Lung volume reduction surgery (LVRS)

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What is lung volume reduction surgery?

Lung volume reduction surgery (LVRS)

is a surgical procedure

applied for

selected patients with severe emphysema

lung volume reduction surgery

Concept

Concept of LVRS

The basic concept behind LVRS

Is

Resection of nonfunctional areas of lung

To allow

The better areas work more effectively .

(Dr.Brantigan Concept for LVRS 1957)

LVRS _ concept : **Dr. Brantigan , 1957**

In emphysema , the elasticity and circumferential pull on the small airways are lost.

He proposed
“Resection of the most useless area and Down sizing the lung would help to restore
the outward pull
on the small airway”

Emphysema _Overview

Emphysema

is a condition of the lung characterized by abnormal permanent enlargement of airspace distal to the terminal bronchiole, accompanied by destruction of their wall in the absence of fibrosis.

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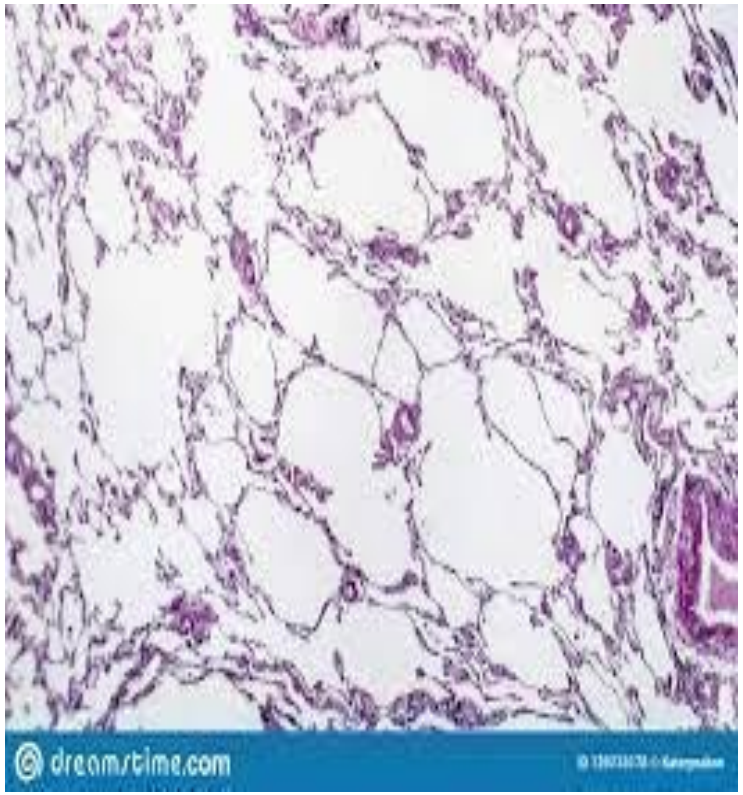
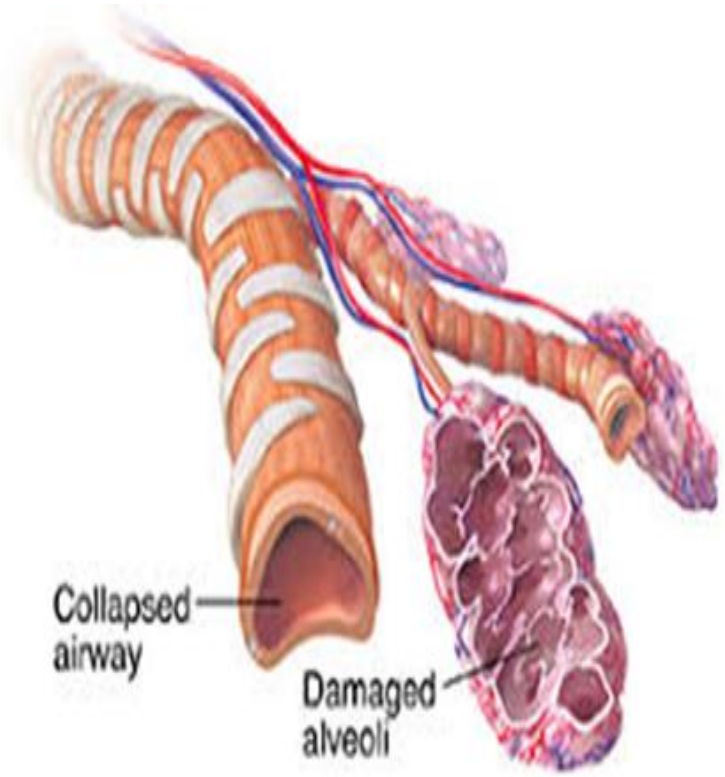
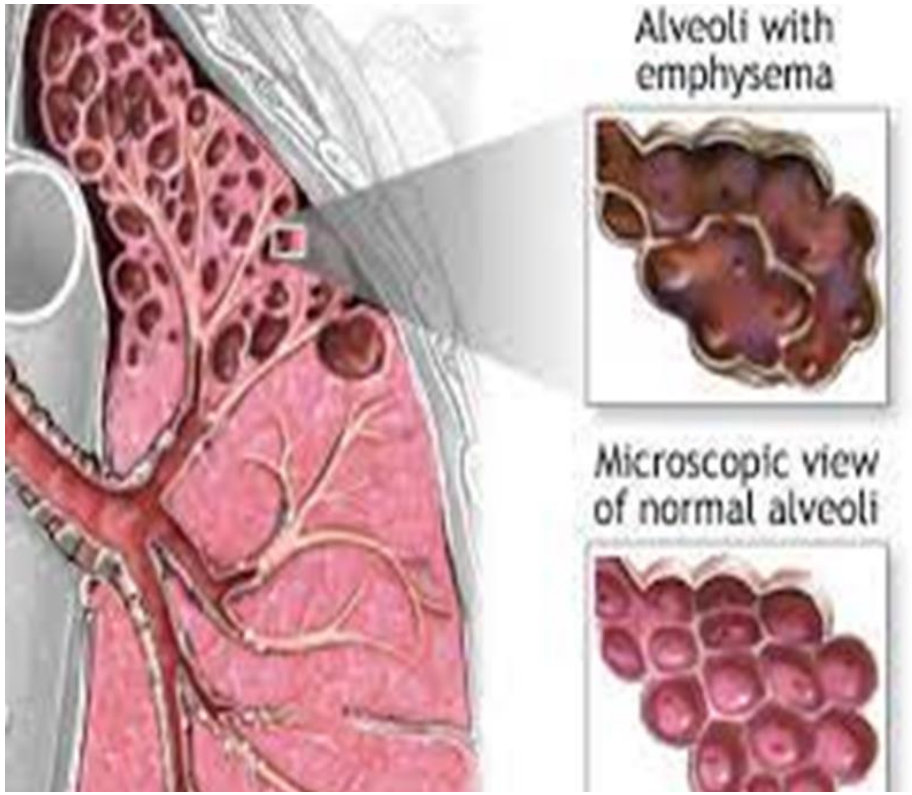






Morphological Types of Emphysema

- Centri-acinar (centrilobar)

Begins in the respiratory bronchioles and spreads peripherally.. Predominantly involves the upper half of the lungs.

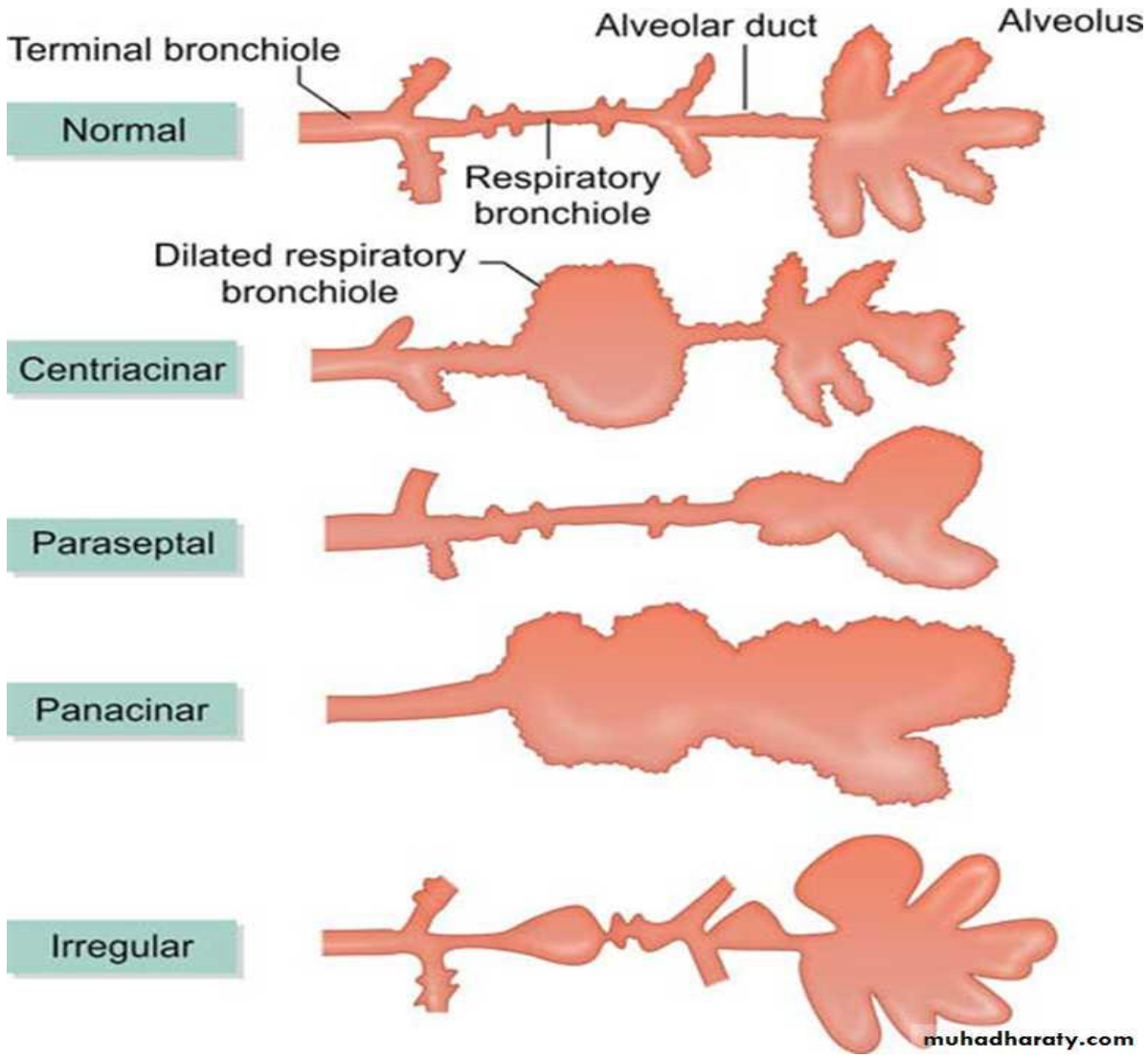
- Distal acinar (Paraseptal)

Preferentially involves the distal airway structures, alveolar ducts, and alveolar sacs Localized around the septae of the lungs

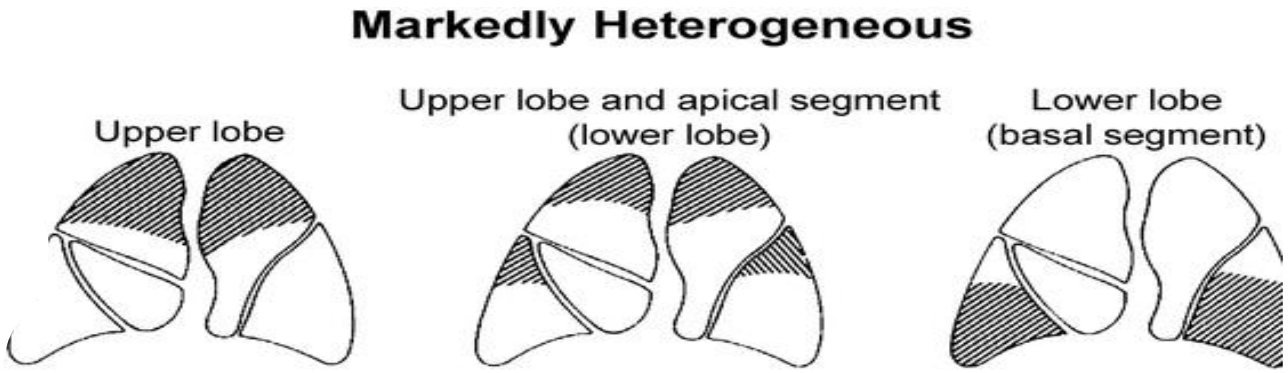
- Panacinar (panlobar)

Destroys the entire alveolus uniformly. Predominant in the lower half of the lungs, Generally observed in patients with homozygous alpha1-antitrypsin deficiency.

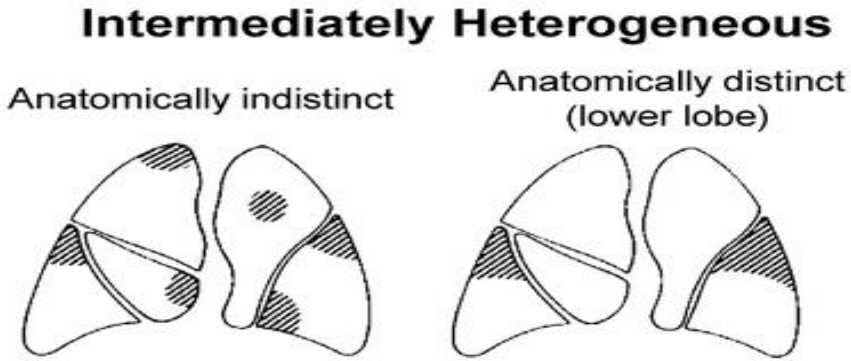
- Irregular emphysema

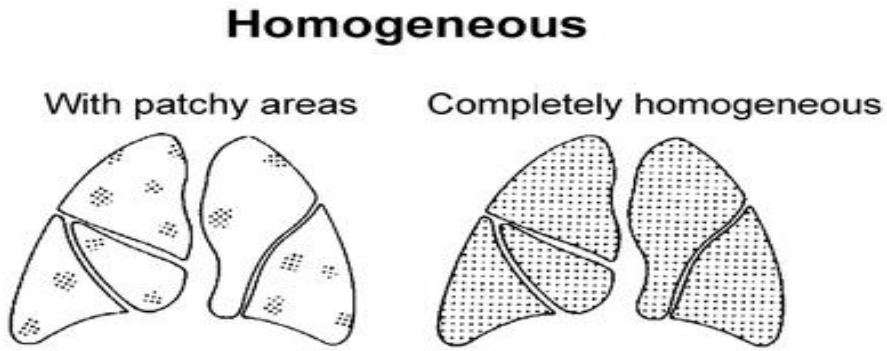


Heterogeneous :

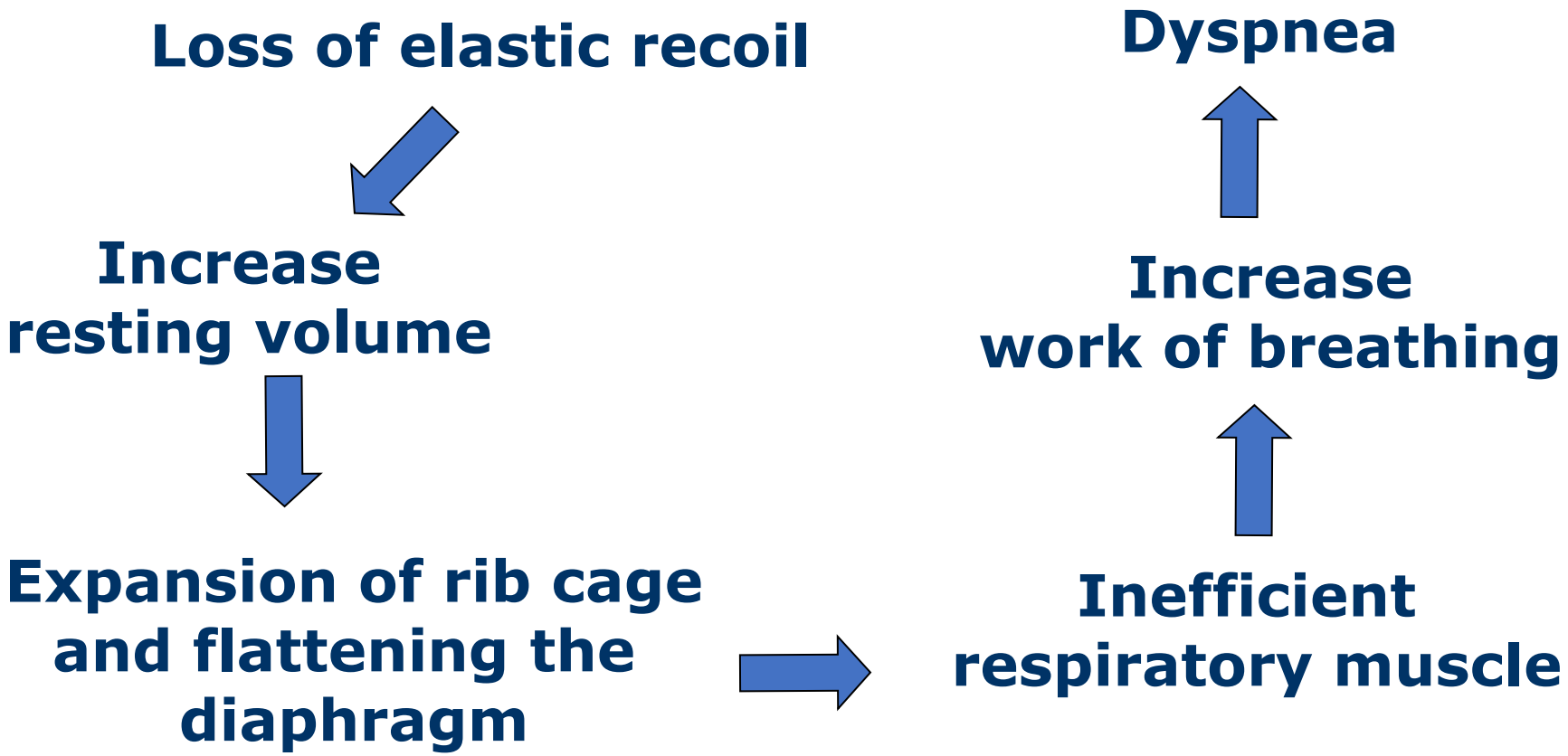


Homogenous :





Patho-Physiology Of Emphysema

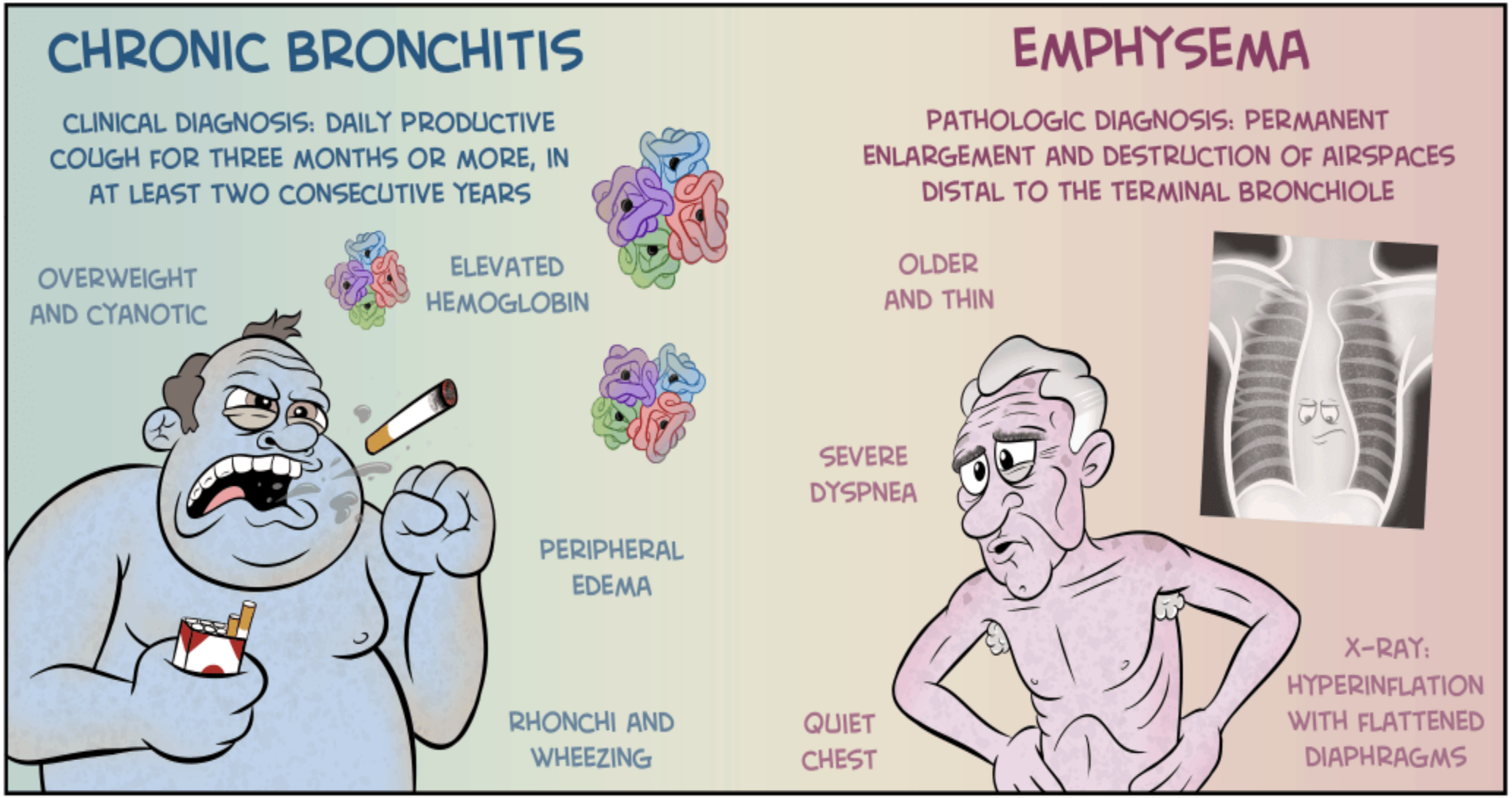


COPD

Emphysema, along with chronic bronchitis, together are referred to as Chronic Obstructive Lung Disease (COPD).

COPD is a leading cause of mortality worldwide, and patients who have severe emphysema have a poor quality of life.

Emphysema, along with chronic bronchitis, together are referred to as Chronic Obstructive Lung Disease (COPD).



Complications of Emphysema and COPD

- Pneumothorax (Can be fatal in patients with severe emphysema because the respiratory reserve is limited).
- Respiratory insufficiency and Respiratory failure
- Pulmonary hypertension &Right-sided heart failure
- Giant bullae (Sometimes half the size of the lung)
- Pneumonia & recurrent respiratory infection
- Depression and anxiety .

LVRS

History And Background
Of
Lung Volume Reduction Surgery (LVRS)

LVRS_ History And Background

In 1957 , **Dr. Otto Brantigan** and his colleagues at the University of Maryland , *described the lung volume reduction surgical technique for patients with end-stage emphysema.*

Unfortunately ,

The operative mortality was significant

(no objective measures of benefit could be documented. Thus, early LVRS was abandoned as a viable therapy for patients with end-stage emphysema until 1993.)

LVRS_ History And Background

The modern era of lung volume reduction surgery (LVRS) was first described by

Dr. Joel Cooper

and his colleagues at Washington University

In 1994 .

Using a **median sternotomy to perform bilateral stapled wedge resections on patients with heterogeneous emphysema .**

LVRS_ History And Background

Although early results were encouraging,

(there were a number of criticisms of the published reports relating to small patient numbers, variable selection criteria, lack of patient randomization, incomplete follow-up, and lack of long-term results.)

Analysis of the outcome data for Medicare patients revealed

A 23% mortality rate at 12 months following LVRS

prompting the discontinuation of funding for this procedure in 1996 due to the associated high risks and costs

LVRS_ History And Background

Subsequently, the National Heart, Blood, and Lung Institute designed a prospective, randomized clinical trial across 17 institutions with over 1,000 patients enrolled

The National Emphysema Treatment Trial (NETT) published in 2003 ,

Evaluated the efficacy and safety of LVRS plus medical therapy vs. Medical therapy alone .

It is considered a landmark study, and the results of the comprehensive NETT study guide our current selection criteria for LVRS patients.

Who is a candidate for lung volume reduction surgery?

National Emphysema Treatment Trial (NETT) study, first published in 2003, identified four sub-groups of patients who had different risks and benefits from LVRS:

- Group 1: Patients with predominantly upper lobe emphysema and low exercise capacity Have improved survival and functional outcomes after LVRS compared to medical therapy

- Group 2: Patients with predominantly upper lobe emphysema and high exercise capacity Have improved functional outcomes after LVRS but no difference in survival compared to medical therapy.

- Group 3: Diffuse emphysema and low exercise capacity. These patients have similar survival rates and function after LVRS as after medical treatment.

- Group 4: Diffuse emphysema and high exercise capacity. These patients have worse survival rates after LVRS than after medical treatment, and do not appear to benefit from surgery.

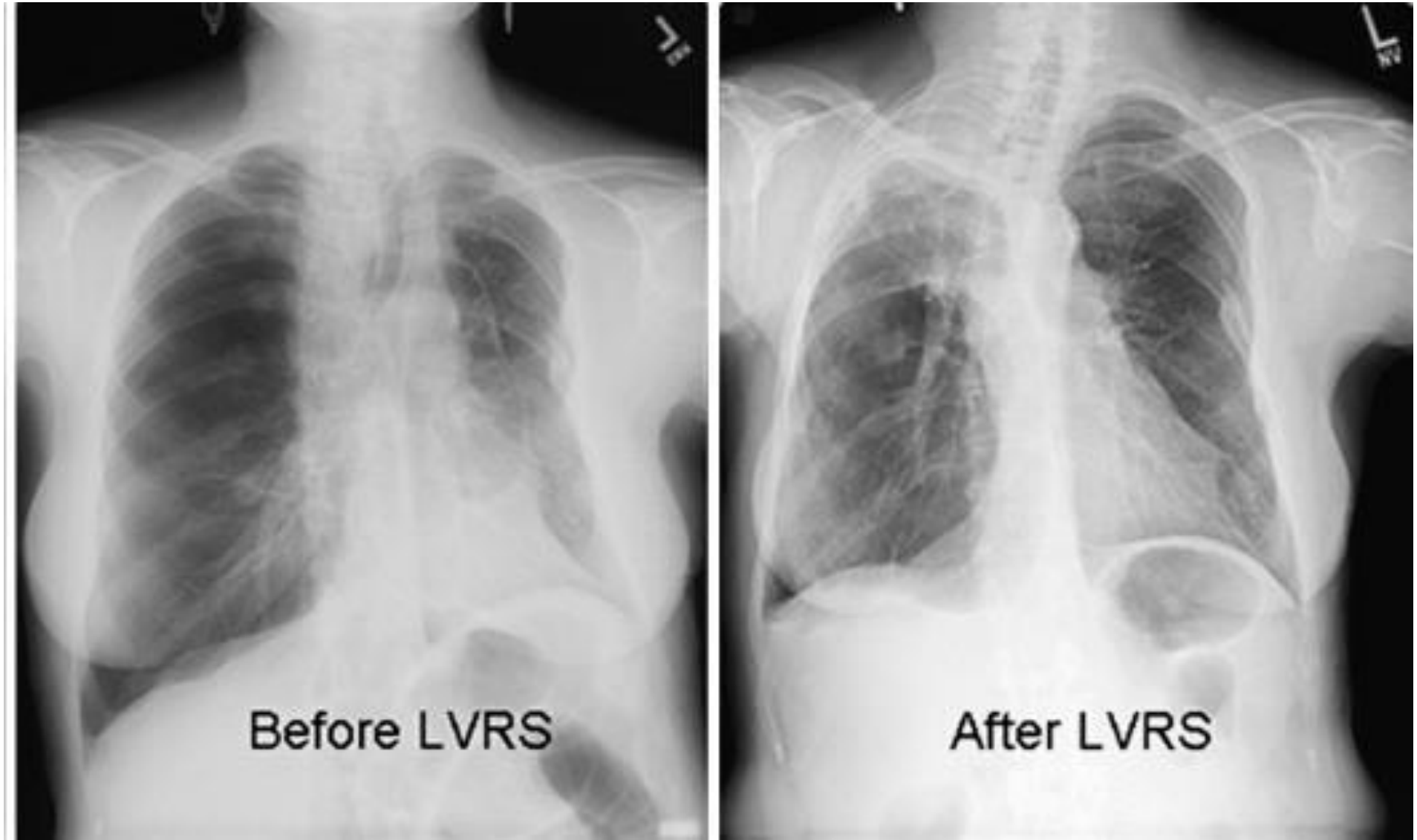
Patients who fall into Group 1 are the best candidates for LVRS

Lung Volume Reduction Surgery

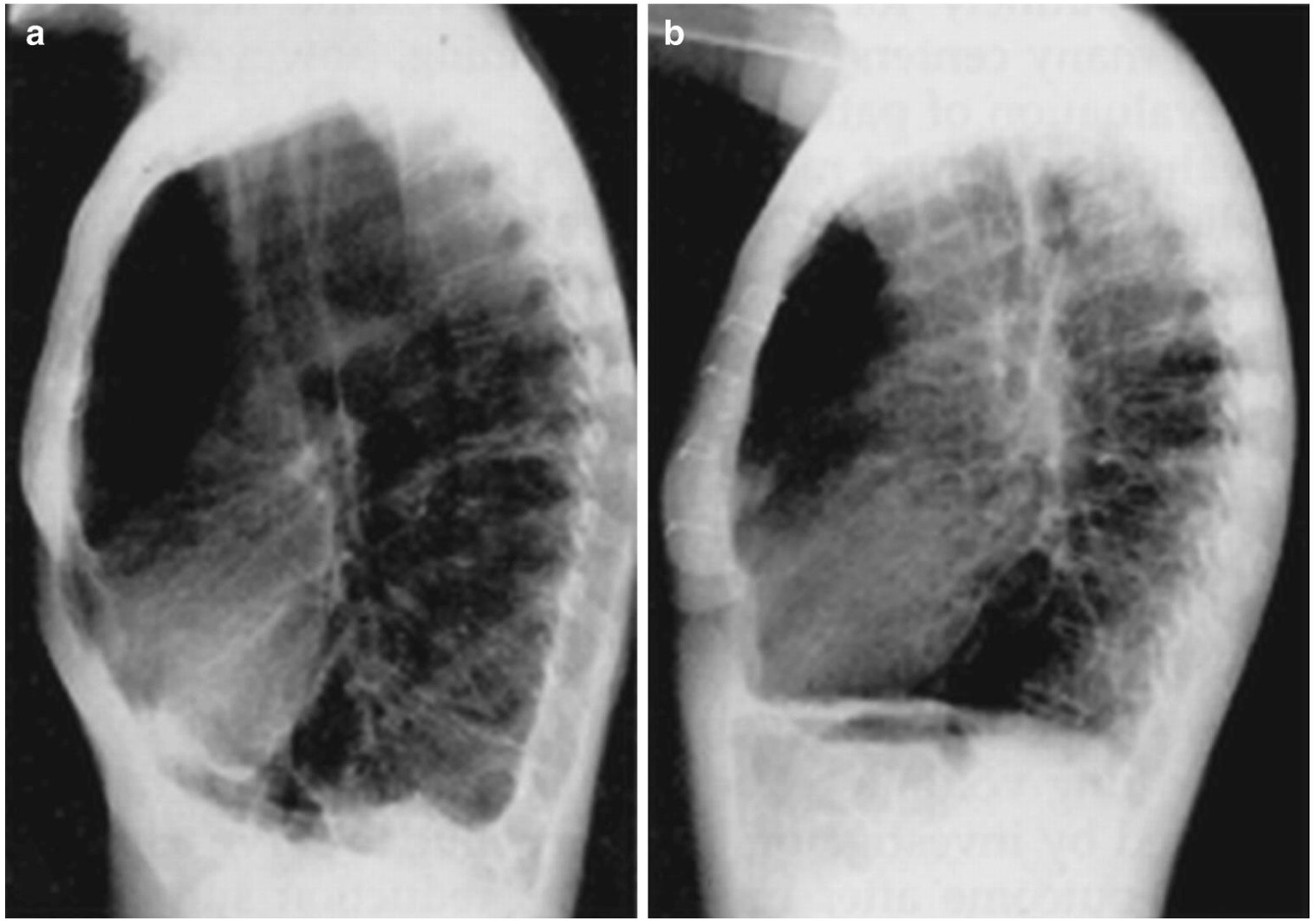
Anticipated Benefits :

- hyperinflation decreases, diaphragm and chest wall mechanics would improve.
- Increase in elastic recoil thereby restoring the outward pull on bronchioles and increase expiratory flow ; Increase flow would decrease dynamic hyperinflation
- Improvement in ventilation and perfusion matching improves alveolar gas exchange which in turn may decrease need for supplemental oxygen.

LVRS : Anticipated Benefits (CXR pre and post LVRS)



LVRS : Anticipated Benefits



A lateral chest X-ray is shown.
(**a**) before LVRS :
the thorax is barrel-shaped with high transparency of the lungs, a large retrosternal air-filled space, and a flattened to concave diaphragm.

(**b**)The chest X-ray of the same subject is shown 3 months after LVRS:
the lung fields are less transparent, the air-filled retrosternal space decreased significantly, and the diaphragm exhibits an almost normal, convex shape

LVRS

Inclusion Criteria And Indication

LVRS : Inclusion Criteria and Indications

- Candidates have severe emphysema and are symptomatic despite maximal medical management.

  (These patients have difficulties with simple activities of daily living, such as taking a shower, doing household chores, bending, and carrying anything.).

  (Maximal medical management includes medicines, inhalers, steroids, oxygen, and pulmonary rehabilitation.)

LVRS : Inclusion Criteria and Indications

- Age less than 75 years
- Body mass index (BMI) less than 32 kg/m2
- Radiological evidence of heterogenous distribution of emphysema.

(The most important selection factor for LVRS is the presence of a heterogeneous pattern of emphysema , Only about 20% of patients with severe emphysema have a heterogeneous pattern of emphysema)

LVRS : Inclusion Criteria and Indications

- Forced-expiratory volume in 1 second (FEV1) of less than 45% predicted (FEV1 between 15% and 35% of predicted)
- The arterial partial pressure of carbon dioxide (PaCO2) of less than 60 (55) mm Hg (
- The arterial partial pressure of oxygen (PaO2) of greater than 45 mm Hg .
- A 6-min walk test distance of greater than 140 m
- No smoking for at least 4 months before initial screening

LVRS : Inclusion Criteria and Indications

- Highly motivated and stable psychosocial patient

- Pulmonary function tests for candidates include the following:

  -forced expiratory volume 1 < 45% predicted

  -mean total lung capacity 140% predicted,

  -mean residual volume 250% predicted.

LVRS : Inclusion Criteria and Indications

- Commitment to pre-operative supervised pulmonary rehabilitation for 6 weeks .
- Absence of symptomatic coronary artery disease
- No previous thoracotomy or pleurodesis
- Prednisone requirement <20 mg/day
- PAPsys < 50 mmHg

LVRS

Exclusion Criteria And Contraindications

LVRS : Exclusion Criteria And Contraindications

This particular subgroup of LVRS patients was defined as those with:

- FEV1 (less than 20% predicted)
- DLCO of less than 20% predicted
- OR Homogenous emphysema on computed tomography (CT) scan.

- This subgroup of patients was more likely to be harmed than to benefit from surgical intervention for the treatment of severe emphysema, with a higher risk for death after LVRS (high-risk group)

LVRS : Exclusion Criteria And Contraindications

- In the landmark NETT trial, the cut-off for stopping the protocol was greater than 8% 30-day mortality rate for patients enrolled in the treatment arm of the study.

- The NETT Research Group found that, after randomization, patients with an FEV1 less than 20% predicted and either a diffusion capacity for carbon monoxide (DLCO) of less than 20% predicted or the presence of homogenous emphysema, had a 30-day mortality rate of 16% in the LVRS arm (69 patients) compared to 0% medical therapy alone arm (70 patients).

LVRS : Exclusion Criteria And Contraindications

- **Advanced age, above 75 years**
- **$Paco_2$ more than 55 mmHg. (60)**
- **Mean pulmonary artery pressure >35mmHg**
- **Psychosocial unstable**
- **Severe active infection: bronchiectasis, TB**
- **Malignancy with life expectancy less than 2 years**
- **Significant coronary artery disease not candidate for revascularization.**

LVRS : Exclusion Criteria And Contraindications

Persistent smoking
Not fit for pulmonary rehabilitation
Pulmonary arterial hypertension (mPAP >35 mm Hg)
Very severe obstruction (FEV_1 <20% predicted)
Severe impairment of gas exchange
Diffusion capacity <20% predicted
Severe hypoxaemia
Hypercapnia
Major comorbidities
Lung infection / bronchiectasis

LVRS

COMPLICATIONS

LVRS : Complications

Post Operative complications include:

- Air leak
- Major cardiovascular complications, including arrhythmias, myocardial infarction, or pulmonary embolus.
- Hypoxia
- Infections, including pneumonia
- Major pulmonary complications including respiratory failure requiring reintubation, prolonged intubation or tracheostomy
- Death (3-8% up to 15 in more severe emphysema)

LVRS : Complications

- Air leak is one of the most common complications following LVRS, with the NETT trial patients estimating 90% in the 30-day postoperative period.
- However, only 12% of patients had an air leak greater than 30 days.
- It was concluded that not having an air leak post-operatively was not associated with the specific surgical technique

LVRS : Complications

- in the NETT trial, patient cohorts were analyzed for operative mortality and cardiopulmonary morbidity.
- The subanalysis found that cardiopulmonary morbidity remained high at approximately 5.5%.
- Major pulmonary and cardiovascular complications were also relatively high, occurring in 20% to 30% of patients (out of 511) who were considered a non-high-risk subset of LVRS patients.
- Naunheim et al. found that patients with non-upper-lobe-predominant emphysema were one of the factors associated with increased mortality.

LVRS

Pre –Operative Evaluation And Preparation

LVRS : *Pre –operative evaluation and preparation*

Prior to LVRS,

pulmonary rehabilitation program

is instituted with the goals of:

stop the progressive decline in lung function

preventing exacerbations of the disease

improving exercise capacity and quality of life,

prolong survival.

LVRS : *Pre –operative evaluation and preparation*

pulmonary rehabilitation program *is achieved through :*

- exercise training,
- optimization of medical therapy,
- patient education,
- psychosocial evaluation,
- nutritional counseling and management

LVRS : *Pre –operative evaluation and preparation*

pulmonary rehabilitation program *is achieved through :*

- cessation of smoking for at least 6 months prior to considering the patient as a surgical candidate for LVRS.
- Influenza immunization and pneumococcal vaccination
- Treatment of Exacerbations of bronchospasm.
- Anxiolytic therapy may be necessary during the preoperative and perioperative period.

LVRS : *Pre –operative evaluation and preparation*

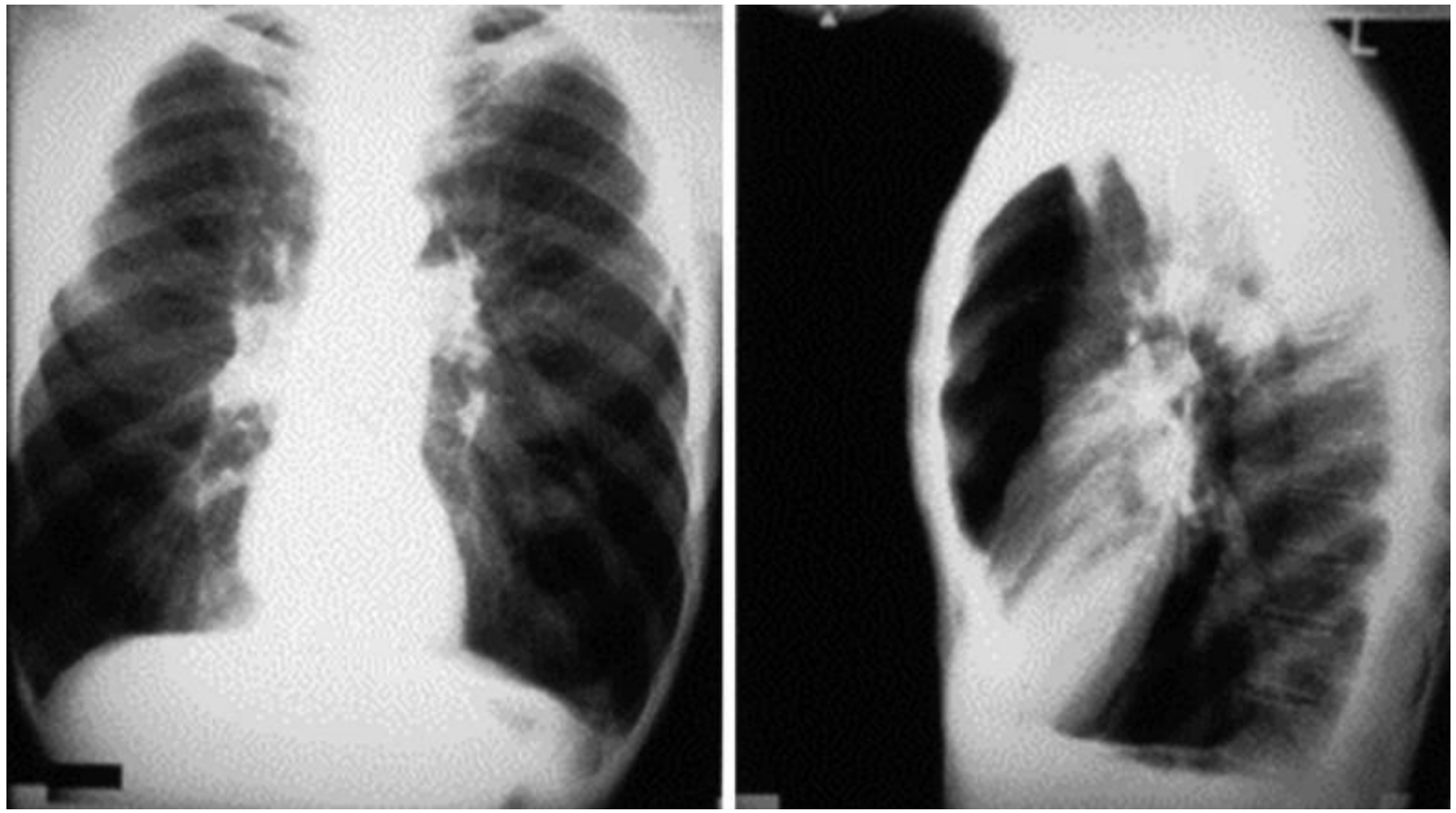
- CHEST X RAY
- HRCT scan
- Quantitative V/Q scan
- Lung-volume measurement/ PFT
- Maximal exercise testing-6-minute walk test (140 m)
- CARDIOVASCULAR WORKUP

LVRS : *Pre –operative evaluation and preparation*

CHEST X RAY should provide :

- Marked HYPER INFLATED lungs is noted with flattend and low diaphragm
- Intercostal space becomes widen
- A horizontal pattern of ribs
- A long thin heart shadow
- Decreased markings of lung peripheral vessels

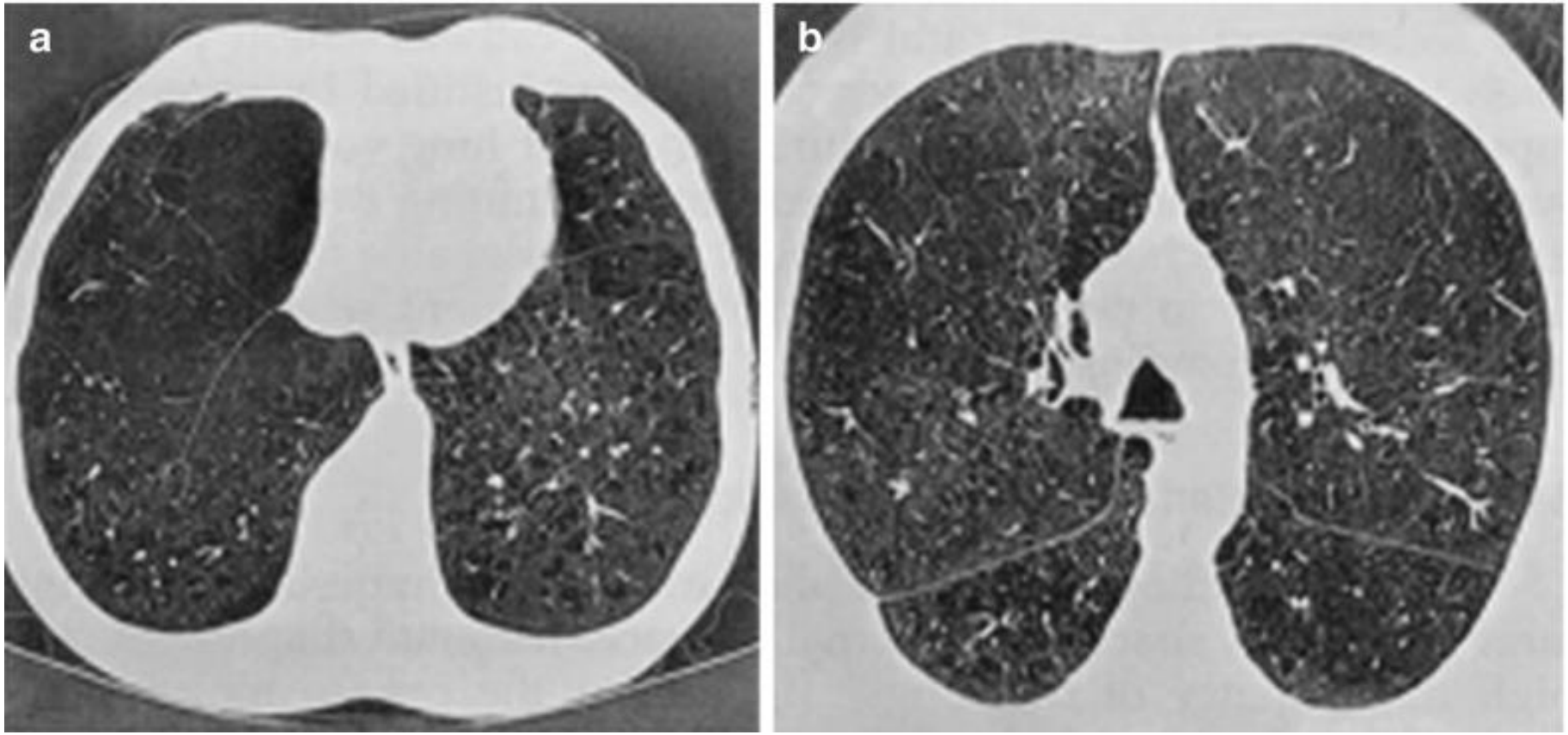
Marked hyperinflation of emphysema as seen on PA and lateral chest x-ray. Note the flattened hemidiaphragms and increased AP diameter



LVRS : *Pre –operative evaluation and preparation*

CT SCAN

- Document the presence of emphysema
- Rule out the presence of infiltrative processes/ occult lung cancer , solitary nodule
- HRCT – whether Emphysema is homogenous or heterogenous
- Upper lobe predominant or lower lobe predominant



(a) HRCT scan show heterogenous distribution of emphysema.
Parenchymal destruction is greater in the ventral portions of the lung; thus, the functional portions are easily distinguished from nonfunctional segments.

(**b**) HRCT scan show homogeneous distribution of emphysema.
It is much more difficult to determine which segments need to be resected

LVRS : *Pre –operative evaluation and preparation*

TIPS : clinical significance

- *An ideal anatomical precondition for LVRS is marked inhomogeneity of the lung structure, where normal lung tissue and severely destroyed, overdistended tissue are present in the same lung.*
- *Homogeneous distribution of the disease proved to be an unfavorable precondition*
- *Several authors have demonstrated that patients presenting with severe inhomogeneity are very likely to benefit from LVRS , Two reasons might account for this:*

  (1) compressed, normal lung tissue is released after removing adjoining hyperinflated, nonfunctional, destroyed tissue, and thus, the pulmonary mechanics of the remaining tissue are improved; and

  (2) surgery is easier to perform if the target areas are clearly visible.

LVRS : *Pre –operative evaluation and preparation*

pre - operative ***Anatomic/Radiologic Evaluation***

TIPS

- Patients usually have severe destruction of the parenchyma in the upper lobes bilaterally. Patients with severe destruction in the lower lobes (related both to smoking and to alpha-1 antitrypsin deficiency) are potentially candidates.
- patients with a homogeneous pattern of emphysema are not candidates for LVRS

LVRS : *Pre –operative evaluation and preparation*

LVRS : Physiologic Evaluation

- preoperative FEV1 < 20% of the predicted value in combination with homogenous morphology or a carbon monoxide diffusion capacity <20% of the predicted value is regarded as contraindication for surgery.

- These patients were found to have significantly increased mortality after LVRS compared with conventional medical treatment alone .

LVRS : SURGICAL APPROACH

Unilateral

- Thoracotomy
- VATS

Bilateral

- Sternotomy
- VATS

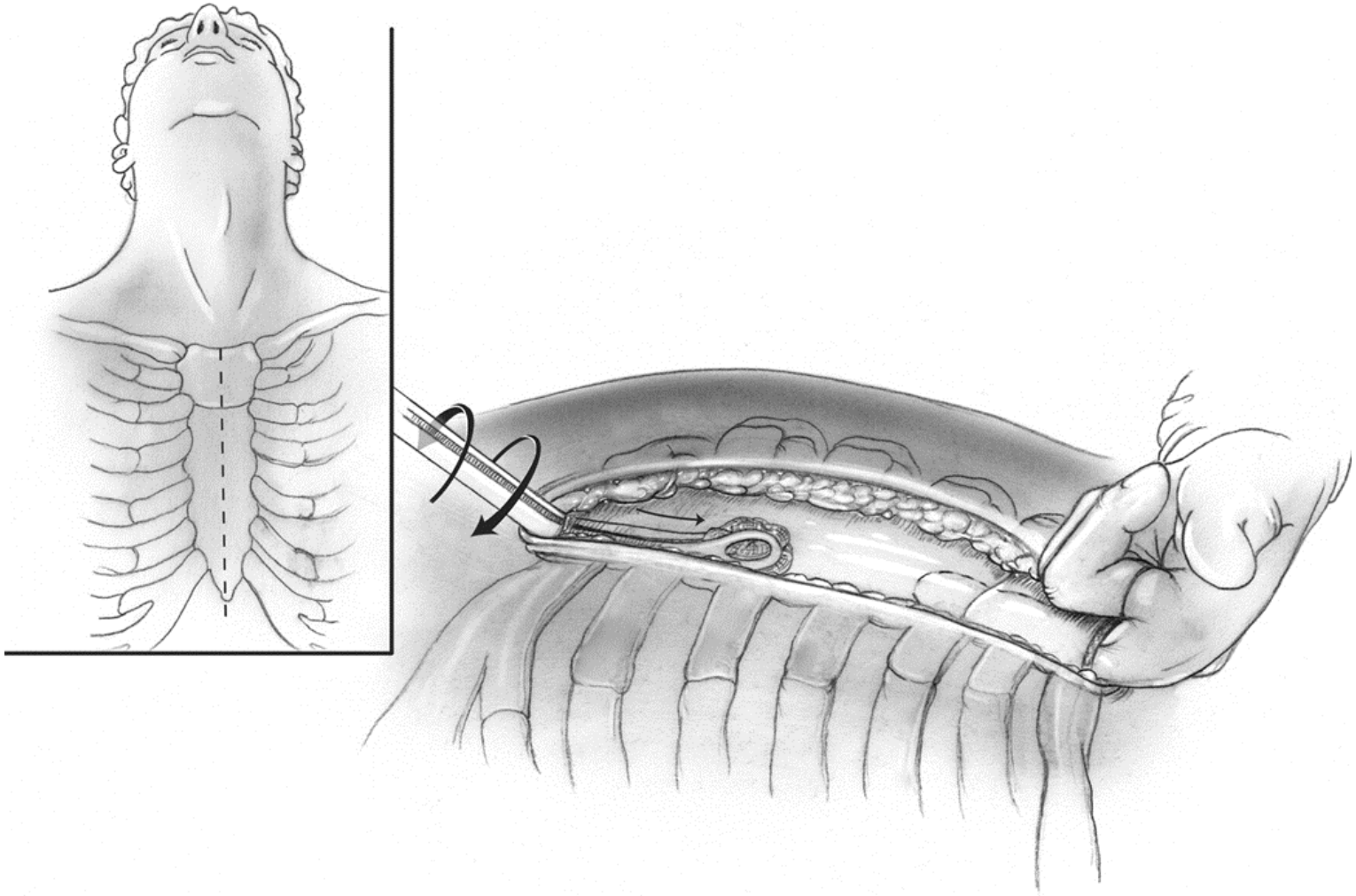
LVRS : MEDIAN STERNOTOMY

- Cooper et al in 1994 published this procedure.
- Division of sternum, pleura is incised, and adhesion dissected
- With the help of stapling device, 20-30% of lung volume is resected.
- For the removal of damaged upper lobe, resection start medially on the horizontal fissure of the middle lobe or on the base of lingula, proceeding further apically and dorso laterally resulting in a “U- shaped” or “hockey stick” shape of resection.
- Cooper et al 1994 proposed to buttress the staple line with strip of bovine pericardium
- The lungs is reventilated and carefully checked for air leak.

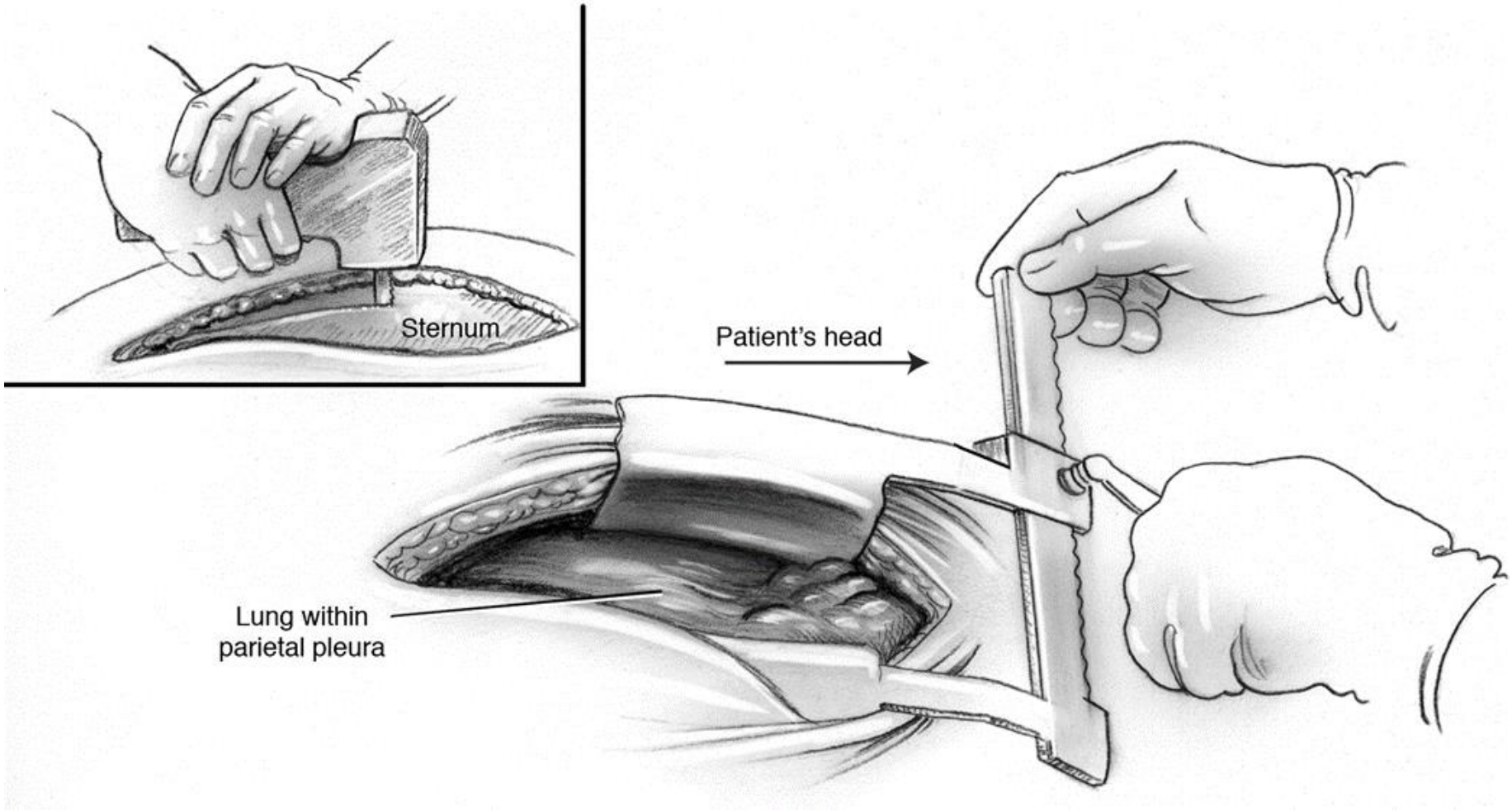
LVRS : Median Sternotomy

The patient is supine for a standard median sternotomy incision.

Before sternal division, the xiphoid is excised and an angled sponge forceps with a sponge ball is used to sweep the pleura away from the midline on either side to avoid entrance into the pleura and/or injury to the lung at the time of sternal division.



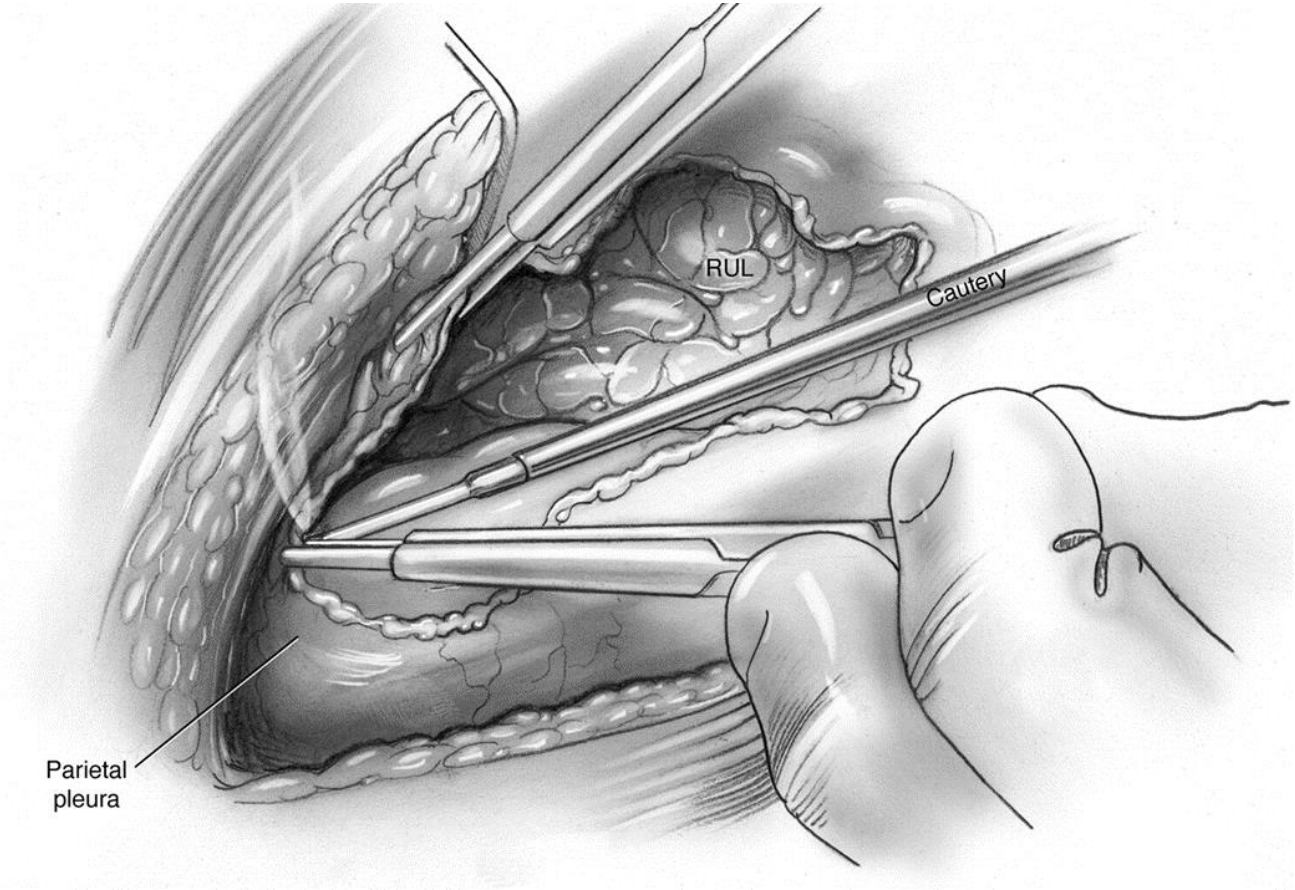
LVRS : Median Sternotomy



A sternal retractor with broad blades is used to spread the sternum and gently elevate the sternum on the side to be addressed first. These patients are older, and often on steroids, increasing the fragility of the sternum and costal cartilages.

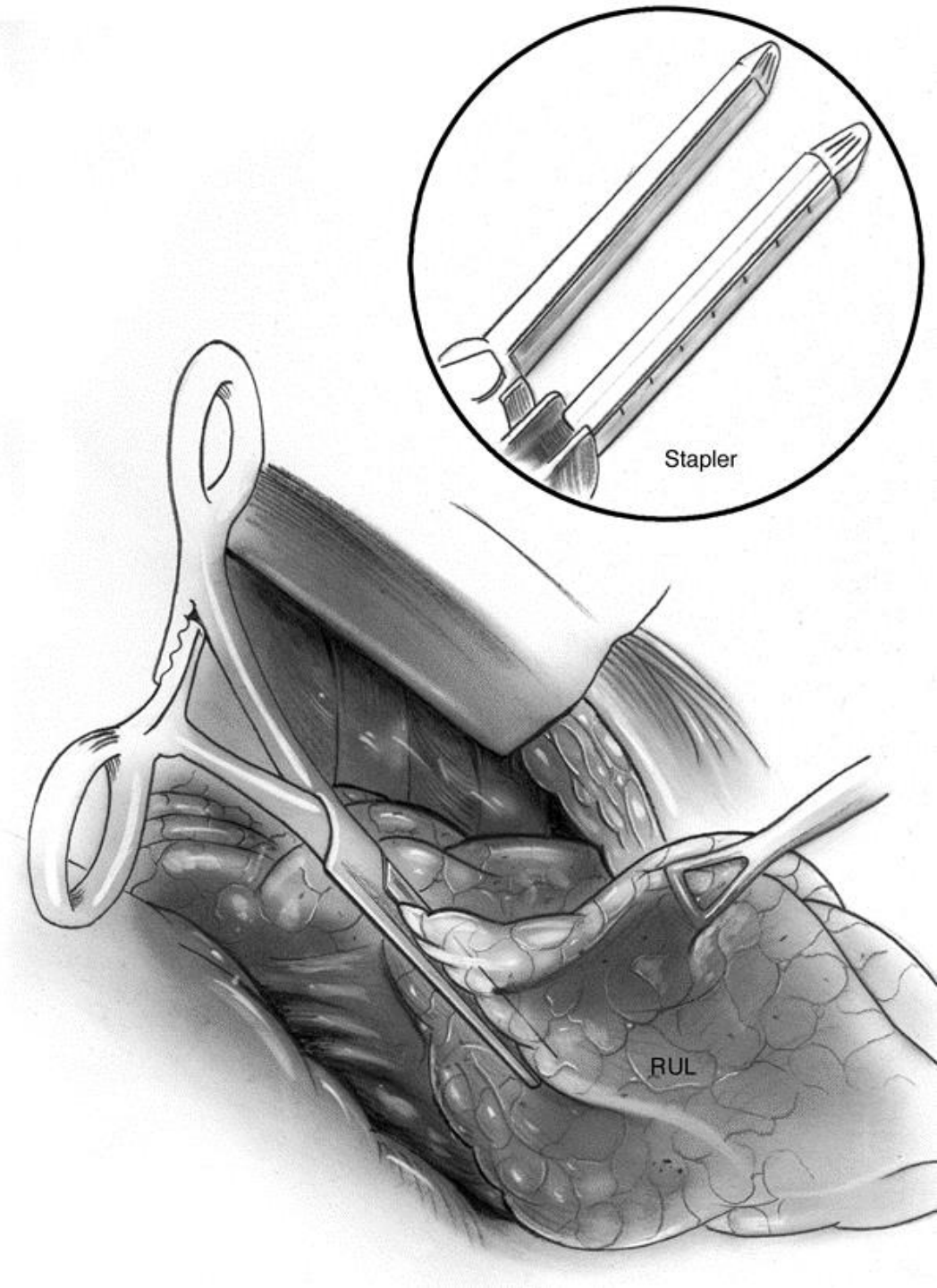
LVRS : Median Sternotomy

The mediastinal pleura is carefully incised, taking great care to avoid injury to the phrenic nerve, especially at the upper end of the pleural incision on the left side, where the phrenic nerve is particularly vulnerable to injury.



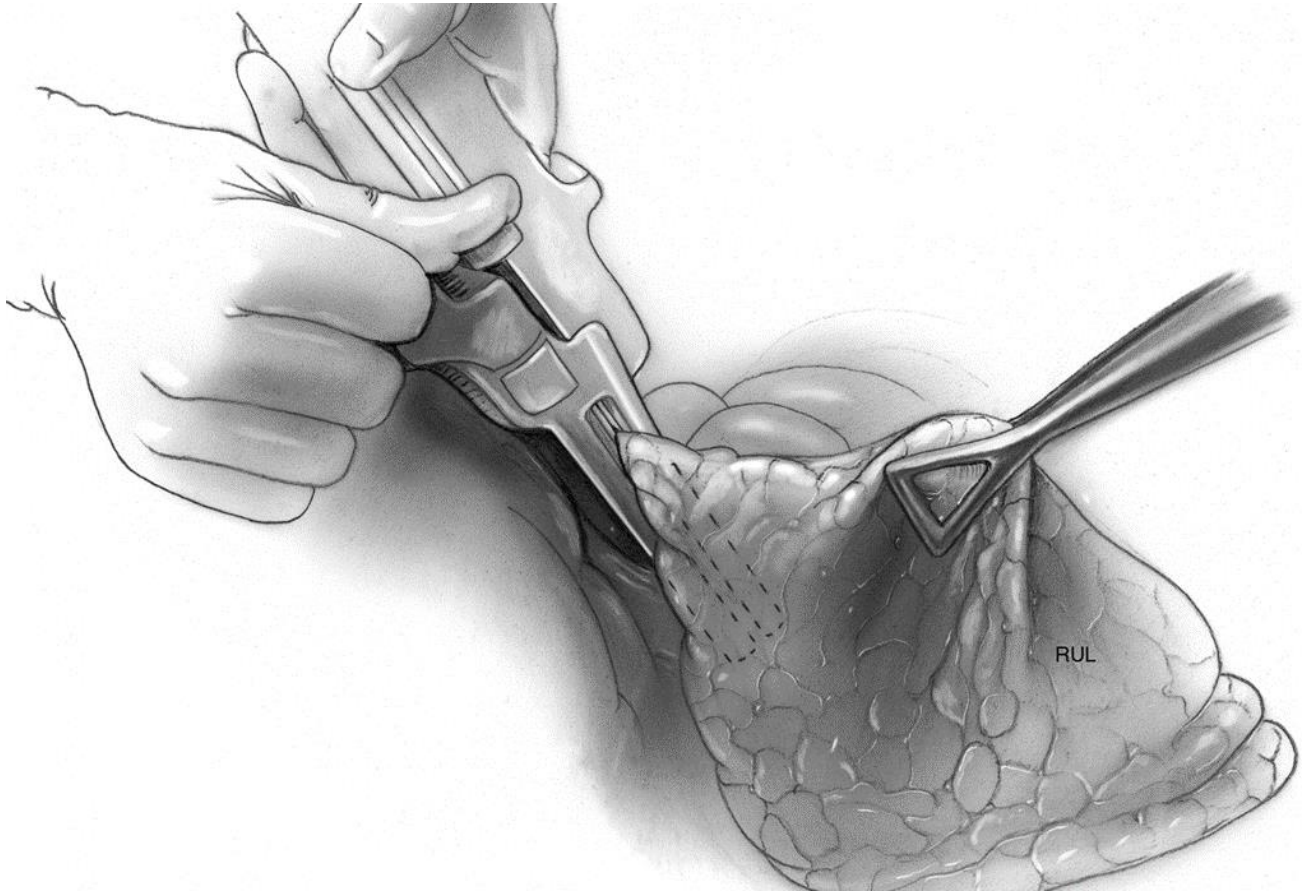
LVRS : Median Sternotomy

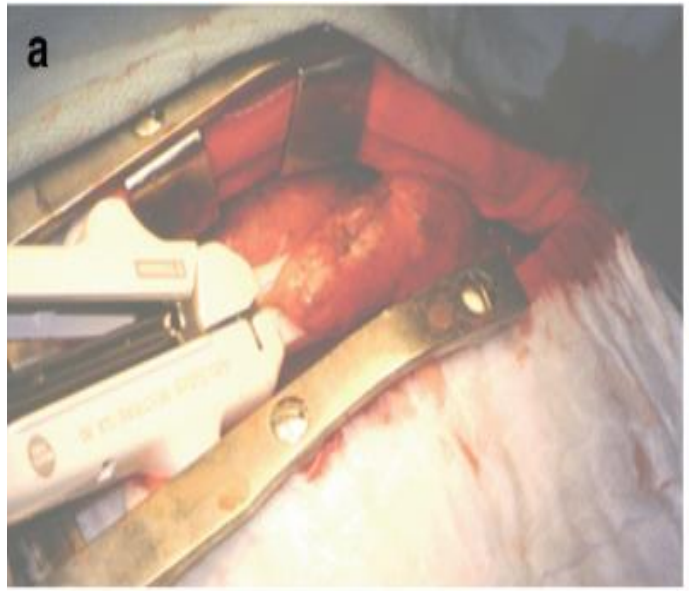
- A non crushing, straight, intestinal clamp is often used to compress and demarcate the lung parenchyma where the stapler is to be applied.
- The linear GIA stapler is fitted with strips of bovine pericardium to act as a staple line buttress.

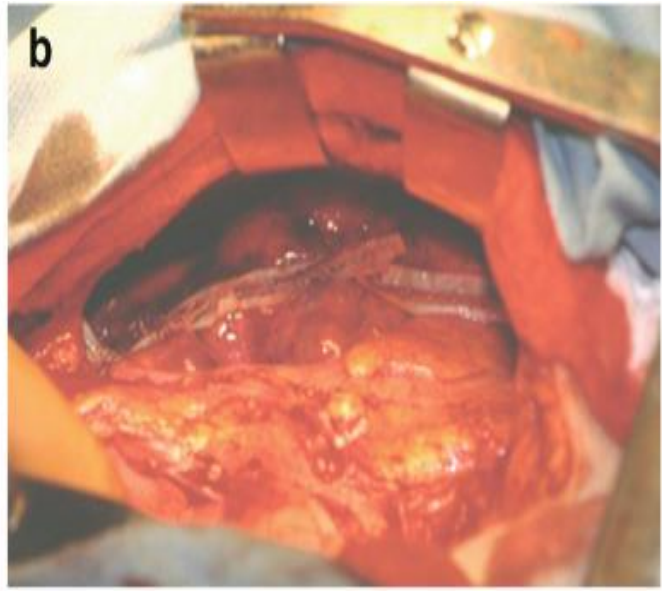


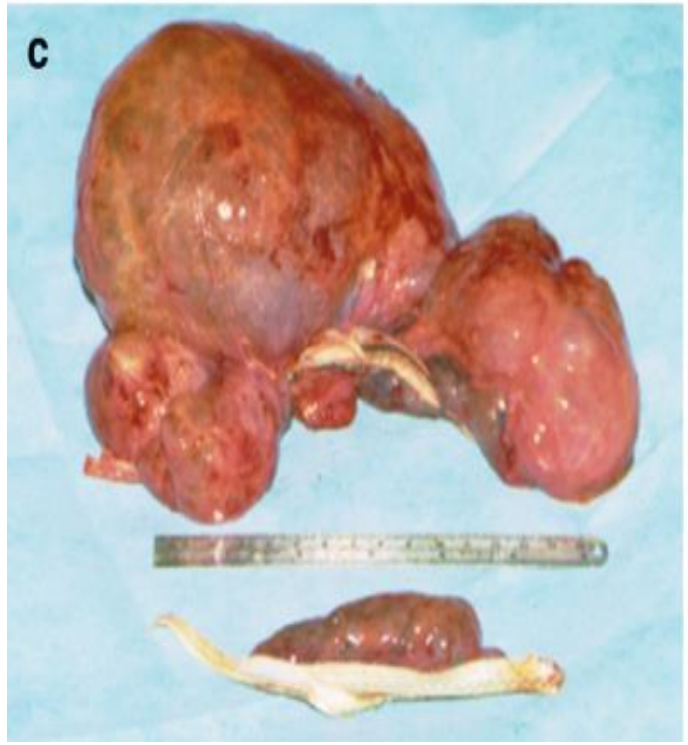
LVRS : Median Sternotomy

- The intestinal clamp is removed, and the GIA stapler is applied, beginning on the medial aspect of the right upper lobe about 2 cm above the horizontal fissure line.
- The stapler is directed toward the axilla.
- The pericardial strips are flooded with saline to soften them before the stapler is removed





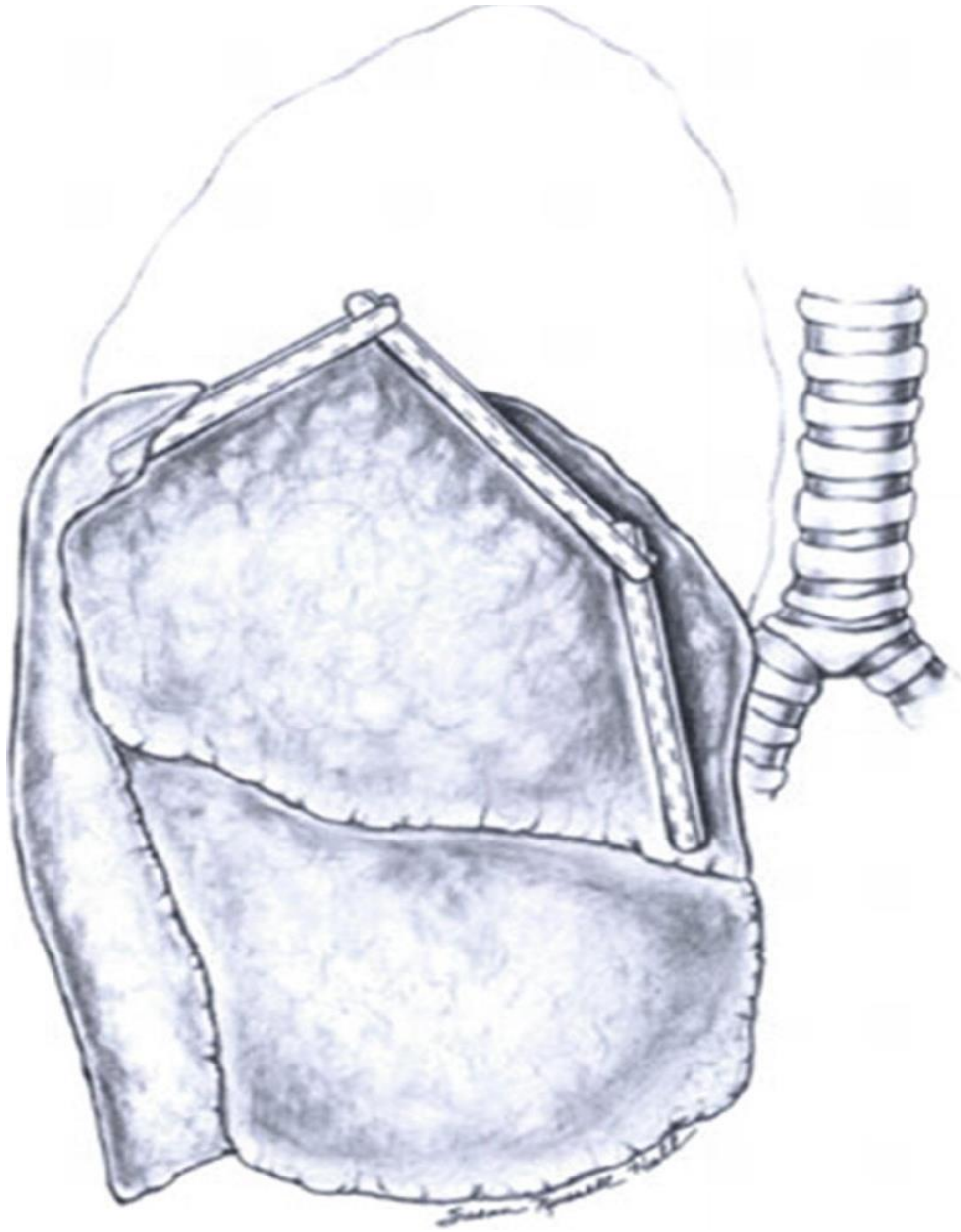




(a) Buttressed surgical stapler starting a right upper lobe LVRS via a median sternotomy. The staple line begins along the anterior segment, progressively extending to the apical and posterior segments in repeated applications of the stapler.

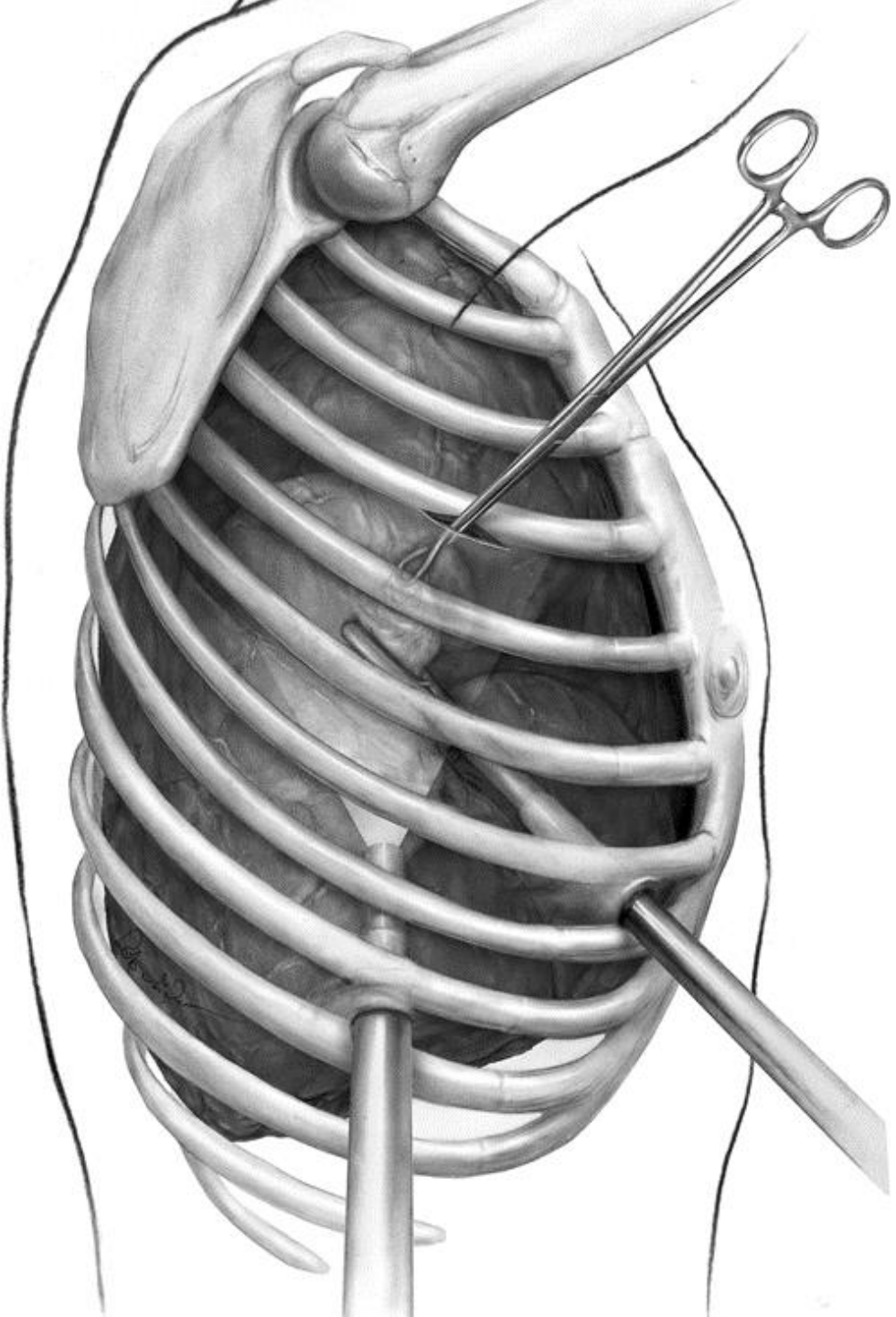
(b) (**b**) A complete RUL lung reduction showing a buttressed staple line and smooth continuation of one staple firing to the next.

(c) (**c**) Resected specimen of RUL lung reduction, with approximately 60–70% of RUL excised



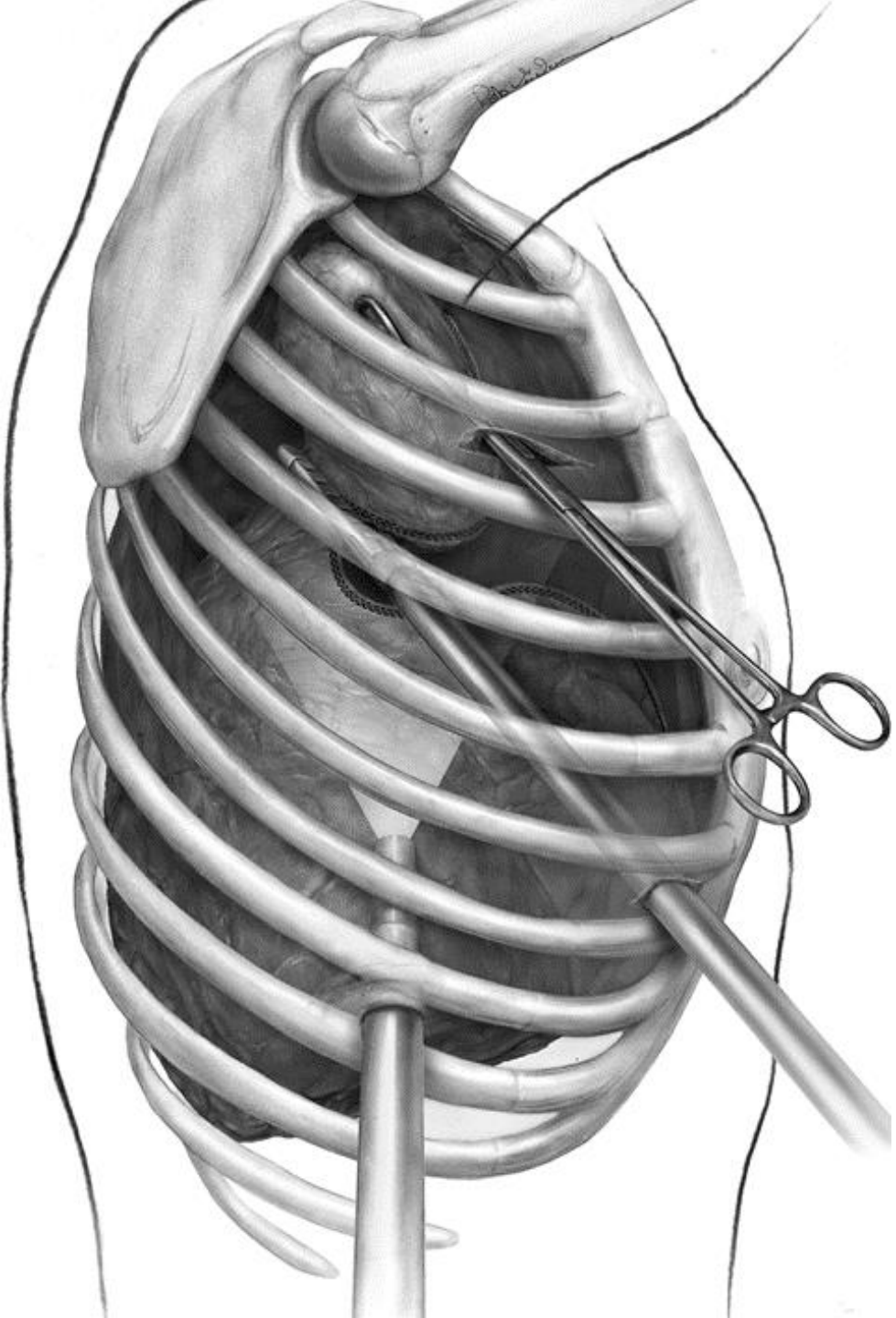
Schematic drawing of right upper lobe LVRS,

removing 60–80% of the RUL parenchyma using a buttressed stapler



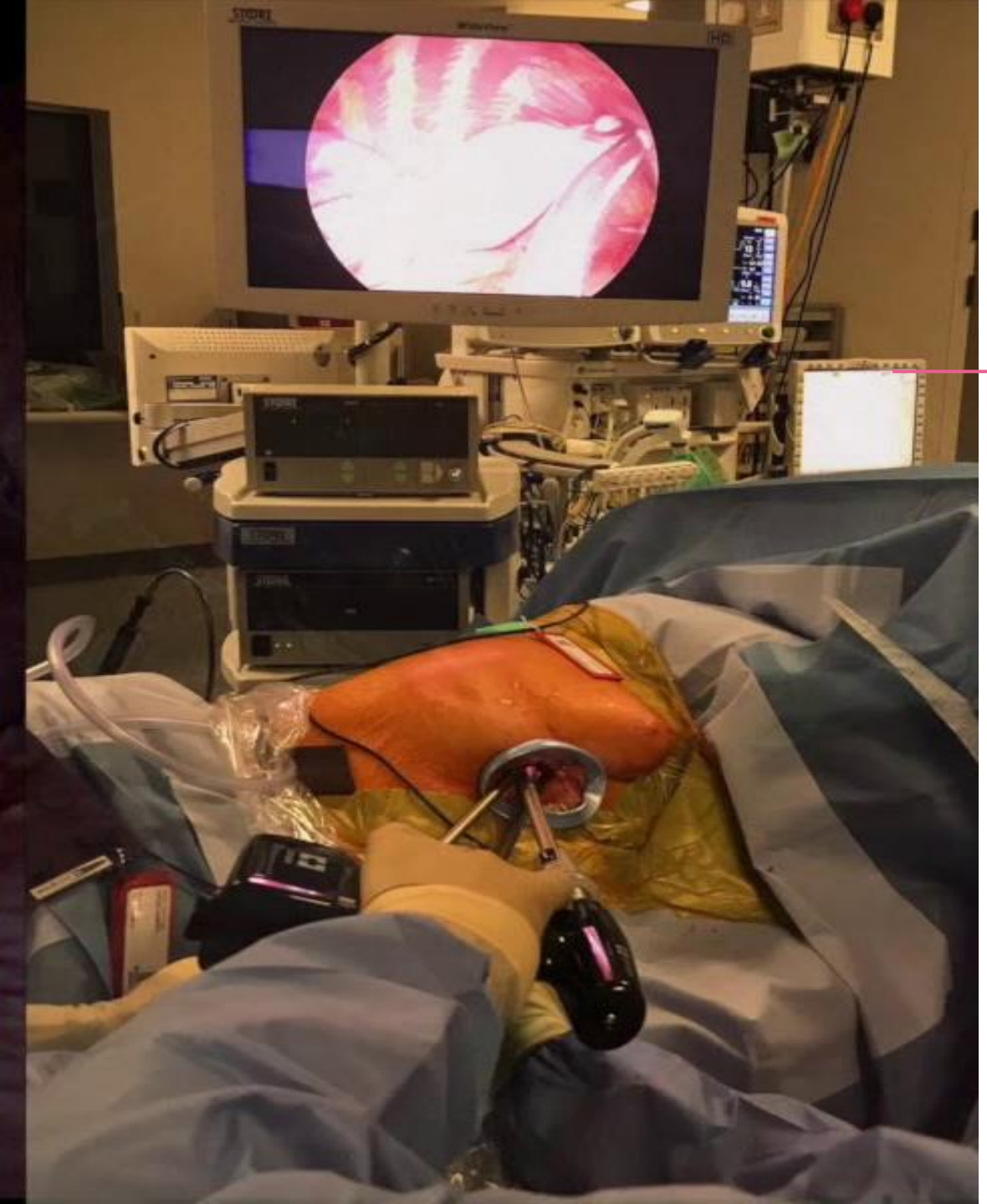
LVRS : VATS

- The surgeon stands in front of the patient, who is in a full lateral decubitus position.
- 9th intercostal space in the mid-axillary line → for The 5-mm trocar and 30° thoracoscope.
- 6th intercostal space in the mid-clavicular line→ The stapler passes for the pulmonary resection.
- 4th intercostal space in the mid-axillary line → A ring forceps passes through this incision to hold the lung for the stapler.



LVRS : VATS

- For upper lobe emphysema, the resection usually starts medially at the junction of the anterior segment of upper lobe with the middle lobe on the right or the anterior segment and the lingula on the left.
- The resection proceeds from anterior to posterior, over the top of the lobe.
- On the right, the resection parallels the minor and then the major fissure



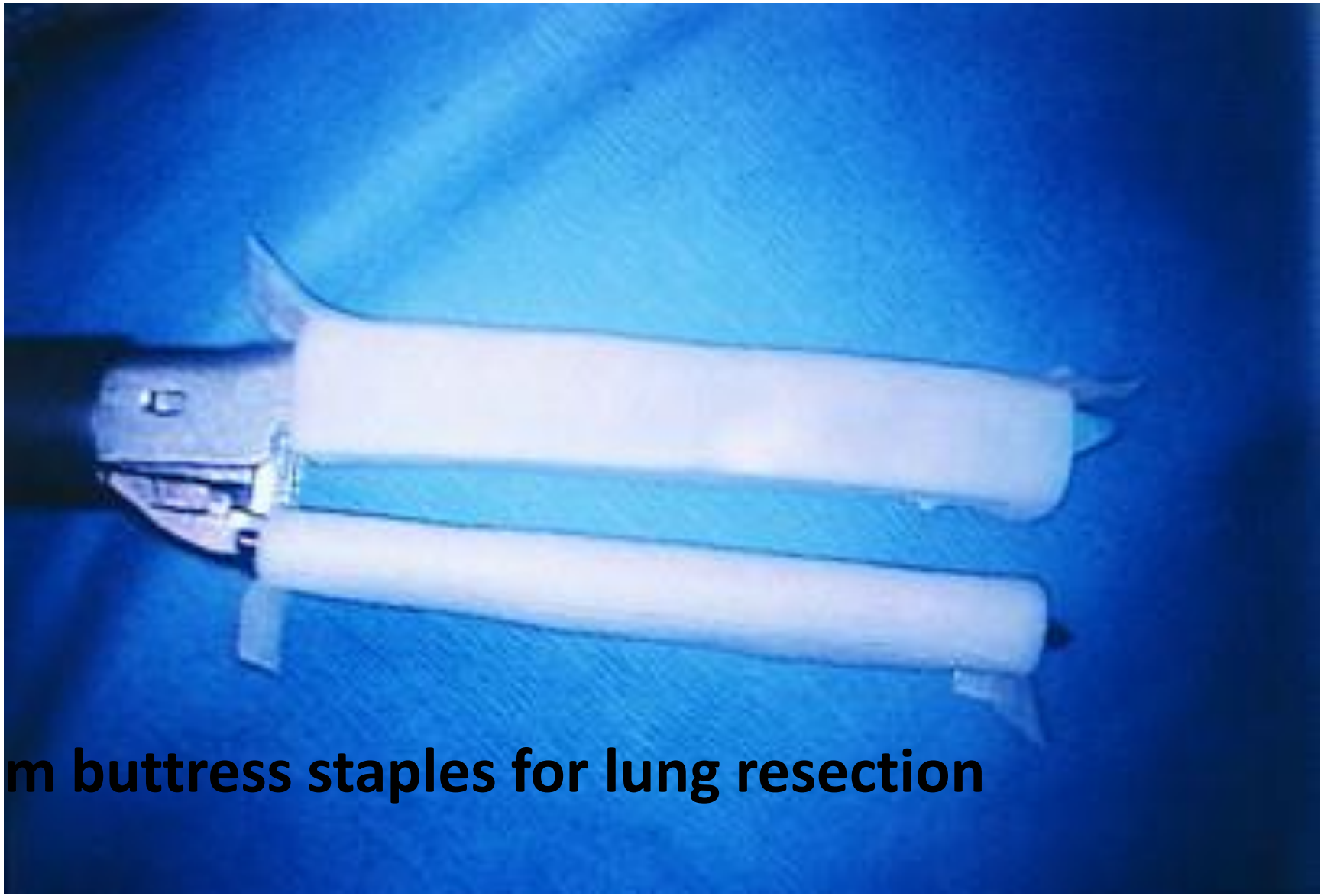
LVRS : Uniportal VATS

- subxiphoid uniportal video-assisted thoracoscopic surgical (VATS) approach for unilateral lung volume reduction surgery has been reported by Abraham Nashaata in 2018 .
- Potential drawbacks are the relative difficulty in left-sided procedures as compared to the right because of the position of the heart

LVRS : Staplers

LVRS : Staplers

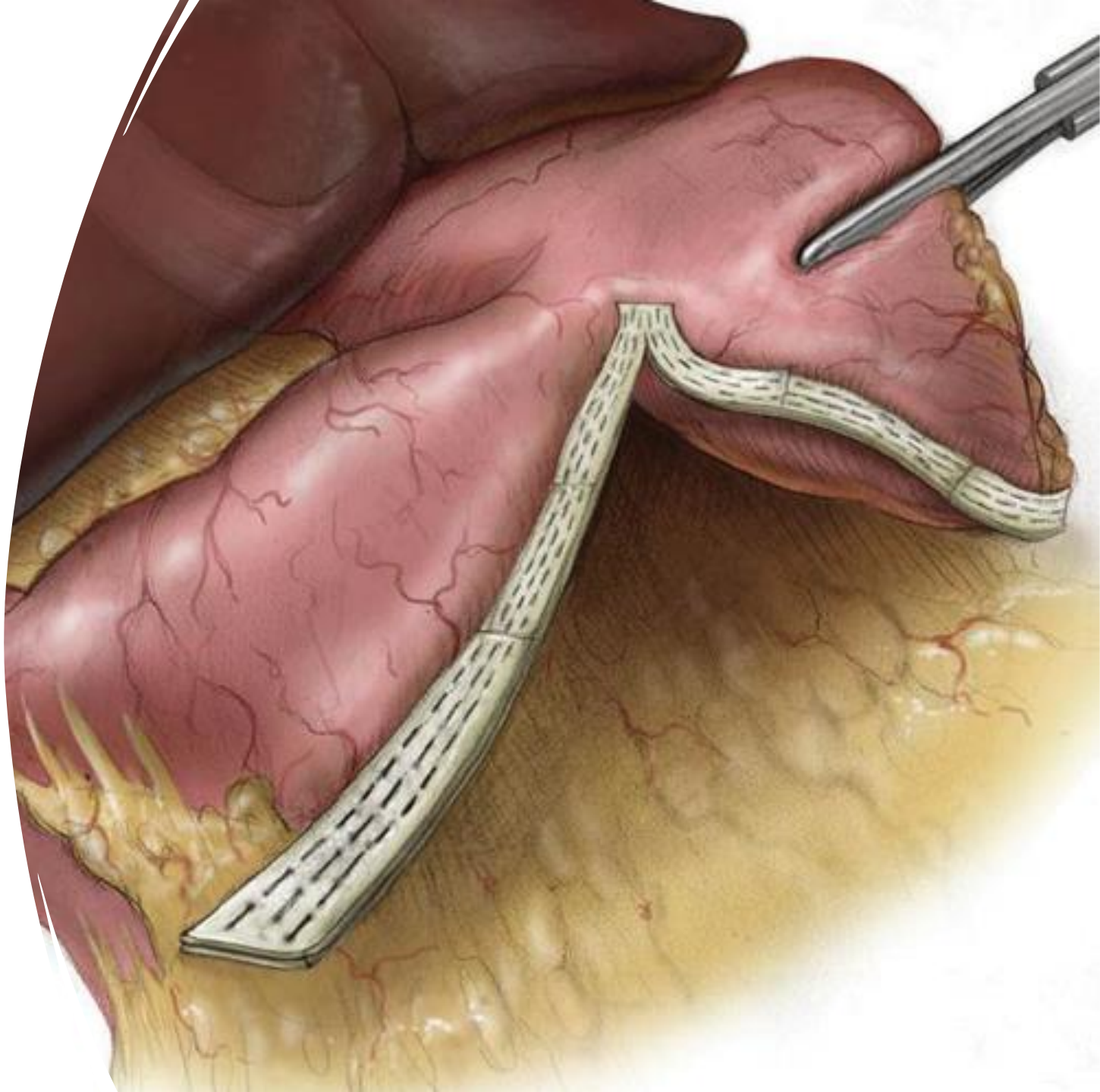
LVRS : staplers



Bovine pericardium buttress staples for lung resection

LVRS : Stapling

Peri-strips buttressing the staple line in pulmonary resection



LVRS : VATS

ECHELON flex
Thoracic
endostaplers

LVRS : VATS

Thoracoscopic linear-cutter-staplers (VATS)

LVRS : Extubation criteria after LVRS

Early Extubation

- It is difficult to avoid air leakage entirely despite the use of new surgical techniques that use staplers buttressed with bovine pericardium.
- Air leakage can be exacerbated by positive pressure ventilation, whereas the negative intrapleural pressure generated during spontaneous breathing minimizes air leakage.
- Therefore, early extubation after LVRS is of prime importance.

LVRS : Extubation criteria after LVRS

Extubation criteria after LVRS

1. Patient awake and cooperative
2. Patient breathing sufficiently, rapid shallow breathing index (respiratory frequency per min/tidal volume in L) is below 70
3. Sufficient arterial oxygenation: $SaO_2 \geq 92$ while patient is breathing spontaneously ($FiO_2 \leq 0.35$)
4. Adequate pain management achieved
5. Patient core temperature >35.5 °C
6. No shivering
7. Stable hemodynamic condition

LVRS :Postoperative Management

Postoperative management is directed to minimize the adverse side effects:

(1) judicious pulmonary toilet

(2) bronchodilator therapy

(3) effective perioperative analgesia with TEA or paravertebral/multimodal analgesia

(4) avoidance of systemic corticosteroids

LVRS
Median sternotomy or VATS ??

- The results of LVRS are comparable, whether LVRS is performed through a median sternotomy or by video-assisted thoracic surgery (VATS).
- The National Emphysema Treatment Trial (NETT) showed that the VATS approach was less costly and provided earlier recovery compared with the median sternotomy.

LVRS : outcome

- LVRS has been reported to be cost-effective , significantly improves pulmonary function, exercise tolerance, quality of life, and even survival for a selected patients .
- Patients with upper-lobe predominant emphysema and low exercise capacity demonstrated the best outcome.

LVRS : outcome

- (In the non-high-risk group, they demonstrated that heterogeneous distribution of upper lobe predominant emphysema and low baseline exercise capacity predicated decreased mortality after LVRS compared to no surgery.)

- (Low exercise capacity was defined as less than 25 Watts (W) for females and less than 40 W for males.)[9]

LVRS

Points to remember

- • Lung volume reduction surgery (LVRS) is a viable option for a select group of emphysema patients.
- • Effective preoperative pulmonary rehabilitation and careful patient selection criteria promote favorable outcomes.
- • Effective perioperative pain management and early extubation are significant factors that minimize postoperative complications and lead to better outcome.
- • LVRS improves dyspnea and exercise tolerance and increases potential for patient survival in appropriately selected patients

Are there alternatives to surgery for lung volume reduction?

Bronchoscopic Lung Volume Reduction (BLVR)

Rationale for BLVR

- **LVRS** may be accompanied by postoperative morbidity and there is a selection criteria that exclude many patients.
- Use of endoscopic methods to make collapse of hyperinflation would have the beneficial effects like resecting these areas without the morbidity of surgery.
- Patients not a good surgical candidates might get benefit from BLVR.

Bronchoscopic Lung Volume Reduction (BLVR)

Less-invasive bronchoscopic approaches to lung volume reduction have been developed to reproduce the effects of LVRS:

- ✓Valves (EBV and IBV) that allow unidirectional airflow in exhalation to collapse target lung lobe
- ✓stents (bypass tracts between cartilaginous bronchi with air trapping and normal lobes).
- ✓Bio-degradable gel into bronchi -→ Biological lung volume reduction
- ✓Coils
- ✓Thermal vapor ablation

BLVR : Zephyr endobronchial valve (EBV)

First generation Zephyr EBV.
Image courtesy: www.ctsnet.org

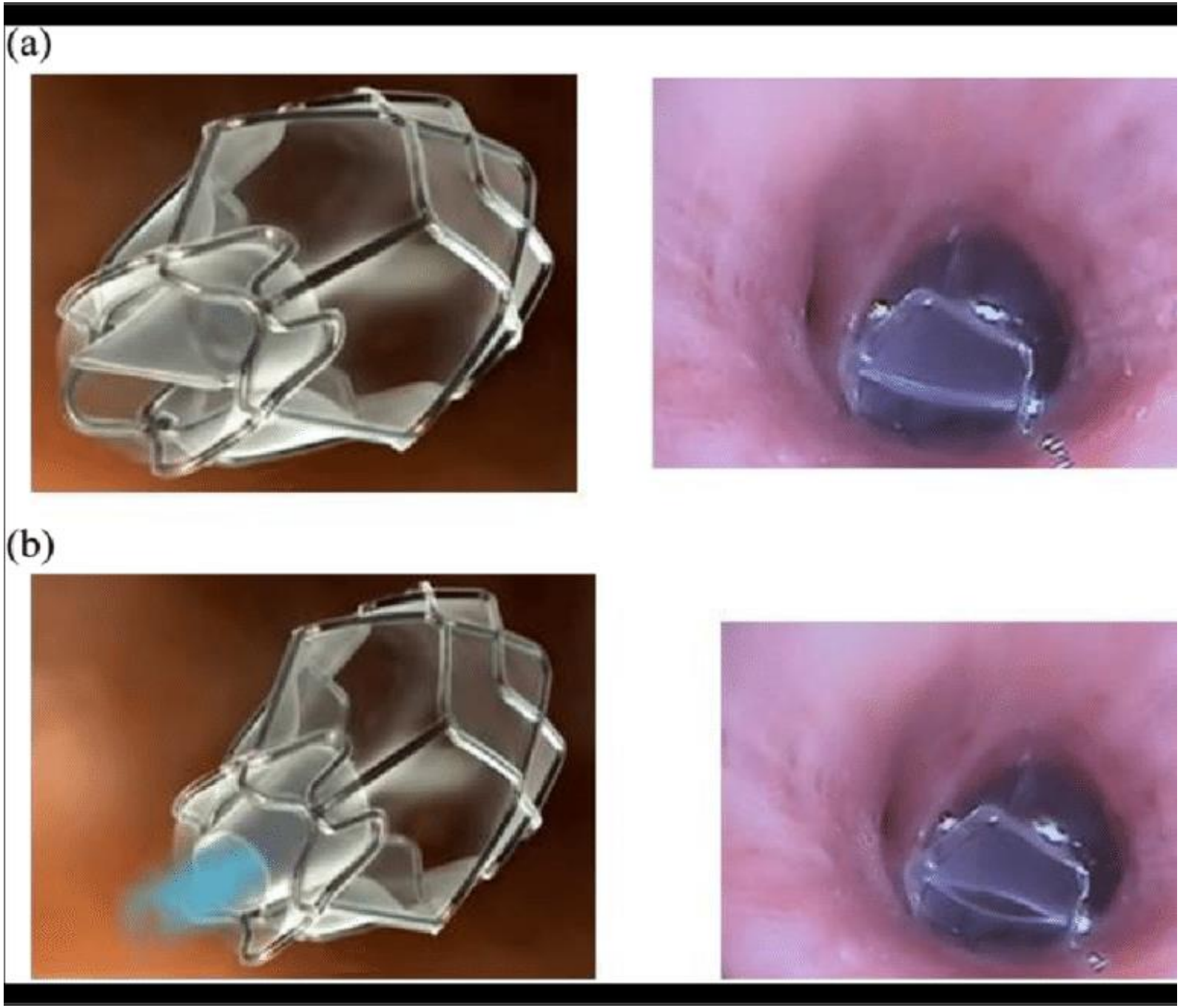
Second generation Zephyr EBV.
Image courtesy: pulmonx.com

BLVR : EBV

Zephyr EBV

during inspiration (a) and **expiration (b)**. The left panel is a schematic presentation (Pulmonx with permission).

The right panel are valves in situ. Please note that the 'duckbill' is closed during inspiration and open during expiration to allow air and secretions out. EBV: endobronchial valve.



BLVR : The Chartis System

used to detect collateral flow and determine the suitability of patients for the Zephyr® EBV.

Chartis® System for Collateral Ventilation Assessment

pulmonX Interventional Pulmonology®

The Chartis® System consists of:

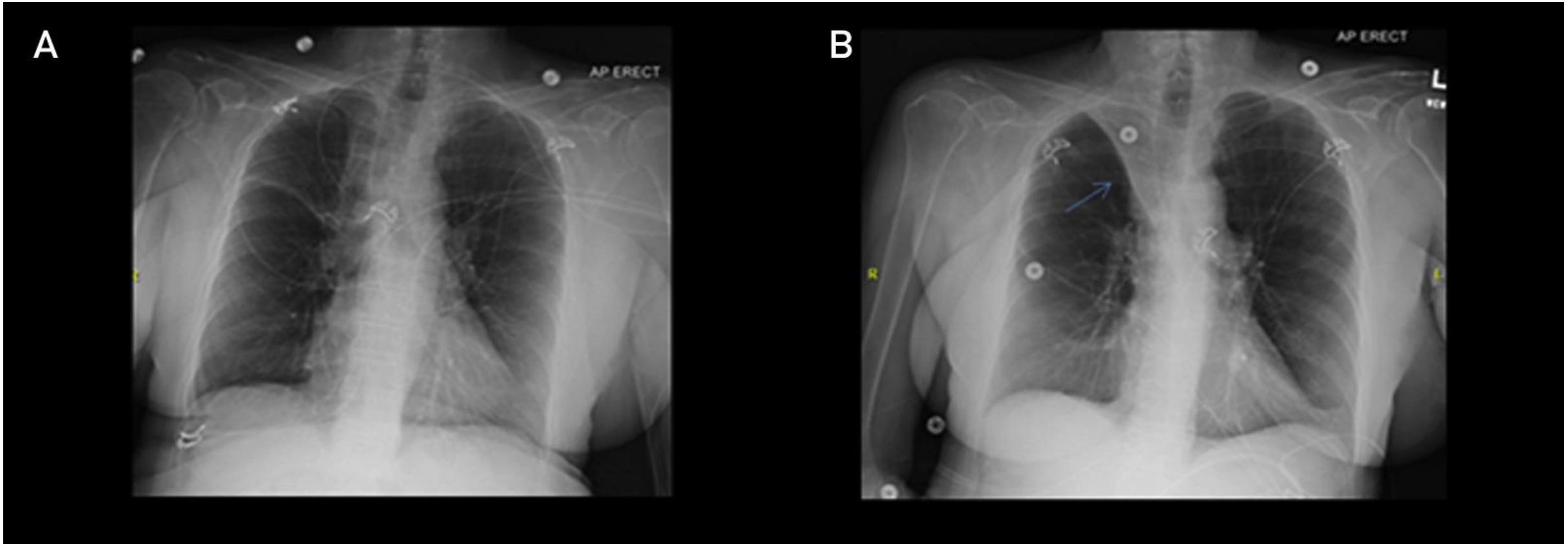
– Console for measuring flow and pressure

– Balloon catheter

Similar to the EBV, the low pressure balloon catheter is delivered through a bronchoscope

The Zephyr® EBV is an investigational device in the United States. Limited by U.S. law to investigational use.

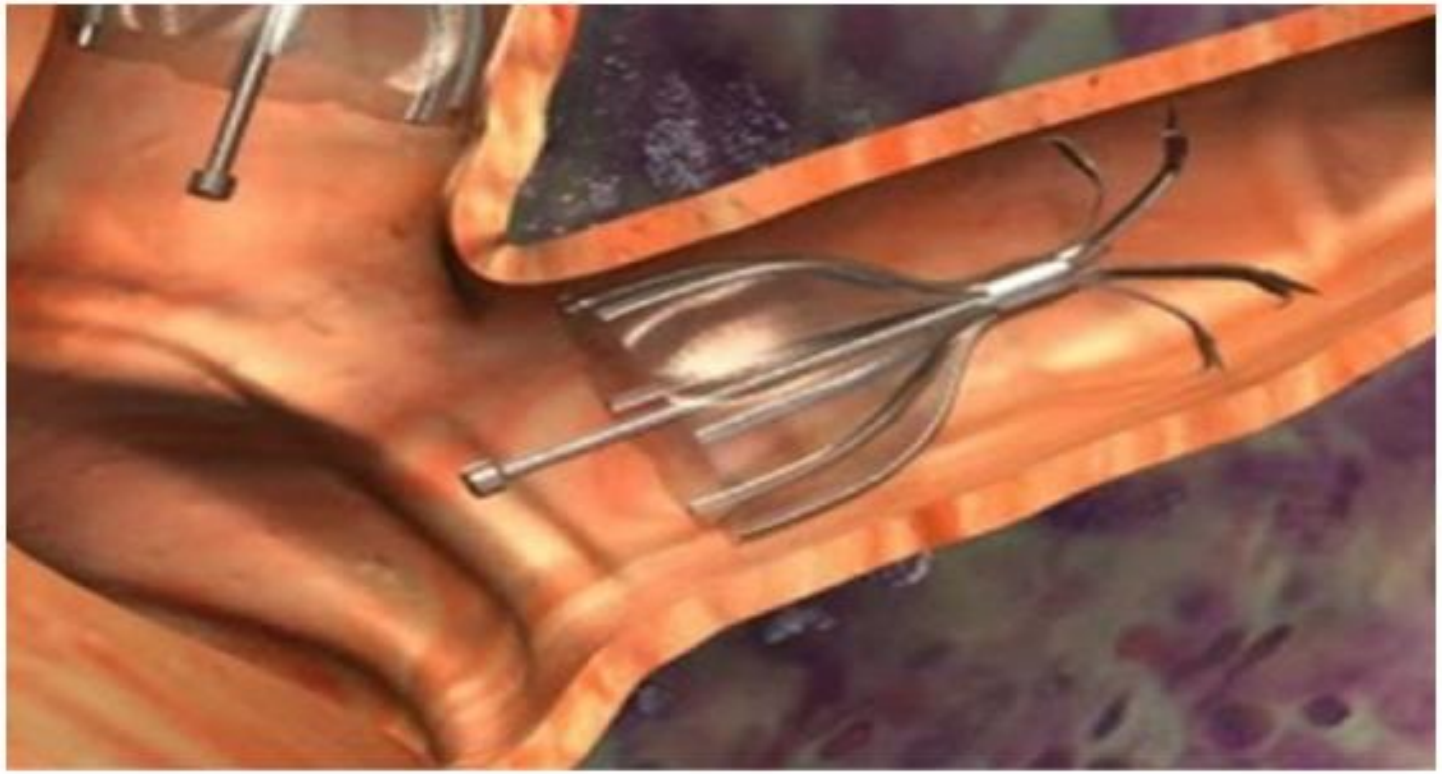
BLVR : Endobronchial valve



Chest x-rays pre- (A), post- (B), of a chest tomography showing volume reduction of the right upper-lobe post-endobronchial valve placement.

BLVR : Intrabronchial valve ; Spiration

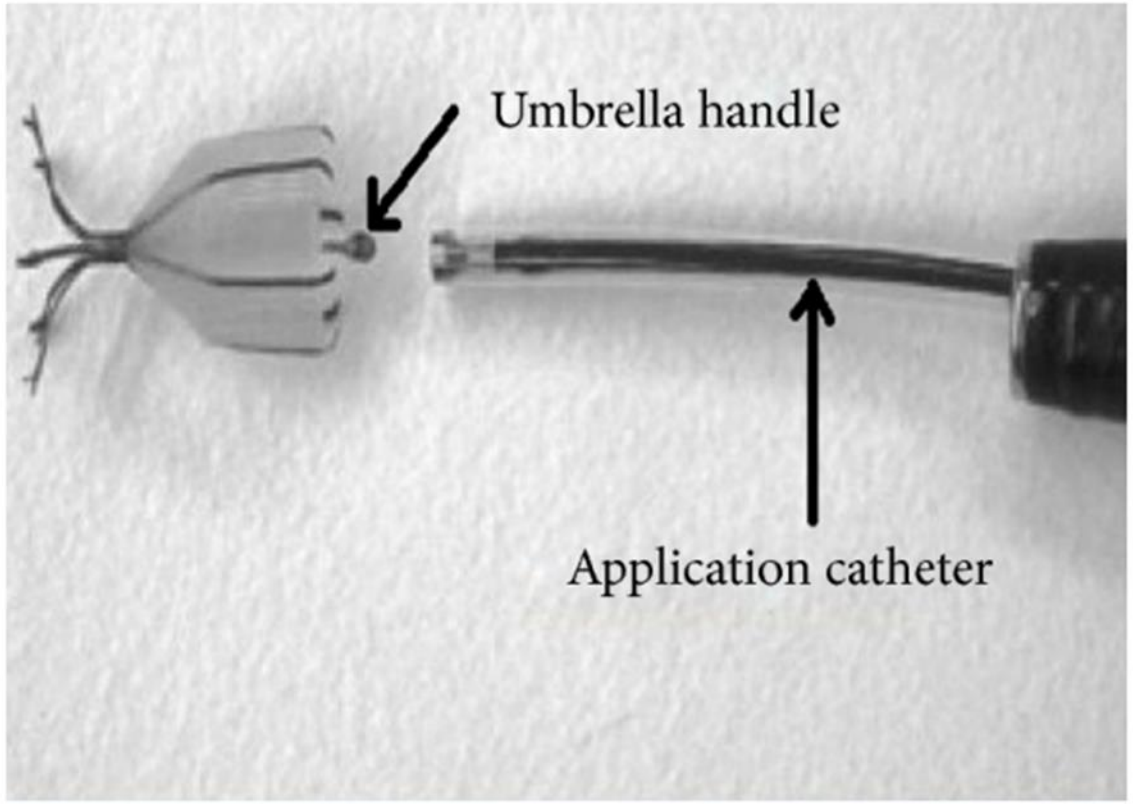
The intrabronchial valve (Spiration Inc., Redmond, WA, USA) has six struts made of nitinol covered by polyurethane membrane in the shape of an umbrella.

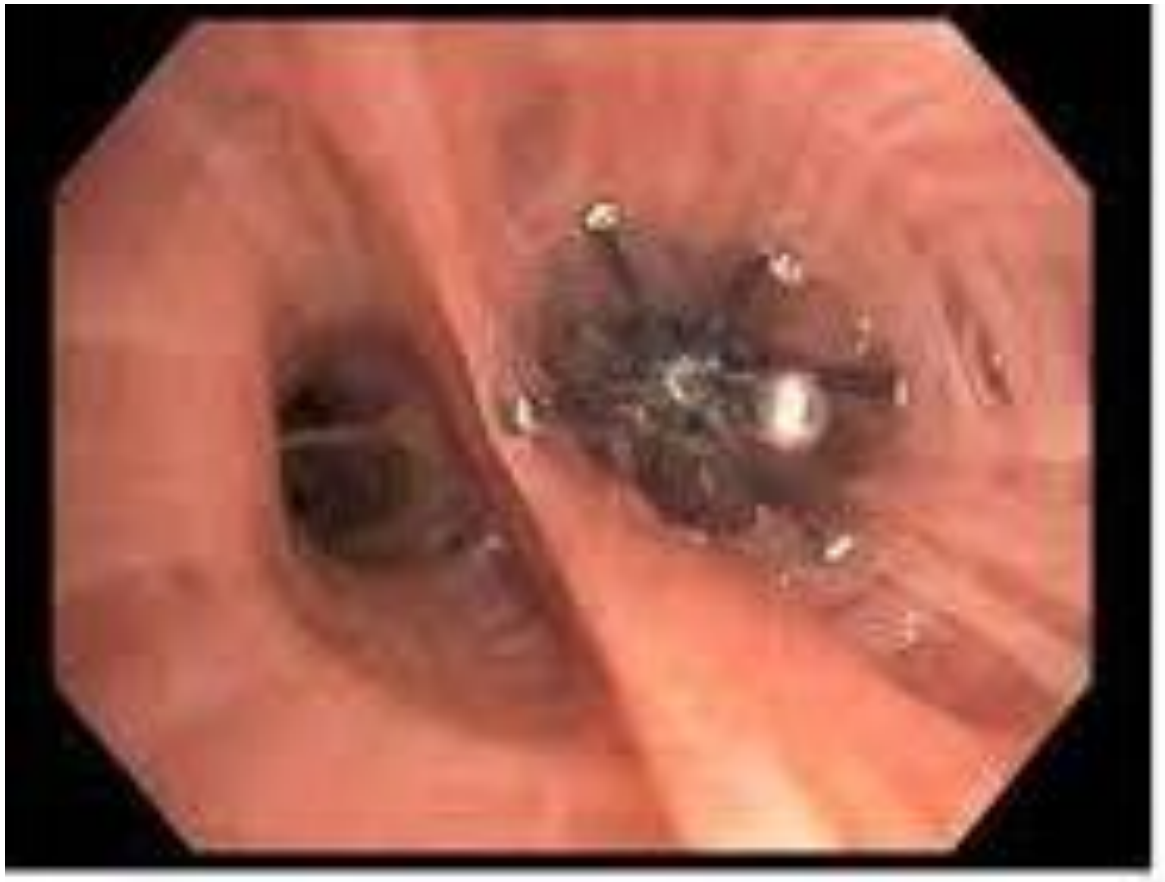


Spiration IBV *in situ*

BLVR : Intrabronchial valve

(IBV; Spiration; Olympus, Tokyo, Japan).

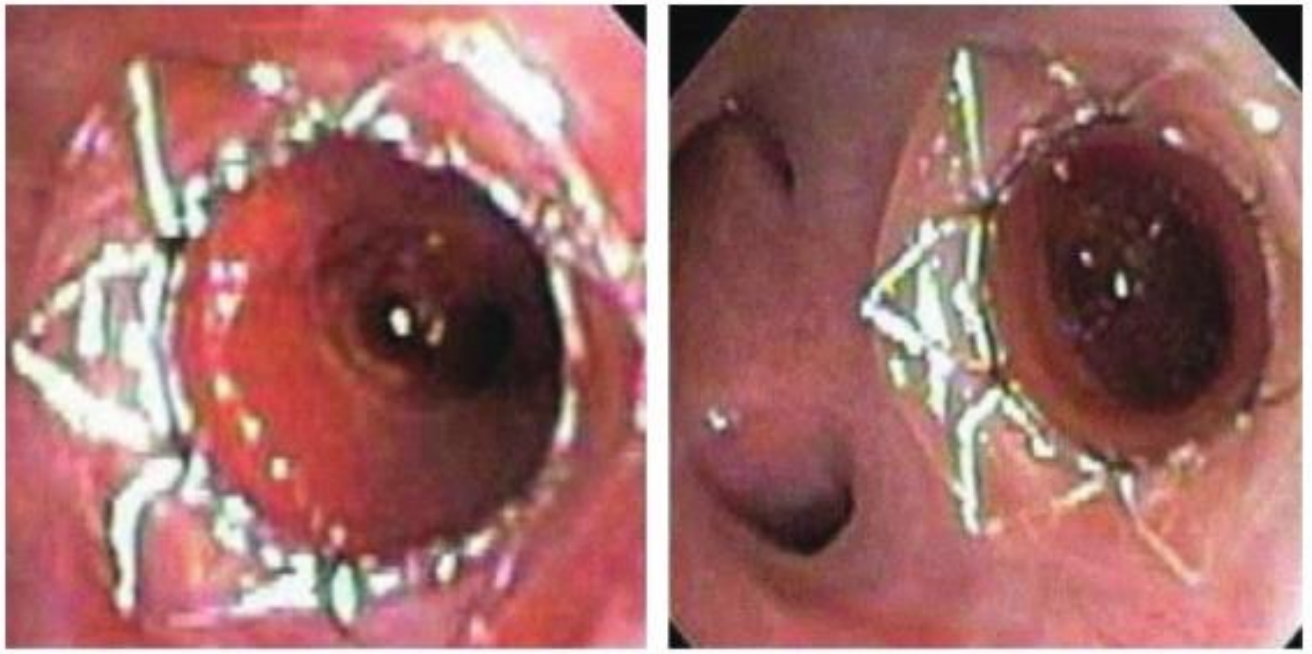




BLVR : STENTS

A Broncus®

Airway Bypass Stent compared in size to the head of a pencil.



Stented airway bypass tracts

BLVR : STENTS

In 2001, Cooper and associate report 6 cases of endobronchial bypass procedure by creating extra-anatomic broncho-pulmonary passage and placing a stent. His concern? How long the stent stay open

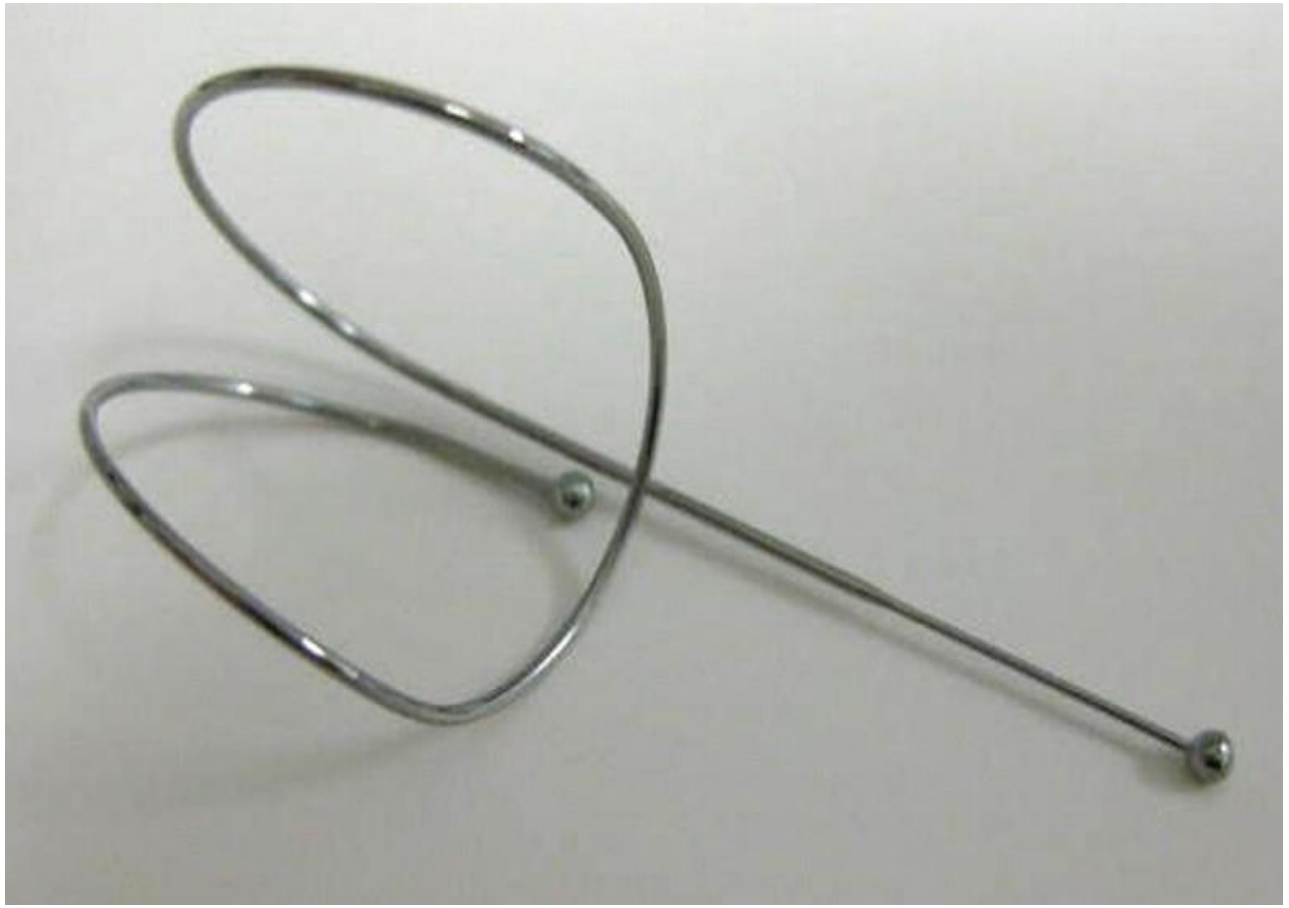
BLVR : Stents

Stented air way bypass tracts

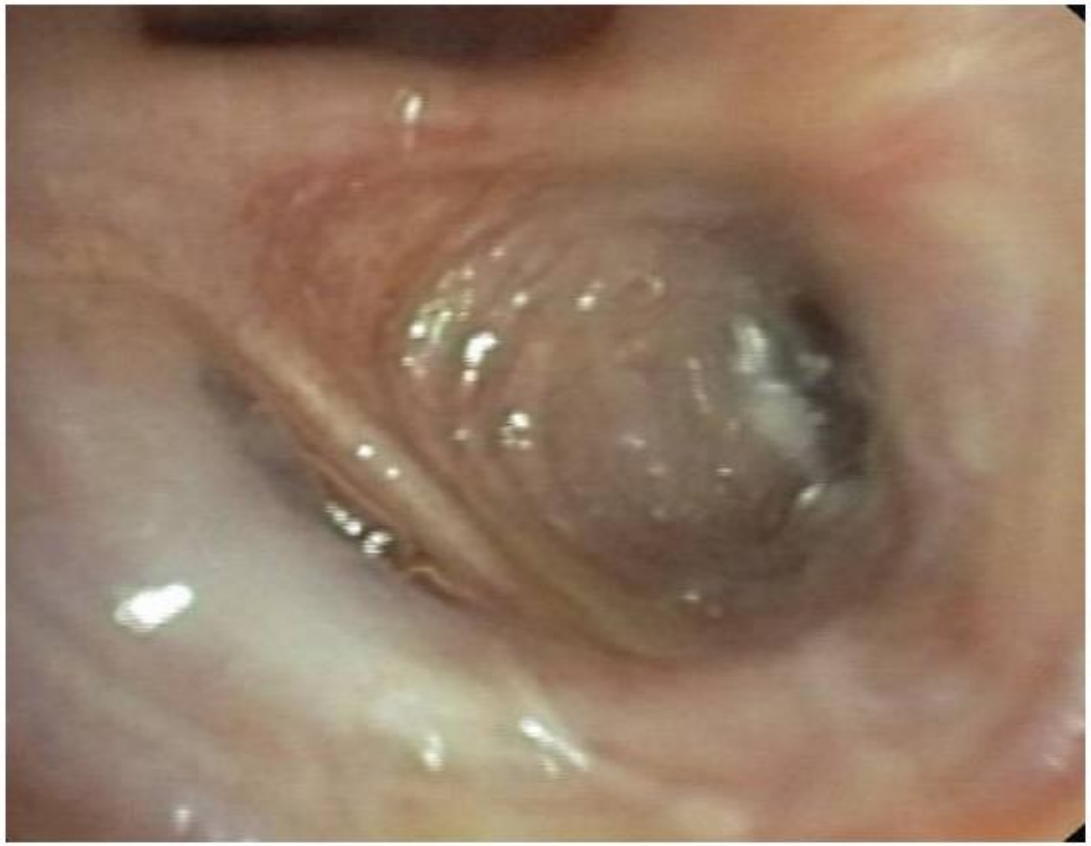
BLVR : COILS

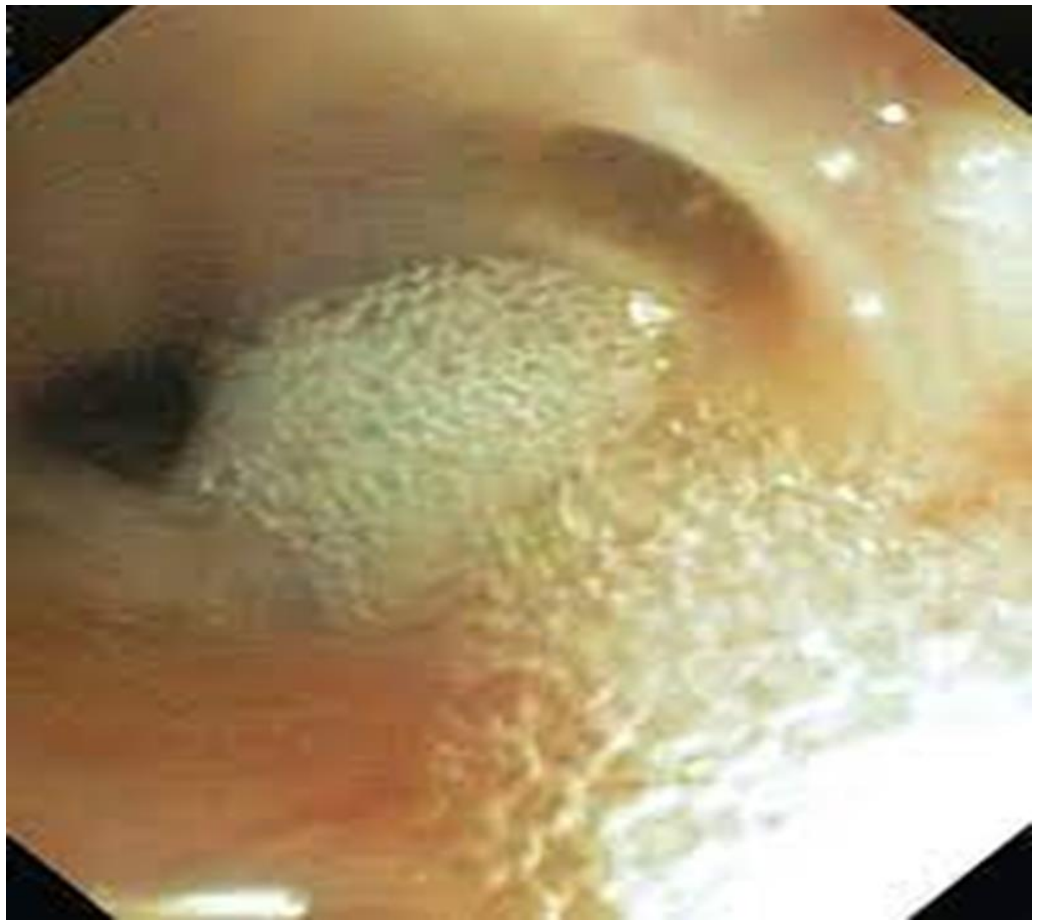
The RePneu™ lung volume reduction device (PneumRx, Mountain View, CA)

- ✓ designed to reduce lung volume for both heterogenous and homologous emphysema.
- ✓ It is effective even when collateral ventilation between lung lobes exists.
- ✓
- ✓ The preformed **coil** is delivered into a segmental or subsegmental bronchus in a straight configuration via a fiber-optic bronchoscope. After deployment, the device resumes its coil shape gathering and compressing emphysematous lung tissue



BLVR :Severe Emphysema Treated by Endoscopic Bronchial Volume Reduction with Lung Sealant (AeriSeal)

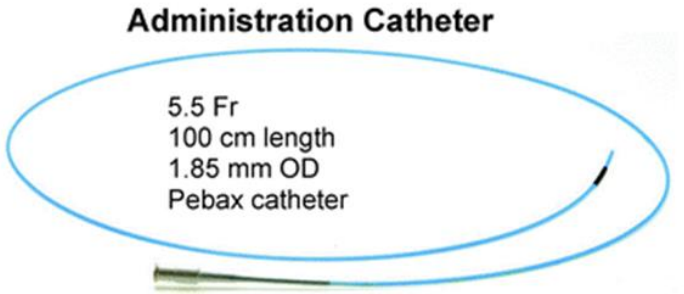




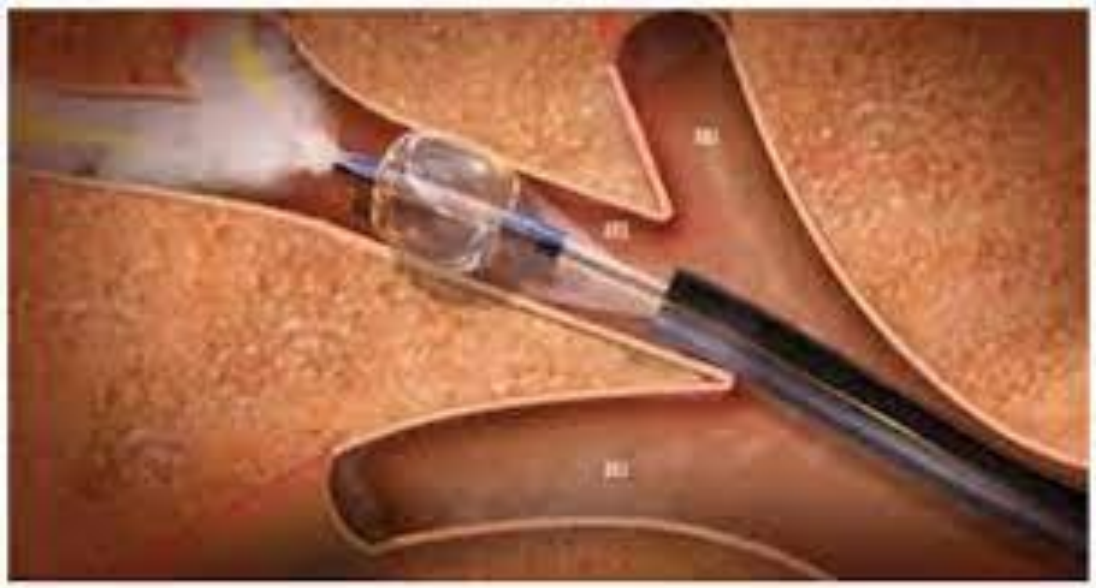
AeriSeal foam Sealant filled the targeted diseased alveolar region the affected lobe.

BLVR : The AeriSeal System: Polymeric Hydrogel Therapy for Advanced Emphysema

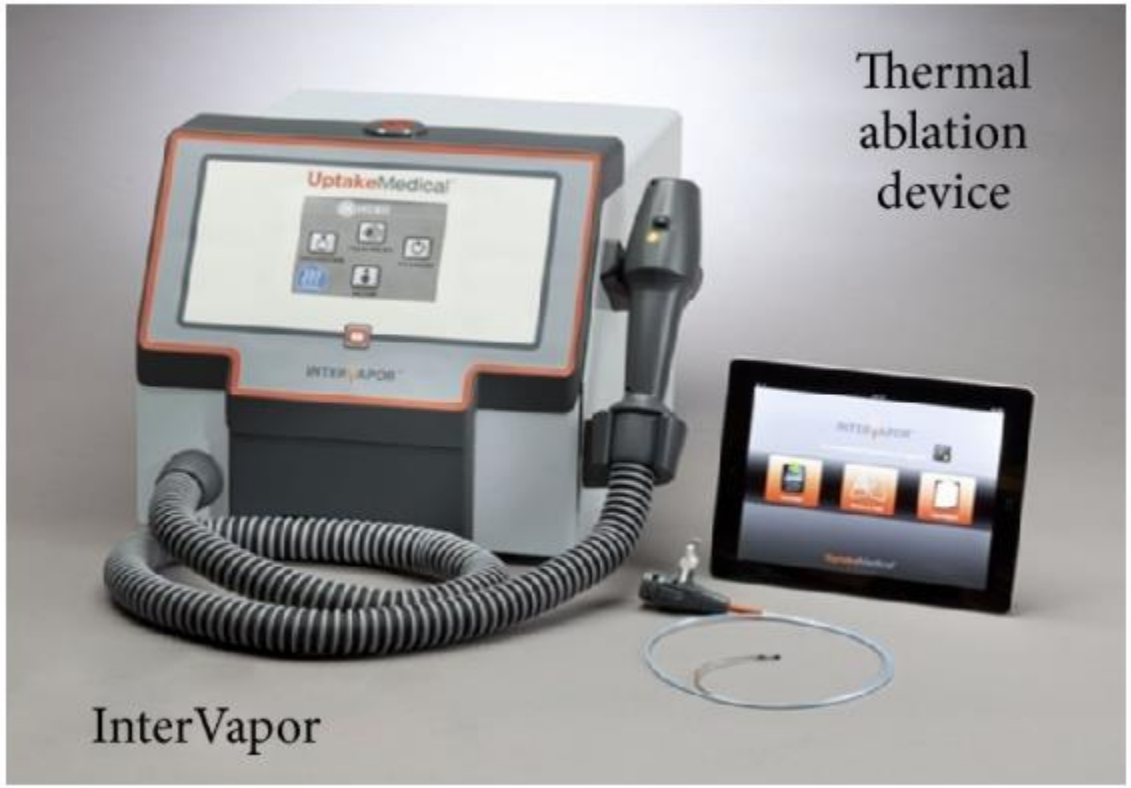
The AeriSeal System hydrogel components are shown.
The polymer consists of a dilute solution of aminated polyvinyl alcohol. The hydrogel is formed by mixing this polymer with a dilute solution of 1,5-pentanedial. When combined, the two components polymerize over 2–3 min. The polymer components are mixed with air to generate a liquid foam that is delivered to the lung using the administration catheter positioned in the distal airway through the instrument channel of the bronchoscope



BLVR: Thermal vapor ablation



Vapor catheter, with inflated balloon that isolates the targeted lung segment



BLVR

Pretreatment Assessment :

- high resolution CT scan to morphologically classify emphysema.
- A pulmonary perfusion scan can be used to record distribution of ventilation and perfusion.
- pulmonary function test must be performed to determine all lung function parameters.
- St. George's quality of life survey and exercise capacity testing (using bicycle method) must be performed to monitor the treatment outcome.
- Degree of collateral ventilation can be determined using Chartis System.

BLVR

Patient Selection :

- (a)Heterogeneous and ULP emphysema bear better prognosis especially if with low exercise capacity.
- (b)Best responders are those with higher degree of air-trapping, residual volume (RV) >225% of predicted, TLC >150% of predicted, FEV1 20–45%, and diffusion capacity for carbon monoxide (DLCO) 20–59%.
- (c)FEV1 <20% and DLCO <20% of predicted are a strict contraindication for BLVR.

BLVR

Procedure Selection :

- (a)In presence of complete fissural integrity (complete lobar exclusion) and no collateral ventilation, endobronchial valves may be preferred owing to their reversible nature, so that they can be removed if the procedure does not work or the condition of patient worsens.
- (b)In presence of collateral ventilation in heterogeneous emphysema or when emphysema is homogeneous, lung sealants or coil implants may be better suited as the work at parenchyma level.

Bronchoscopic Lung Volume Reduction, 7 Tips

- Treatments with endobronchial valves are effective in heterogeneous emphysema if there is “complete lobar exclusion”, meaning there is no collateral communication with other pulmonary lobes or segments.
- Endobronchial valves procedure is a reversible as they can be easily extracted if the patient's condition either worsens or does not improve (which is not possible with foam sealant, coils or vapor).
- As they do not depend on pulmonary ventilation, neither foam sealant, nor coils nor vapor ablation requires complete lobar exclusion to be effective.

Bronchoscopic Lung Volume Reduction, 7 Tips

- Foam sealant and vapor in particular can mask over lung cancer and should not be used in lobes with nodules, scarring or bronchial thickening.
- Coils cause mechanical retraction of the pulmonary parenchyma, and if there is a peripheral air leak it may be very difficult to resolve.
- The patients who demonstrate the best response are those who have a higher degree of air trapping, with a residual volume higher than 225%.
- When the emphysema is very homogeneous on CT, valves cannot be used

Arch Bronconeumol. 2012;48:221-2

BLVR
contraindications

- Not fulfil the selection criteria
- Active lung infection
- Active smoking
- History of allergic reactions to the device materials (silicone, nitinol, polyurethane, nickel)
- Incomplete lobar fissures (valves)
- Any contraindication for bronchoscopy

BLVR

Limitations and disadvantages :

- Cost and availability.
- Technical difficulties & Design defects.
- Better results in unilateral than bilateral applications and entire lobe than segments.
- No improvement & obstruction

BLVR

Complications:

- Pneumothorax (most common).
- Bronchospasm.
- Bronchial hypersecretion.
- pneumonia
- Granulation tissues.

Home message

- LVRS is under utilized procedure
- Regardless of the surgical approach used for LVRS , the outcome is promising and mainly dependent on :
  - ✓ Proper patient selection
  - ✓ Proper pre-operative ,operative and postoperative care
  - ✓ Multi-displinary teamwork co-operation including the patient
- BLVR is rapidly growing technique but still many prosthetic materials used not FDA approved and still need more studies , endobronchial valves are the most widely used .
- There is no doubt the BLVR has added a new dimension to the treatment of emphysema
- However, long-term outcomes for LVRS, unilateral versus bilateral surgery, cost-effectiveness, and LVRS as a bridge to-lung transplant are all areas of LVRS research that are still being explored.

sources

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- Mayo Clin Proc. n February 2021;96(2):464-472 n https://doi.org/10.1016/j.mayocp.2020.03.027 www.mayoclinicproceedings.org n ª 2020 Mayo Foundation for Medical Education and Researc

Thank you