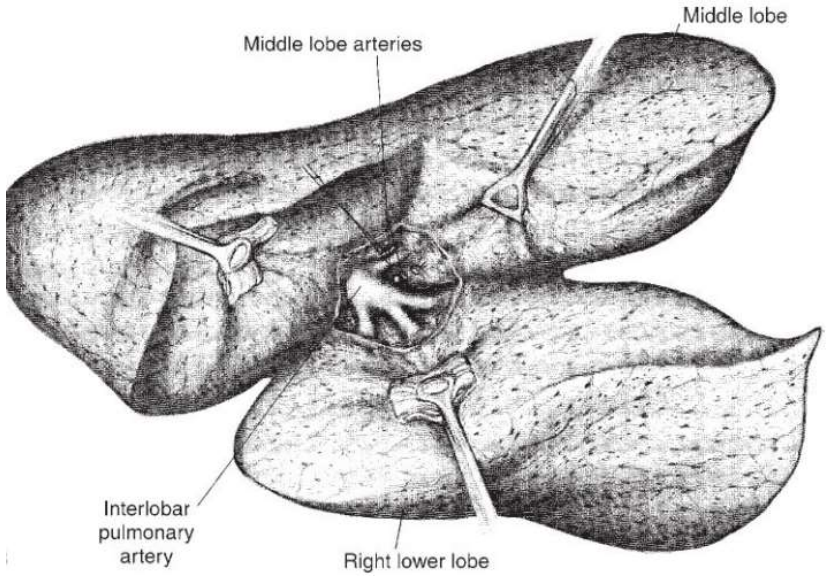
- Posterior hilum to **ligate RML bronchus** (care to avoid injury to posterior segmental artery of upper lobe). Traction on resected bronchus and differential inflation to aid **completion of horizontal fissure**

3.3 Right lower lobe lobectomy

Right lower lobe Lobectomy

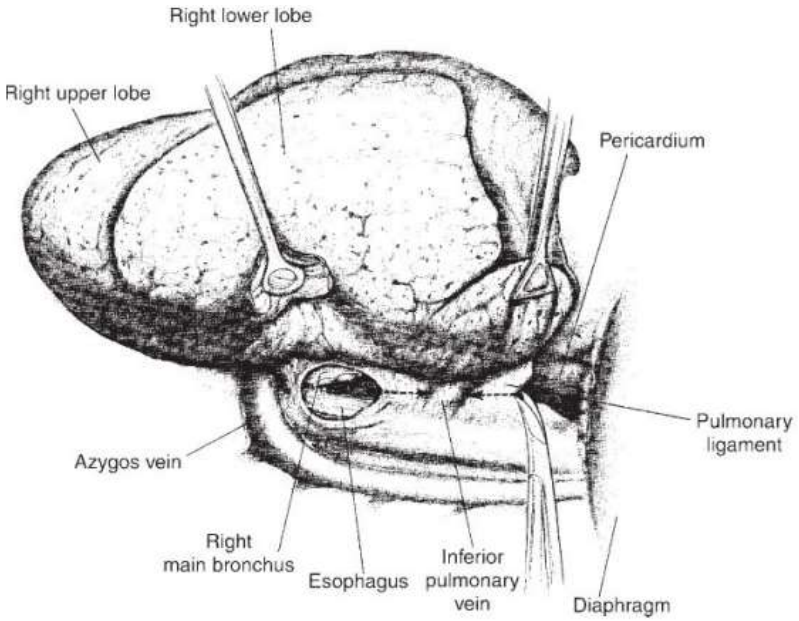
- **Anatomy**
  - Bronchus = superior segmental (same level, opposite to RML bronchus) and basal
  - Arterial supply = inferior trunk (run in horizontal fissure)
    - Single artery for superior segment, occasional arise from ascdnding branch to post segment
  - Venous drainage = inferior PV (superior segmental and basal)
- **Technique**
  - Open horizontal fissure to identify inferior PA and divide branches to lower lobe superior segment avoiding RML branches
  - ligate and divide the apical segmental bronchus
  - Divide arteries to the basal segments can then be divided.
  - **Divide inferior pulmonary ligament** and reflect lung forward to identify inferior PV
  - Go back ant and divide RLL bronchus avoiding RML branch

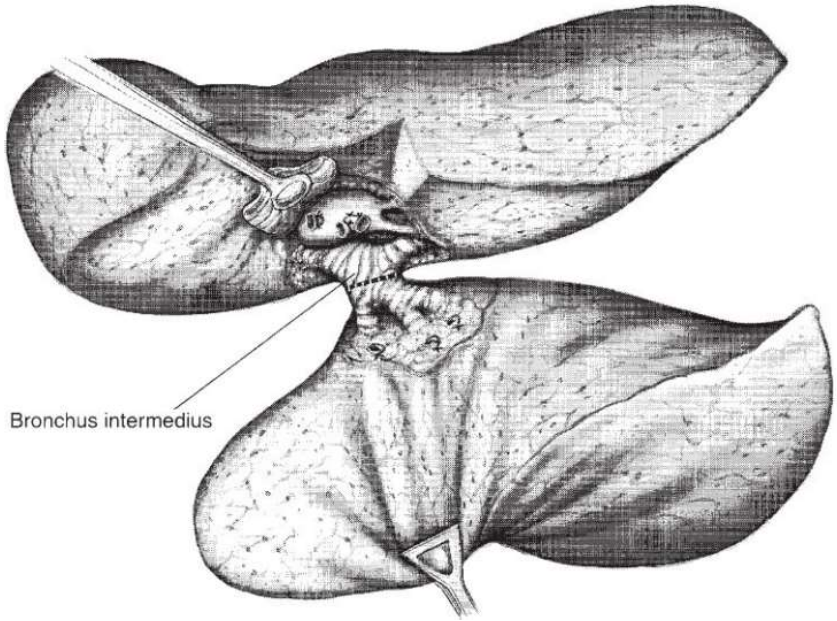
Right lower lobe Lobectomy



- **Exposure of interlobar artery and branches** at the junction of the fissures.

Right lower lobe Lobectomy





- Retracting lung anteriorly (posterior hilum) to open inferior pulmonary ligament and carry pleural dissetion upward to **expose and ligate inferior pulmonary vein.** After this **RLL is easily identified and transected obliquely** to maintain patency of RML bronchus

4. Left lung lobectomy

Left lung Lobectomy

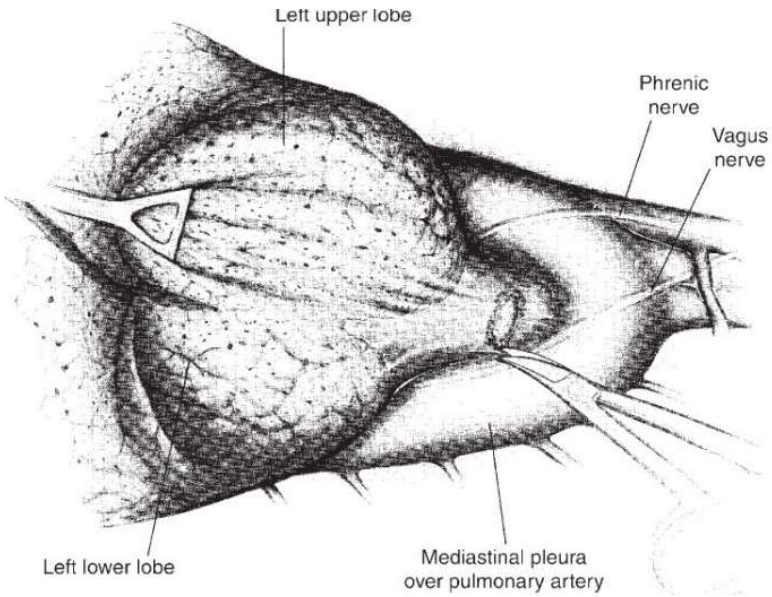
- Has two lobes and 8 segments (no basal medial segment)
  - * apical and posterior segments of upper lobe are fused
- Concave medial border (cardiac notch)
- *Left pulmonary hilum*
  - *Superiorly = Left PA*
  - *Posteriorly = bronchus*
  - *Anterior= superior PV*
  - *Inferiorly = inferior PV (apex of pulmonary ligament)*

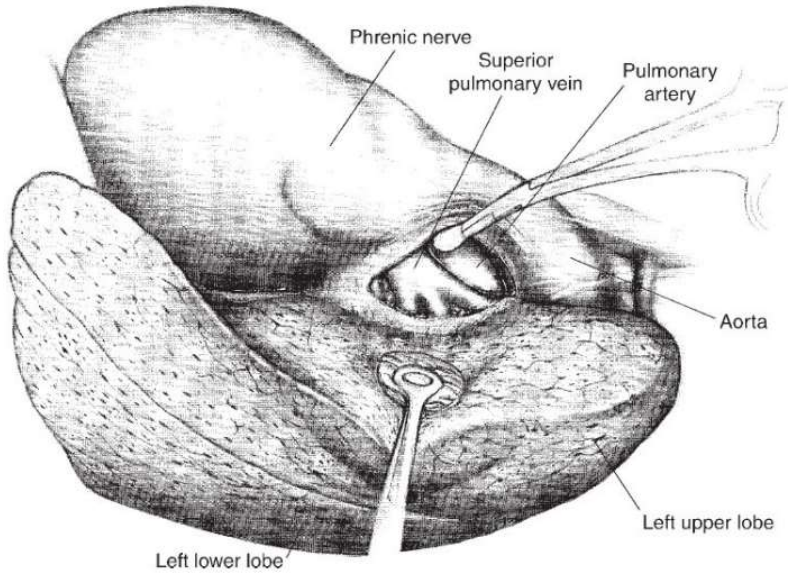
4.1 Left upper lobe lobectomy

Left upper lobe Lobectomy

- **Anatomy**
  - Bronchus = divides immediately into lingular an common ant & apical-post
  - Arterial supply = superior trunk or independent branches (3-8)
  - Venous drainage = superior PV
- **Technique**
  - Ligate pul artery branch to upper lobe (branches to lingual inside fissure may be distal to superior segment branches)
  - Best ligate veins at segmental level and ligate main trunk for added security
  - Divide bronchus flush with main bronchus

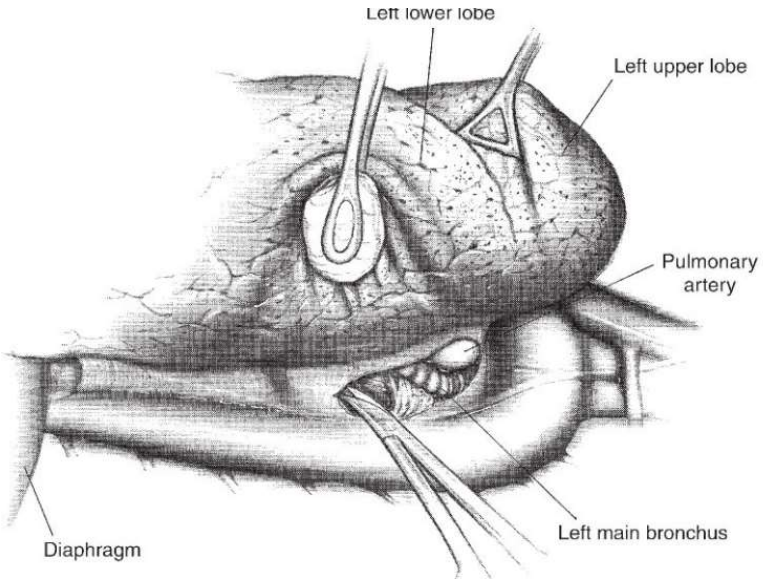
Left upper lobe Lobectomy

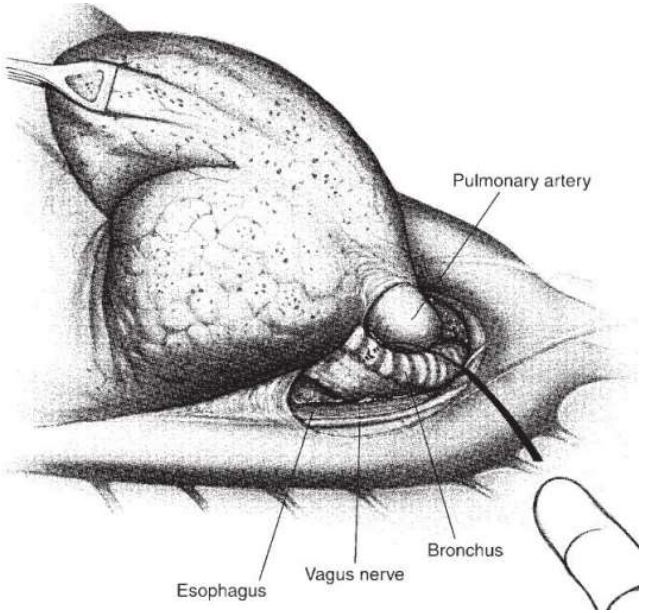




- Left lung retracted inferiorly and posteriorly to open mediastinal pleura anteriorly the phrenic nerve is identified and pleural incision is carried over just lateral to the pericardium. First **exposed is superior arterial trunk then venous trunk.** Occasionaly left superior and inferior veins form common vein (identify inferior vein before ligation)

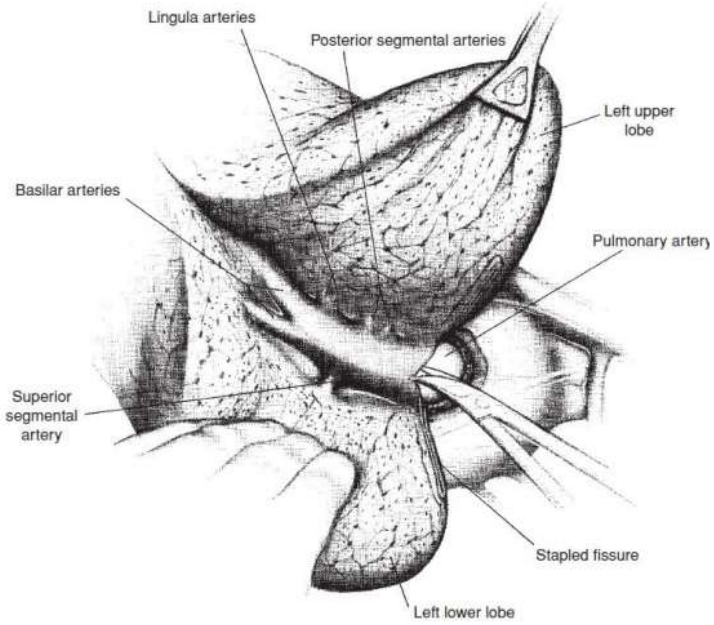
Left upper lobe Lobectomy

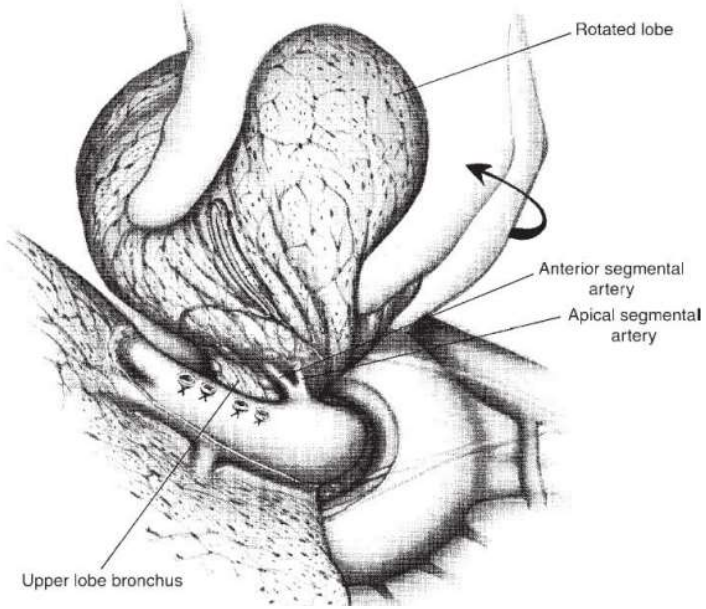




- Dissection of mediastinal pleura posteriorly medial to vagus. Its often easier to **divide bronchus** first via posterior approach. **Division of the fissure** posteriorly.

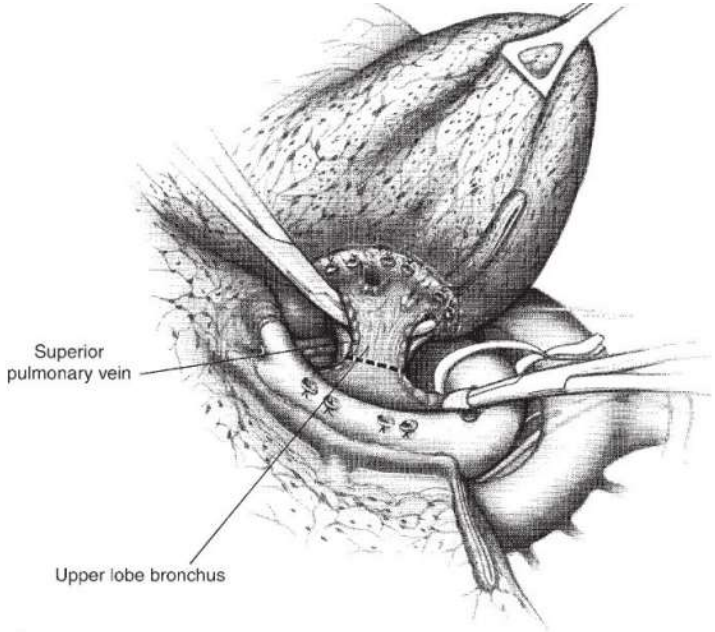
Left upper lobe Lobectomy

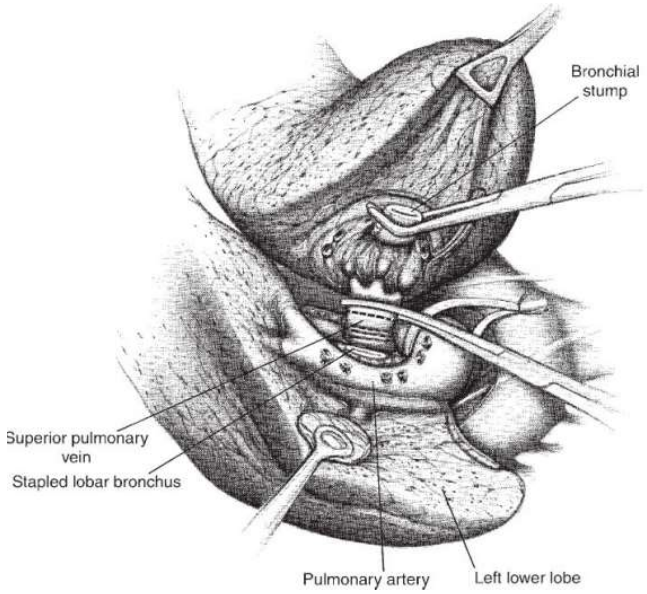




- ** After division of lingular and posterior arteries, rotation of the lobe aids in dissection of anterior and apical segmental arteries

Left upper lobe Lobectomy





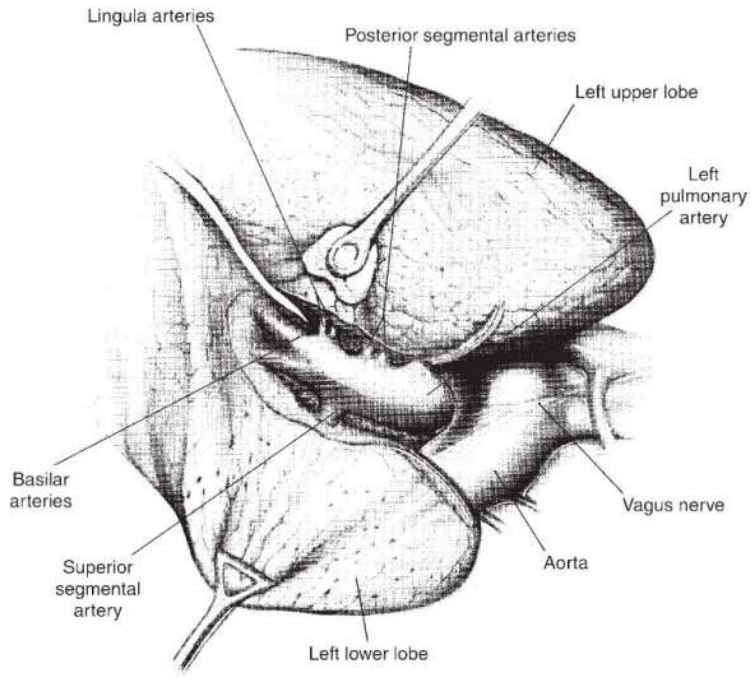
- **Division of the LUL bronchus exposes the superior pulmonary vein

4.2 Left lower lobe lobectomy

Left lower lobe Lobectomy

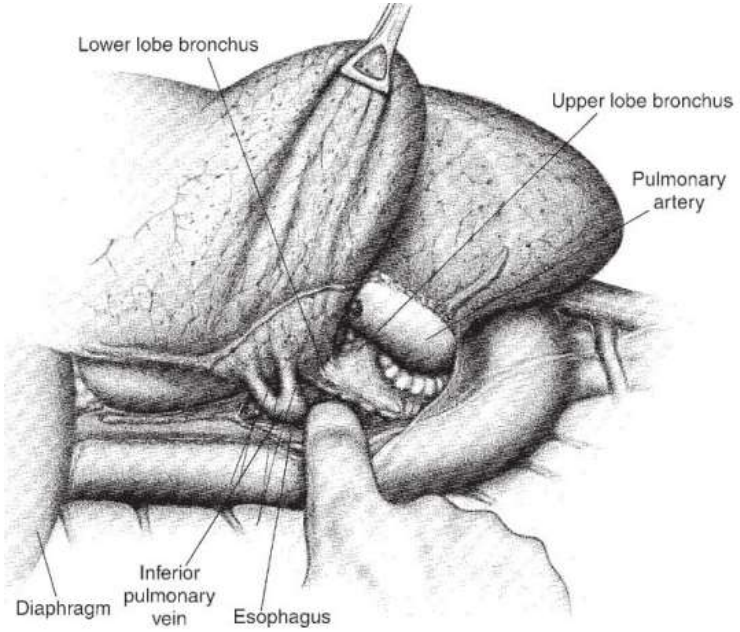
- **Anatomy**
  - Bronchus = divides immediately into lingular an common ant & apical-post
  - Arterial supply = common basal and superior segmental (often proximal to lignular branch)
    - Rarely common origin to branch of posterior segment of upper lobe (like right side)
  - Venous drainage = inferior (superior segmental and common basal)
- **Technique (simplest lobectomy)**
  - pulmonary artery is identified in the fissure
  - Superior segment artery divided first
  - May divided superior segment bronchus as well
  - Divide common basal trunk
  - **Divide inferior pul ligament** to expose and divide inf pul vein
  - Divide LLL bronchus

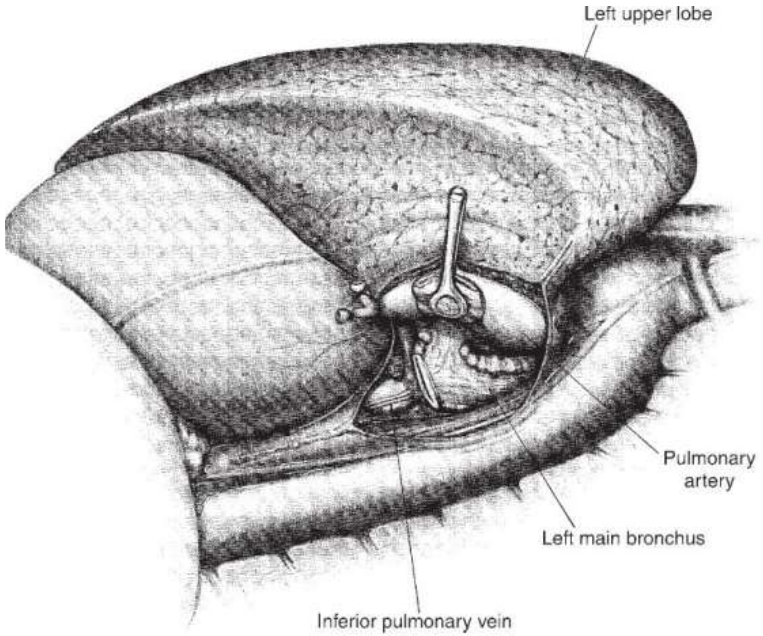
Left lower lobe Lobectomy



- After opening mediastinal pleura and dividing inferior pulmonary ligament, upper lobe is directed anterior-superior and lower lobe posterior-inferior to expose interlobar fissure to **identify pulmonary artery and branches.** Care for lingular vessels as superior segmental artery may arise proximal to them.

Left lower lobe Lobectomy





- Expose posterior hilum. **inferior pulmonary vein divided** (after inf pulmonary ligament). Finally **LLL bronchus exposed** and divided.


That's all Folks!