LVRS And Bullectomy

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Outline

- History of Lung Surgery
- Lung-Volume-Reduction Surgery
  - Overview of LVRS
    - History
    - Clinical Overview
    - Mechanism
- National Emphysema Treatment Trial
    - Findings from NETT
- Bronchoscopic Lung-Volume-Reduction Surgery
- Bullectomy

History

Transverse sternotomy / Costochondrectomy

Stiff chest wall was thought to lead to emphysema so operations designed to increase movement of the thoracic cage

↑VC(500–700 m)L and relief of dyspnea inconsistent results.

Thoracoplasty :-Shrink the chest

Pleurodesis Nourish the lung

Stabilize the airways –tracheal fixation & stents

History

Reduce bronchospasm/mucus secretion

- Sympathectomy
- Vagotomy
- Hilar denervation

Shrink the lung

- Phernectomy
- Radiation

Restore the curvature of diaphragm

- Pneumoperitonium
- Abdominal belts

Pneumoperitonium

22 patients
Emphysema, Chronic cough, Dulled mentality
1700-3000 cc air into peritoneal cavity
Refill, heliox q 2wks
13/22 subjective improvement
VC improved ~ 500 cc{ in 11/22}
↓RV , TLC

Carter et al NEJM 1950

LVRS- History

Otto Brantigan

56patients, 1957-61,age16-73(58)

Staged thoracotomy+hilar dennervation

Subjective improvement in 75% of survivors

No physiologic measurements were taken

Mortality rate 16% immed. postoperative &10% late

Selection criteria poorly described ? 16 yr emphysema

Otto Brantigan *Am. Surgeon 1957*

Brantigan hypothesized

- Relieves pressure on normal lung
- Restore shape of diaphragm
- Restores more negative pl. pressure

  distends bronchi

  ↑ venous return

  Difficult to predict who will benefit from surgery

Brantigan *Am. Surgeon 1957*

Modern Era of LVRS-1995

B/L, LVRS, MS, 20 patients

FEV_1 0.77 to 1.4L(82%, ↑)

FVC 2.2 to 2.8L(27%, ↑)

14/22 on O_2 to 2/15 at 3 mo

Mean TLC ↓(22%), RV ↓(39%)

Improvement in dysponea , QOL score

No mortality

Mean LOS 15d (6-49d)

Air leak >7d in 11/20

cooper et al J. Thoracic cardiovasc surg. 1995

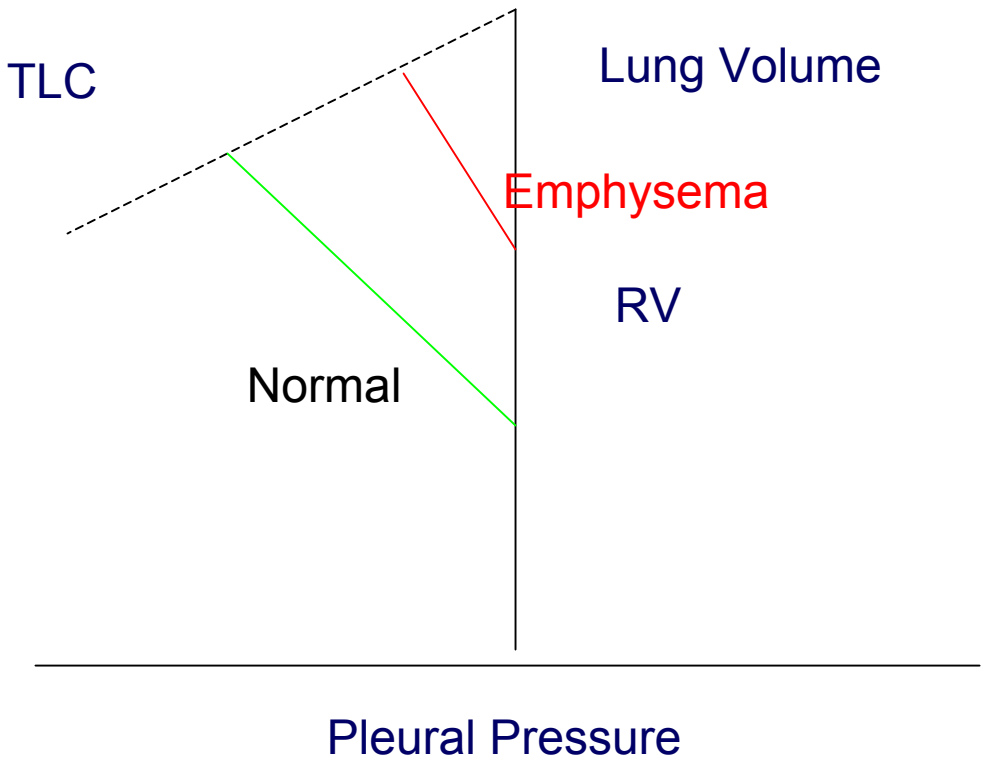
Physiological outcome

Physiologic measurement	Reported improv.after LVRS
• Forced vital capacity	— 15–49% increase
• FEV1	— 20–80% increase
• Total lung capacity	— 15–20% decrease
• Residual volume	— 10–30% decrease
• PaO2	— 10–24 mm Hg increase
• 6 minute walk distance	— 20–90% increase
• Maximum oxygen consumption	— 5–30% increase
• Dyspnea index	— 50–80% improvement

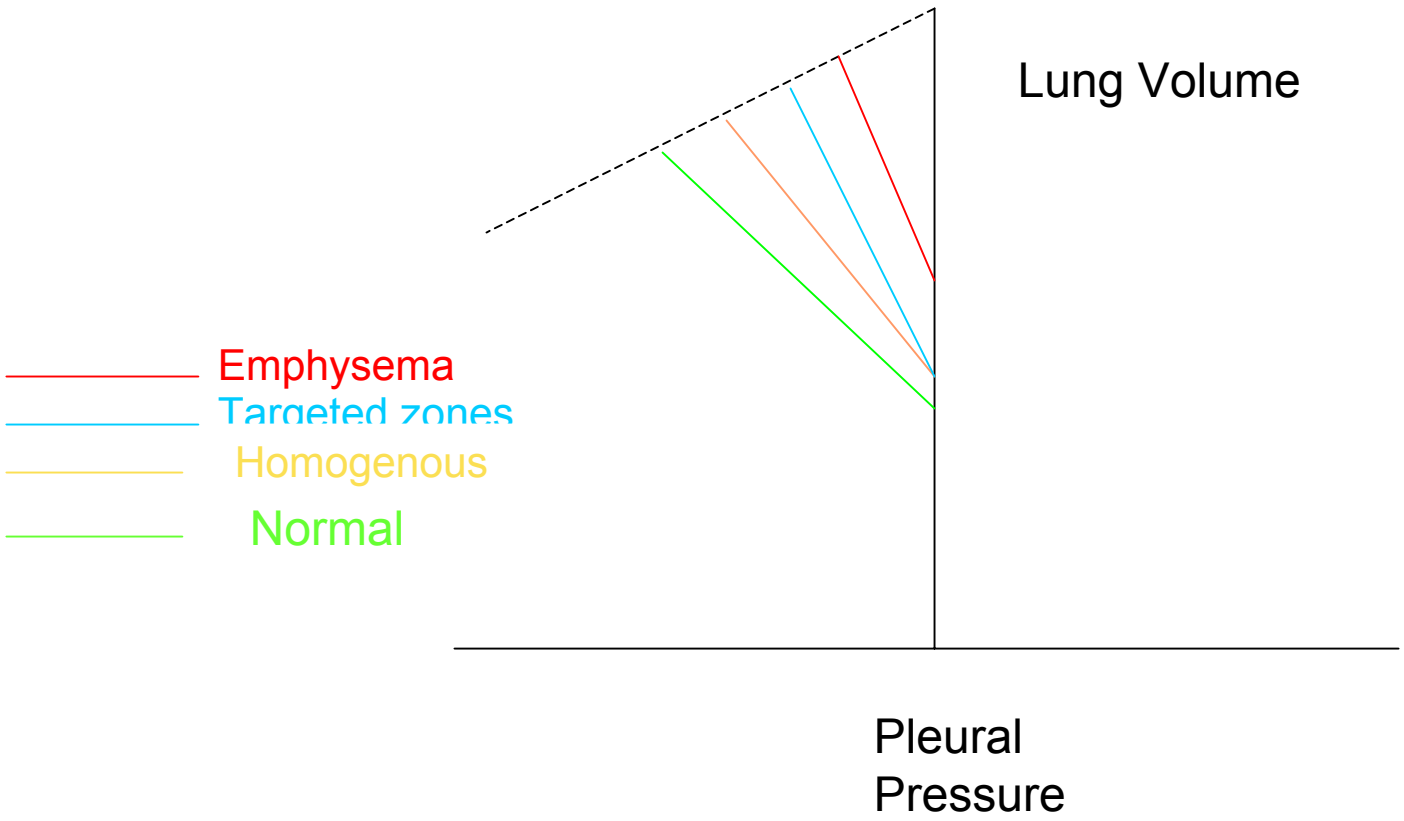
Suggested mechanism of benefit

- Improved respiratory function
- Lung recoil ↑
- Air way conductance ↑
- Resizing the lung to fit the chest
- Relieves "pulmonary tamponade."
  - improved cardiac function
  - increased exercise capacity

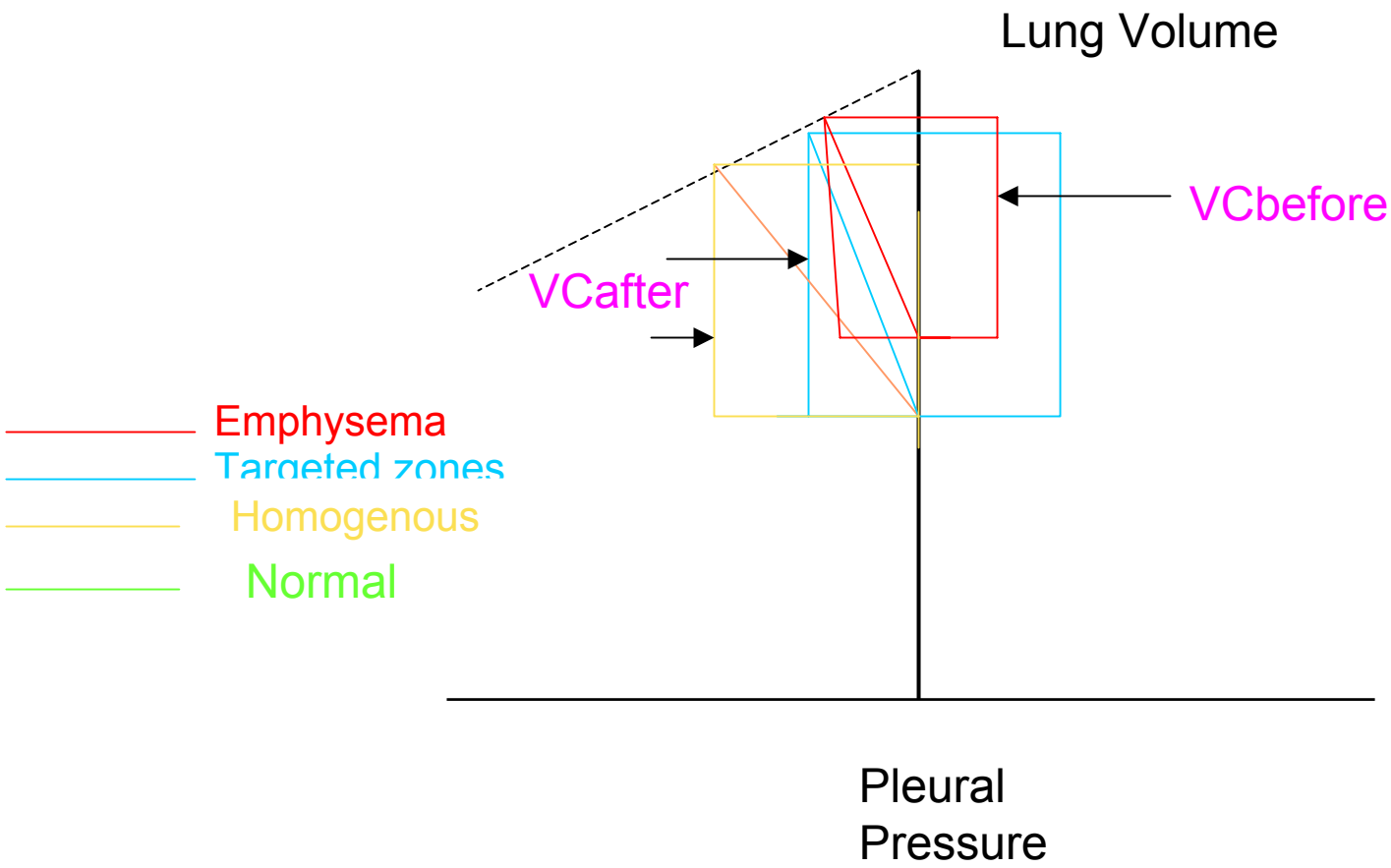
Mechanism of increase VC



Mechanism of increase VC



Mechanism of increase VC



DETERMINENTS OF INCREASE VC

Fraction of lung remove

Targeted zones

RV/TLC

Lung compliance

Inspiratory muscle function?

Indications for LVRS

- HRCT scan evidence of bilateral emphysema
- Severe nonreversible airflow obstruction FEV_1 15 to 35% of predicted
- Evidence of hyperinflation and air trapping :-
  - TLC> 100% of predicted & RV > 150% of predicted
  - HRCT:- emphysematous lung changes and hyperinflation
- Marked restriction in daily activities
- Failure of maximal medical treatment

Contraindications

- Abnormal body weight (<70% or >130% of IBW)
- Coexisting major medical problems
- Significant cardiovascular disease
- Inability to participate in rehabilitation
- Unwillingness to accept the risk of morbidity and mortality of surgery
- Tobacco use within the last 6 months
- Recent or current diagnosis of malignancy

Contraindications

- Age >75 years
- Severe and refractory hypoxemia (Pao2/Fio2 ratio<150)
- Hypercapnic (PCO_2 >55mmHg)
- Ventilator-dependence
- Severe pulmonary hypertension (MPAP > 25 mm Hg)
- Psychosocial dysfunction

LVRS-PATIENT WORKUP

Severity and distribution of emphysema

Cxray, HRCT chest,Quantitative ventilation/perfusion scan

Pulmonary function tests

Spirometry, Lung volume measurements, DLCO, ABG

Exercise test

6-minute walk test, Cardiopulmonary exercise test

Cardiac assessment.

EKG, echocardiogram, Dobutamine-radionuclide scan

Right and left heart catheterization (selected patients)

Surgical approaches

Median sternotomy with bilateral stapling resection

Video-assisted thoracoscopic surgery :-

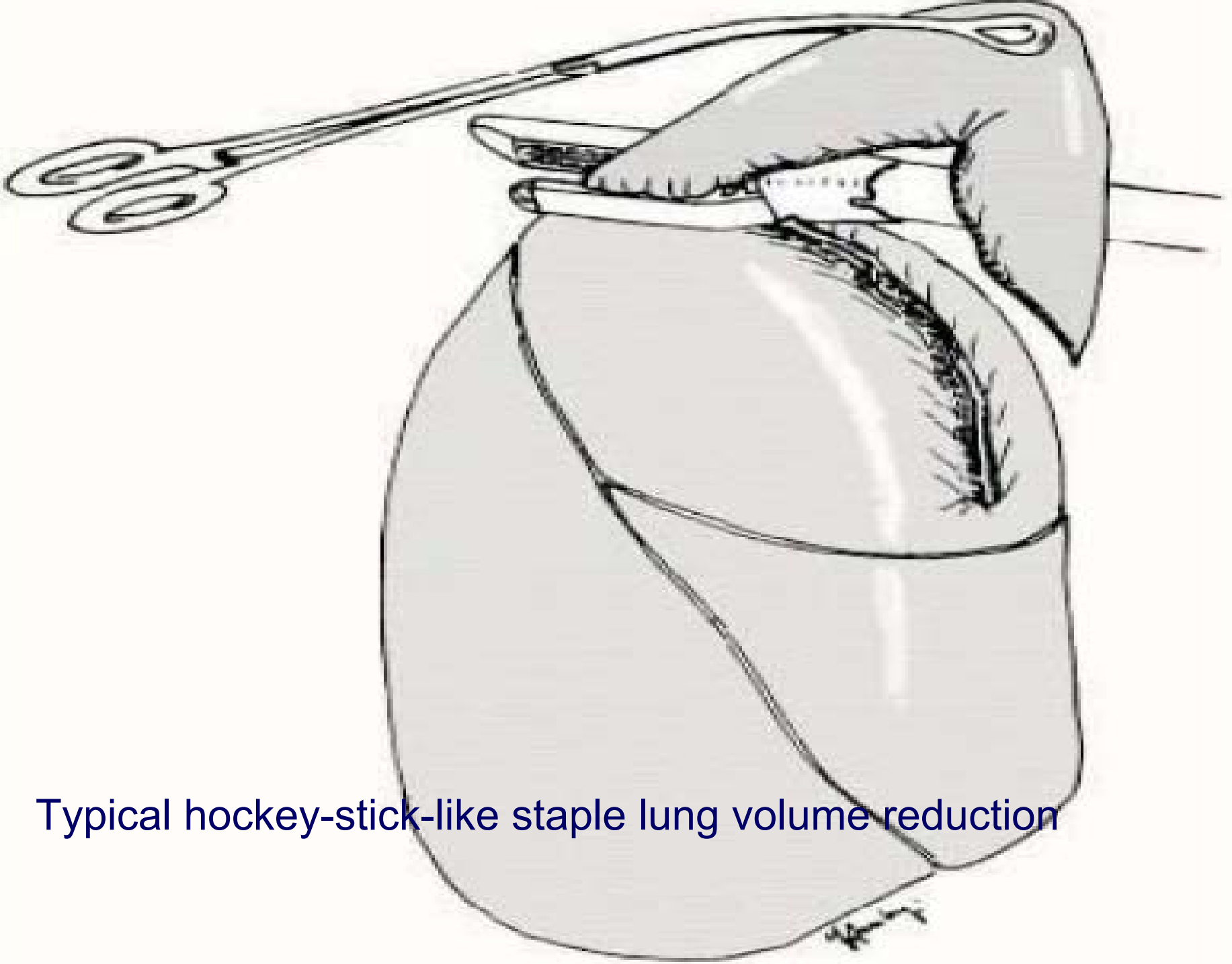
U/L or B/L stapling lung resection

U/L with laser ablation of emphysematous tissue

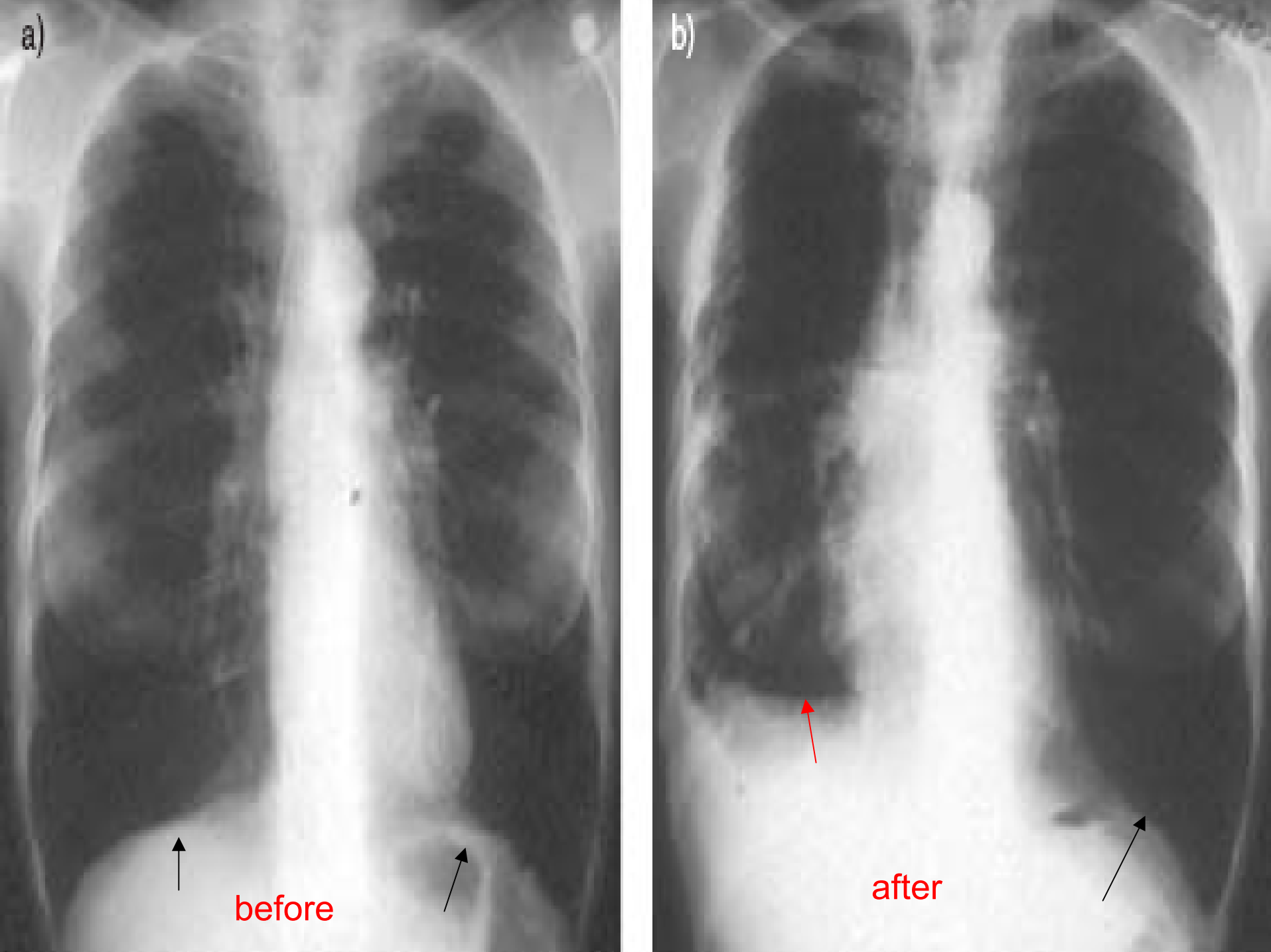
Goal targeted resection 30to 40% emphysematous lung

Both leads to similar improvements in lung function and exercise capacity, though VATS may be associated with lower postoperative morbidity and mortality

Laser surgery is not recommended because of less satisfactory results than with stapled resection.



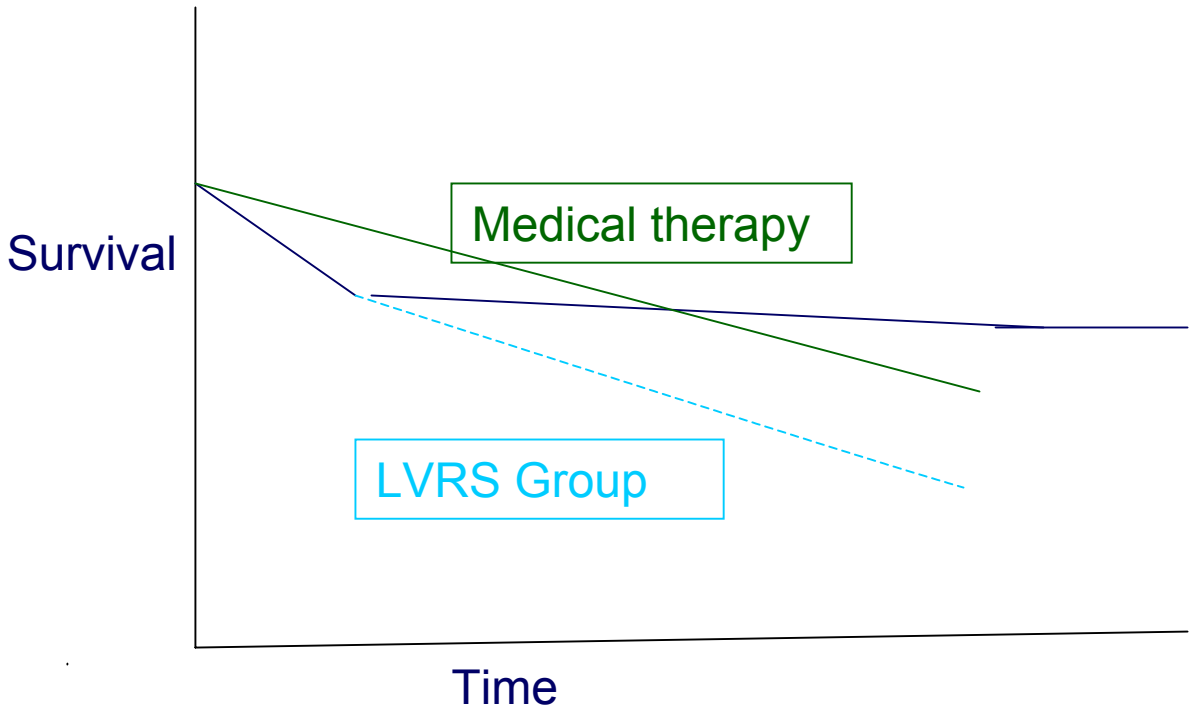
Typical hockey-stick-like staple lung volume reduction


a)
b)
before
after

Postoperative morbidity and mortality

Complications	%
➢ Air leak	— 68.0
➢ Pneumonia	— 14.0
➢ Gastrointestinal complications	— 8.3
➢ Tracheostomy	— 6.2
➢ Arrhythmia	— 8.9
➢ Heimlich valve at discharge	— 6.0
➢ Reoperation for bleeding	— 3.1
Operative mortality	
➢ Respiratory failure	— 2.0
➢ Cardiac related	— 1.5
➢ Sepsis	— 0.9
➢ Multi-organ failure	— 1.2
➢ Pneumonia	— 0.9

Has LVRS got Survival benifit

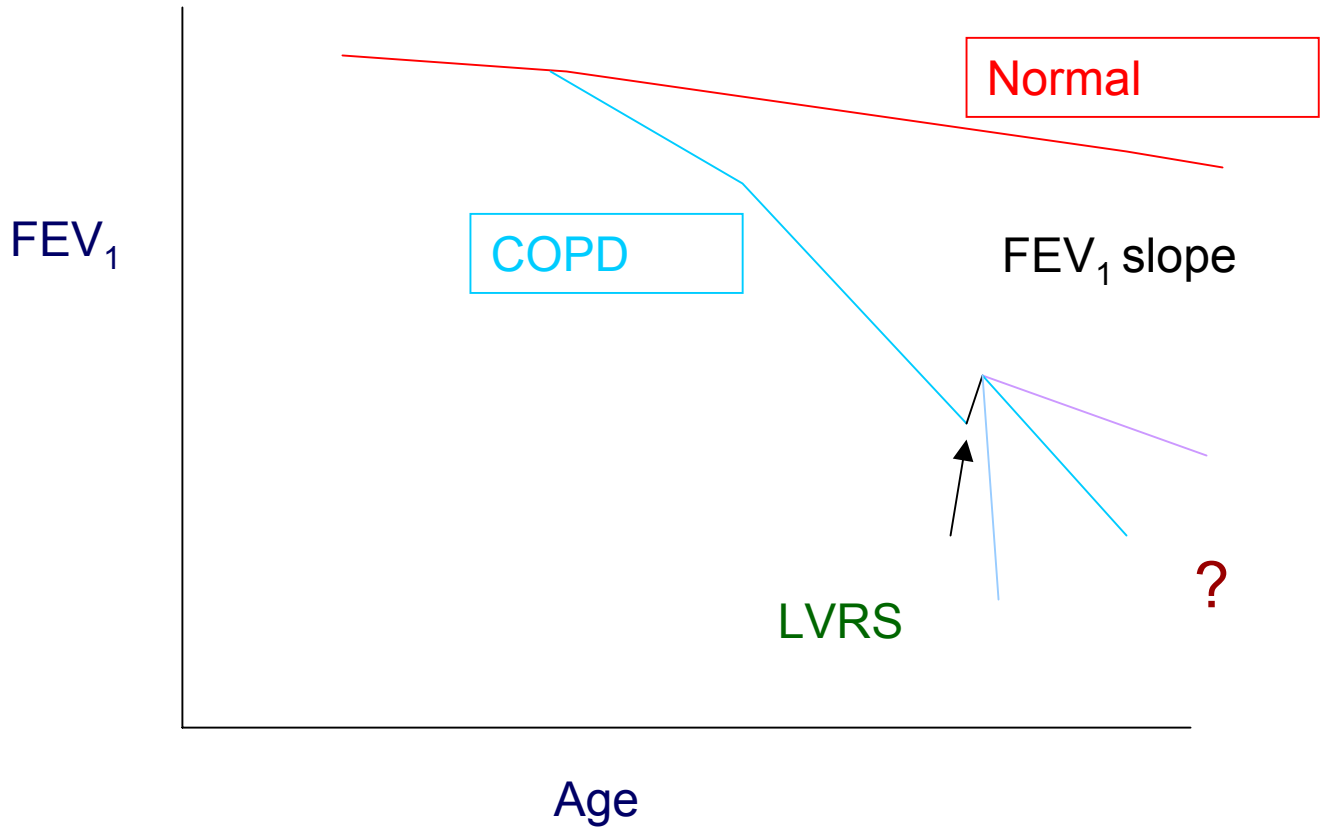


LVRS gr.↕ Early mortality

Does it change natural H/O ds?

Durability of FEV_1 slope

Rate of decline in lung function after LVRS



Why National Emphysema Treatment Trial was planned

What led to NETT

- Expensive procedure ~ 30000$
- Prevalent disease
- The surgical mortality 4 to15 %
- 1-year mortality 17%
- Review of Medicareclaims:- 6-mo.mortality16.9%.

Uncertainty about the risk of LVRS , the magnitude and duration of benefit, and optimal selection criteria led the NHLBI & HCFA to sponsor a MRCT-NETT (designed over a 1-year)

N Engl J Med 2001

NETT RESEARCH GROUP

Carried between January 1998 and July 2002

17hospitals, data coordinating center JHSPH

Patients randomized to medical or surgery treatment

Data reviewed every 3 months- to find group most likely to benefit or likely to be harmed (30d mortality > 8 %)

Primary outcome variables mortality and exercise capacity

Secondary end points included quality of life, pulmonary function, 6-min walk distance

N Engl J Med 2001

NETT RESEARCH GROUP

3777 patients evaluated; 1218 underwent randomization

608 to surgery and 610 to medical therapy

580 (95.4 percent) underwent surgery

70 % MS & 30 % VATS

Prior to completion of the NETT, board identified a subset of patients who had very high mortality **High-risk group**:-

FEV1<20%, DLCO<20%, Homogenous emphysema

30 day mortality 16% (high-risk group) and

constituted ~ 13% of NETT patients

N Engl J Med 2001

Comparing LVRS with Medical Therapy
Effects on mortality

Overall mortality 0.11 death per person-year in both gr.

After excluding at high risk for death from surgery, overall mortality in the surgery group was 0.09 death per person-year,C/W 0.10 death per person-year in the medical-therapy group(RR0.89; P=0.31)

No difference in mortality between the two groups

90-day mortality higher in the surgery (7.9% & 1.3 %)

similar among MS &VATS

No survival advantage over medical therapy

N Engl J Med 2003

Comparing LVRS with Medical Therapy
Magnitude and durability of benefits

Exercise capacity improved by **≥10 W** in 15% in LVRS group, C/W 3 % in the medical-therapy group (P<0.001). at 24 months

LVRS Improves exercise capacity, LFT, QOL& dysponea

At 2yrs, LFT in survivors of surgery returned to base-line

2 factors predicted different responses to LVRS:

1. Upper-lobe vs non-upper lobe distribution of emphysema
2. Low vs high exercise capacity

N Engl J Med 2003

Subgroups based on pattern of emphysema on CT & exercise capacity

	Low exercise capacity	High exercise capacity
Upper lobe emphysema	↓ Mortality ↑ Exercise ↑ SGRQ	↔ Mortality ↑ Exercise ↑ SGRQ
Non- Upper lobe emphysema	↔ Mortality ↔ Exercise ↑ SGRQ	↑ Mortality ↓ Exercise ↔ SGRQ

N Engl J Med 2003

Comparing LVRS with Medical Therapy
Cost-effectiveness ratio

Overall C/W medical therapy (after excluding high risk gr.)

-$190,000 per quality-adjusted life-year gained at 3 years

$53,000 at 10 years

upper-lobe emphysema and low exercise capacity

-$98,000 per quality-adjusted life-year gained at 3 years and $21,000 at 10 years

Given its cost and benefits over 3yr of Fu, LVRS is costly relative to medical therapy

Bronchoscopic LVRS

Designed to reduce hyperinflation and obtain atelectasis of the most destroyed, functionless parts of the lungs

Safer alternatives to LVRS, in advanced disease

Occlusive stents /synthetic sealants with unidirectional- valves (silicon and nitilol)

Block segmental or subsegmental bronchi→ distal atelectasis & volume reduction

Clinical trial conducted in 8 centres worldwide

~70 patients have been treated

EDWARD P. Am J Respir Crit Care Med 2001

Matt Brenner,CHEST 2004

Bronchoscopic LVRS Procedure

Performed in OT under general anesthesia

Patient intubated and FB is advanced through ET

Target segmental bronchus is visualised and a guidewire is inserted into the operating channel of bronchoscope to reach the desired segment. Leaving the guidewire in place, the bronchoscope is withdrawn and the delivery catheter is passed on the guidewire. After the removal of the latter the valve is delivered.

EDWARD P. Am J Respir Crit Care Med 2001

Bronchoscopic LVRS

Between three and five valves

Postoperative hospital stay ~ 2 days

All show ↑FEV_1 and ↓ RV

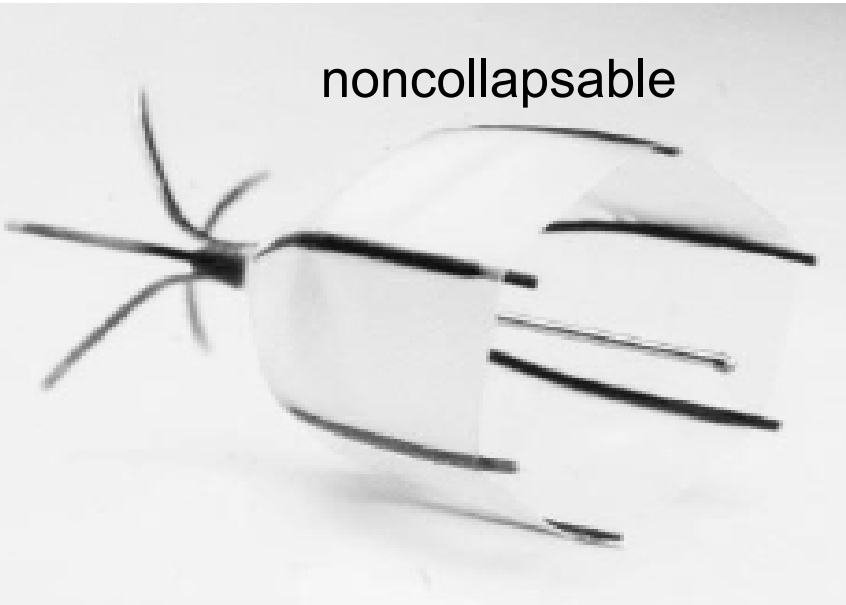
Improvement in dyspnoea score, supplemental 0_2 requirement and quality of life

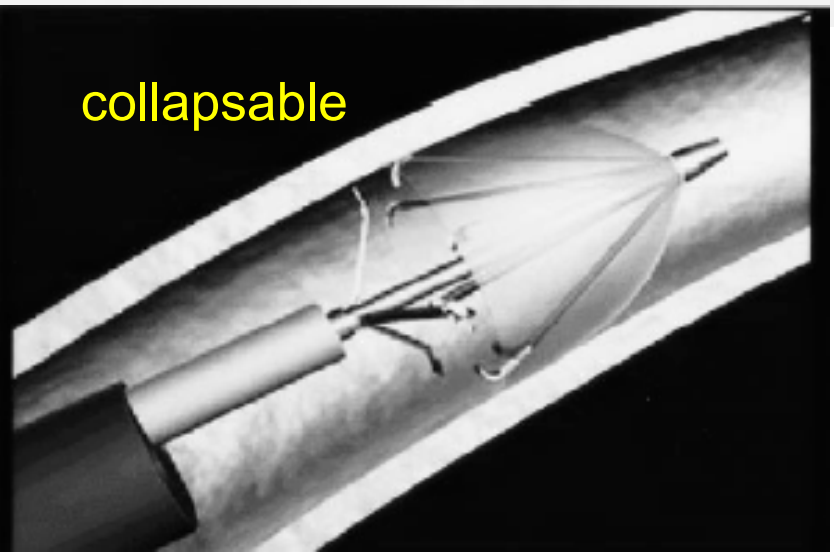
Complications

Pneumothoraces

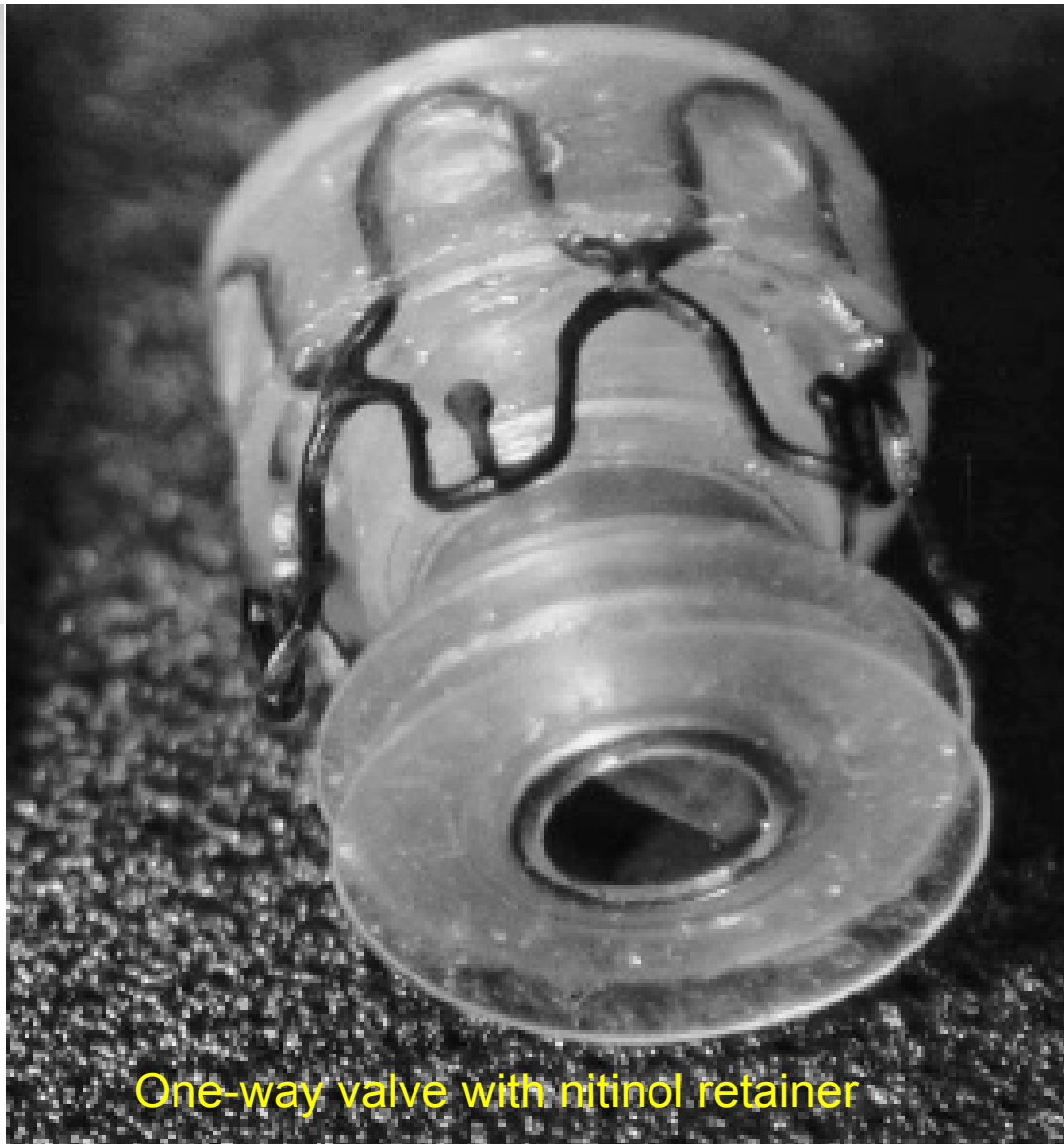
Pneumonia in a non-treated lobe

Endobronchial blocker





Endobronchial valve



Bullae

Bulla :- markedly dilated air spaces within the lung parenchyma >1cm

Bullae in emphysema

Range from 1 to 4 cm in diameter

Upper lung zones

Etiology?

1. ball-valve mechanism
2. relatively lower blood flow to upper lung & presence pleural pressure gradient from apex to base, ↑ stress in the upper lung zones

Bullae

2:1 right-sided preponderance due to larger size of right lung
Basilar bullae in elderly nonsmokers R/O alpha1 -protease inhibitor deficiency

Giant bullae > 1/3 hemithorax
Impairment of pulmonary function in giant bulla:-
Compression of underlying lung tissue
Lack of transmission of the respiration mechanics
Ventilation-perfusion mismatch

Indications for Bullectomy

- **Large bulla** occupying 30–50% of hemithorax, ↓ FEV1 and radiological signs of compression of normal lung
- **Complications arising in bullae:-**

  Hemoptysis

  Complicated or repeated pneumothorax

  Repeated infection.

  Malignant degeneration of the bulla (nodular opacity, thickening of the bulla wall, and alteration in the bulla's appearance)

How Bullectomy Helps

Allows expansion of underlying compressed lung

Improve elastic lung recoil

Decrease pulmonary vascular resistance

Who will benefit from bullectomy difficult to predict

INVESTIGATION

Objective

Size of bulla, extent of disease, underlying lung

CT is the most accurate in determining - size of bulla, compressed & normal underlying lung

Bullectomy -PATIENT WORKUP

Radioisotope ventilation lung scans→ ventilatory defects are localized or diffuse

Single-breath DLCO → evaluate concomitant emphysema

Comparison of **TLC** measurements obtained by **single-breath gas dilution** and by **body plethysmography** → measures "trapped gas"

Serial Cxray and spirometry helps in judging whether compression of normal lung is responsible for current functional state or it represents progression of emphysema

Outcome of Bullectomy

In carefully selected patients outcomes appears to be good and durable in terms of symptom relief and improvement of pulmonary functions

FitzGerald et

Followed 84 pat. who underwent bullectomy for 23yrs

- 2.1% operative deaths
- Significant ↑ FEV1 in those with bullae occuping >50% hemithorax without emphysema elsewhere
- Improvement in pulmonary function lasted for ~ 20 yrs

Summary

LVRS palliative Rx advanced symptomatic emphysema

Improve lung function, exercise capacity, and quality of life and dysponea

High-risk group:-

FEV1<20%, DLCO<20%, Homogenous emphysema

Predominantly upper-lobe emphysema and low exercise capacity had lower mortality and better functional status while non-upper-lobe emphysema and high exercise capacity had higher mortality

At 2yrs, LFT in survivors had returned to baseline

LVRS is costly relative to medical therapy