Preoperative Evaluation of Patients Undergoing Lung Resection Surgery

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Introduction

- Advances in surgical and anesthetic techniques have resulted in a marked reduction in postoperative complication
- Preoperative PFT evaluation is an integral part
- About 30,000 lung resections are performed annually in the USA

Commonly performed surgeries for lung cancer

- Pneumonectomy
- Lobectomy
- Wedge Resection
- Segmentectomy

Indications for Pulmonary Resection

- Neoplastic Disease
  - Primary
  - Metastatic
- Bullous Lung Disease: LVRS
- Diagnosis & Management of inflammatory conditions
  - Granulomas
  - Pulmonary infiltrates
  - Resection of segments destroyed by bronchiectasis

(Deb apriya D et al. CHEST 2003;123:2096–2103)

Complications after thoracic surgery

Most Common

- Pneumonia
- Atelectasis
- Arrhythmias (AF)
- CCF

Less common

- MI
- Prolonged air leak
- Empyema
- Bronchopleural fistula

Mortality Rates

- Pneumonectomy: 6.8%
- Bi-lobectomy: 4.4 %
- Lobectomy: 3.9%
- Lesser Resection: 1.4%

(*Damhuis et al., Eur Respir J 1996; 9:7–10*)

Postoperative complication of pulmonary resection

- Pneumonectomy-39%
- Lobectomy-19%
- Wedge resection-6%

Changes in Lung Volume

Pneumonectomy:	Lobectomy:
* FEV1 reduced by 34- 36%	* FEV1 reduced by 9 - 17%
* FVC reduced by 36 - 40%	* FVC reduced by 7 - 11%
* VO2 max reduced by 20 - 28%	* VO2 max reduced by 0 -13%

(*Mazzone PJ et al., Am J Med 2005; 118:578-583)*

Risk assessment for pulmonary surgery

High risk

- Age >70
- Higher extent of resection (Pneumonectomy>lobectomy>resection)
- Poor exercise performance
- Low PPO FEV1
- Low PPO DLco
- High Pco2 (controversial)
- Prolong operative time

Risk assessment for pulmonary surgery

Low risk

- FEV1 >2 L for pneumonectomy,>1 L for lobectomy,>0.6 L for segmentectomy
- PPO FEV1 >30-40% predicted
- Stair climbing >5 floor for pneumonectomy, 3 floor for lobectomy
- PPO DLco >40% predicted
- Vo2max uptake >15-20 ml/kg/min

Indications for pre-operative assessment

- To make a decision whether patient can tolerate surgery “pulmonary clearance”
- To predict the occurrence of post operative respiratory complications
- To assess the postoperative respiratory disability

(*Pulmonary function tests in health and disease by Prof S K Jindal)*

Minimal respiratory evaluation

- Good history taking
- Physical examination
- Chest roentgenography
- PFT

Important components of history in preoperative evaluation

- Presenting symptoms
- Prior diagnosis of pulmonary or cardiac disease
- Co-morbid conditions: DM,LD,RD
- Prior experiences with GA/Surgery
- Cigarette smoking: never/current/ex
- Medication/allergies
- Alcohol use, history of withdrawal syndrome

Preoperative Evaluation

Who should be evaluated?

The general answer

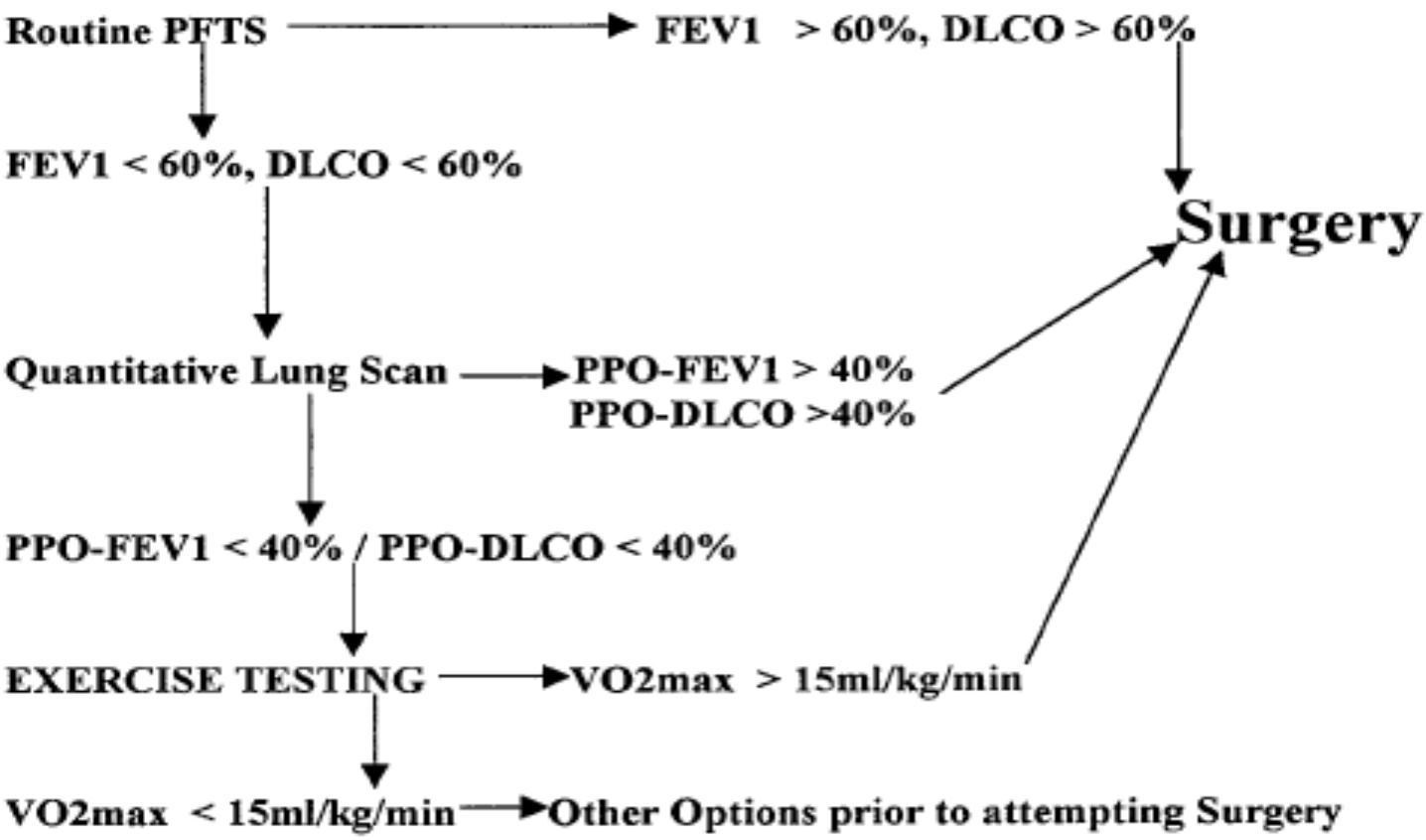
All patients undergoing lung resection surgery, irrespective of age or extent of the lesion

Pulmonary-Specific Evaluation

- **There is no single measure that is a "*gold standard*" in accurately predicting complications**
- **However, certain criteria, when applied have been shown to be predictive of outcome**

(Debapriya D et al. CHEST 2003;123:2096–2103)

Stepwise approach of evaluation



Smoking

- Smoking is a risk factors for the development of post operative complication
- Relative risk of complication after surgery for smoker 1.4 to 4.3 fold.

  (*SmetanaGW et al., N eng J Med 1999;340:937-944)*
- Smoking cessation decreased postoperative pulmonary complication
- Recommendations- Surgery should be delayed for 8 weeks after smoking cessation

Pulmonary-Specific Evaluation

Pulmonary Function Tests Include:

- Spirometry
- Lung Volumes
- Diffusion Capacity
- Arterial Blood Gas Analysis
- Radionuclear Lung Scanning
- Cardiopulmonary Exercise Testing

Stages of Pulmonary-Specific Evaluation

Stage I Assessment (Preop lung function)
* Spirometry
* Arterial Blood Gas Analysis
* DLCO

Stage II Assessment (Postop lung function)
* Quantitative Ventilation-Perfusion Scan
* Quantitative CT Scan

Stage III Assessment
* Exercise Testing: Oxygen Uptake (VO2 Max)

(*Debapriya D et al. CHEST 2003;123:2096–2103*)

Stage I Spirometry:

- Simple, inexpensive, standardized & readily available
  - FVC → reflect lung volume
  - FEV1, FEF25–75% → reflect airflow
  - MVV→ Muscle Strength
- Predicted values of pulmonary function depend on age, height, gender and race

  (*Debapriya D et al. CHEST 2003;123:2096–2103*)
- Spirometry can provide cut-off values of acceptable risk in patients for thoracic surgery

  (*Alfredo et al. Acta Biomed 2006;77:69-70)*

Stage- I (Spirometry) FEV1

- Preop. FEV1 <60% of predicted, Strongest predictor of postope. complications
- ACCP & BTS Guidelines:
  - FEV1 > 2 L tolerate pneumonectomy
  - FEV1 > 1-1.5 L tolerate lobectomy

  (*Mazzone PJ et al. Am J Med 2005; 118:578-583)*
- Postope. pulmonary complication in patients with FEV1<2L was 40% VS 19% for those with FEV1 >2L

  (*Stephan MK et al. Chest 2000;118:1263-1270)*

Stage- I (Spirometry) FEV1

BTS Guidelines compiled on data from >2000 patients in 3 large series

Mortality Rate < 5%

- FEV1 > 1.5 L for Lobectomy
- FEV1 > 2 L or > 80% predicted for Pneumonectomy

(*Beckles MA et al., CHEST 2003; 123:105S-114S*)

Stage- I DLCO

- Reflects alveolar membrane integrity & pulmonary capillary blood flow in the patient's lungs
- Was the most important predictor of mortality & was the sole predictor of postoperative pulmonary complications
- Equally significant predictor of postoperative complications as FEV1

(*Debapriya D et al., CHEST 2003;123:2096–2103)*

Stage- I DLCO

- Routine measurement of DLCO in all candidates for lung resection, irrespective of their FEV1 value, in order to improve surgical risk stratification

  (Brunelli A et al., Eur J Cardiothoracic Surg 2006;29;567-70)

- DLCO < 60% predicted associated with ↑ mortality.
- DLCO & FEV1 should be viewed as complementary physiologic tests

  (Beckles MA et al., CHEST 2003; 123:105S-114S)

Stage I
Arterial Blood Gas Analysis (ABG)

- Not extensively studied as predictor of postoperative complication
- PCO_2 >50 mm Hg - traditional contraindication to lung resection
- But In recent studies

  Patients with a PCO_2 of 45 mm Hg did well postoperatively

  Was not predictive of postoperative complications

(Debapriya D et al. CHEST 2003;123:2096–2103)

Stage I
Arterial Blood Gas Analysis (ABG)

- Preoperative $PCO_2 < 45$ mmHg vs. $PCO_2 > 45$ mmHg, postope.complications17% vs. 13%
- Hypoxemia ($SaO_2 < 90\%$) was associated with ↑ risk of postoperative complications

(Kearney DJ et al., Chest 1994;105:753-759)

Stage-I (Spirometry) Recommendation

- Pneumonectomy
  MVV > 55% of predicted,FEV1 >2 L,
  FEF25–75% >1.6 L/s.
- Lobectomy
  MVV >40% of predicted,FEV1 >1 L,
  FEF25–75% >0.6 L/s.
- Segmentectomy or Wedge Resection
  MVV >40% of predicted, FEV1 >0.6 L,
  FEF25– 75% 0.6 L/s

(Miller JI et al., Surg Gynecol Obstet 1981; 153:893–895)

Stage-I (Spirometry) Criteria of increased postope. complications and mortality

Pneumonectomy:

FEV1 <2L or 60% of predicted , MVV < 55% of predicted

DLCO <50% of predicted , FEF25–75% < 1.6L/s.

Lobectomy:

FEV1 <1 L , MVV <40% of predicted

FEF25–75% <0.6 L/s, DLCO <50% of predicted.

Wedge resection/Segmentectomy:

FEV1 <0.6 L , DLCO <50% of predicted.

(Stephan F et al., Chest 2000; 118:1263–1270)

Stage-II Assessment

Consist of measurement of individual lung function (Regional lung function)

- Quantitative V/Q scan
- Bronchospirometry
- Lateral position testing
- Quantitative CT scanning

Stage-II
Indication of regional lung function

- Significant airflow obstruction
  * FEV1 <65% predicted
  * FEV1/FVC <0.70
- Significant pleural disease
- Known and suspected endobronchial obstruction
- Central lung mass
- History of prior lung resection

Stage-II Quantitative Ventilation-Perfusion Scan:

- Measures predicted Postoperative lung function
- Readily available with negligible risk
- Highly accurate in the prediction of postoperative pulmonary function following resection
- Inhaled 133Xe or IV 99Tc

(*Jeng-Shing Wang et al., Resp Med 2004; 98:598-605)*

Stage II
Inhaled 133Xe or IV 99Tc

- % of radioactivity contributed by each lung correlates with the contribution of the function of that lung
- Normally: 19 Segments (10 R & 9 L)
  Right Lung (3/2/5): 55 % & Left Lung(3/2/4): 45%
- Calculation: 1
  PPO FEV1:-Preope.FEV1X % of radioactivity contributed by nonoperated lung

(Kristersson et al., Chest 1972;62:696-698)

Stage-II

- Calculation-2

Expected loss of function=Preope. FEV1X % of function of affected lung

No. of segments in lobe to be resected

X----------

total No. of segments in the whole lung

(*WemlyJA ., Thoracic cardi Surg 1980; 80:535-543)*

- Juhl formula for PPO FEV1

PPO FEV1= preopr.FEV1X(1-[SX5.25]/100)

S= No of BPS involved

(*JuhlB,Frost B Acta anaesthesiol Scand 1975;49:8-13)*

Stage-II

Using 133Xe Inhalation:

- PPO FEV1 of < 1 L is indicative of physiologic inoperability.
  (Kristersson S et al.Chest 1972; 62:696–698)

Using 99Tc Macroaggregate of Albumin Perfusion:

- PPO FEV1 of < 0.8 L is indicative of surgical inoperability.
  (Olsen GN et al. Chest 1974; 66:13–16)

- More widely accepted formula by Kristersson/Olsen formula for PPO FEV1

(Sietske A et al, .CHEST 2004; 125:1735–1741)

Stage-II
Predictors of Morbidity & Mortality after lung resection

- PPO FEV1 < 40% of predicted - 50% ↑Mortality
- PPO FEV1 > 40% of predicted - 50% ↓Mortality
- PPO DLCO < 40% of predicted - ↑ Mortality

(*Markos J et al., Am Rev Respir Dis 1989; 139:902–916)*

Stage-II Recommendation

- If PPO FEV1 >40% and PPO DLCO > 40% - allowed to surgery
- If PPO FEV1<40% and PPO DLCO<40% need further evaluation

(*Markos J et al., Am Rev Respir Dis 1989; 139:902–916)*

Stage-II

Other Tests:

- Bronchospirometry, Lateral position testing & Total Unilateral pulmonary artery occlusion
- Invasive tests & Require specialized equipment with a high level of technical expertise
- These test are no longer performed in the preoperative evaluation of patients awaiting lung resection

(Debapriya D et al., CHEST 2003;123:2096–2103)

Stage- III Assessment
Cardio-Pulmonary Exercise Testing

- Indicated when PPO FEV1<35 to 40% and DLCO <40% of predicted
- Stresses the entire cardiopulmonary & oxygen delivery system
- Provides a good estimate of cardiopulmonary reserve
- Pulmonary/cardiac function & peripheral oxygen utilization

Stage-III Assessment (CPET)

Measurement of exhaled gases

- Oxygen uptake (Vo2)
- Maximal Vo2 (Vo2max)

Formula for estimating Vo2

Predicted Vo2=5.8xwt.in kg+151+10.1(W of workload)

Stage-III (CPET)

- VO2max

  With increasing muscular work VO2 rises to a point where there is a plateau of the VO2 work rate slope.

- VO2 max is a measure of aerobic capacity of the peripheral tissue (Oxygen Consumption)

  (Mazzone PJ et al., Am J Med 2005; 118:578-583)

Stage-III Assessment (CPET)

3 major types of tests

- Fixed exercise challenge

  (Sustained level of work)
- Incremental exercise challenge

  (Work rate is sequentially increased to a desired end point)
- Submaximal vs. Maximal oxygen consumption(VO2 Max)

(Debapriya D et al., CHEST 2003;123:2096–2103)

Stage-III(CPET)
Fixed Challenge Exercise Testing

Fixed Challenge Exercise Testing

* Climbing a certain number of stairs
* Walking a fixed distance

- Patients who able to climb up to three floor (i.e. 75 steps) had ↓ number of postoperative complications

  (*Olsen GN et al., Chest 1991; 99:587–590*)

- Prospective study of 16 patients 6-min walk distance > 1000 feet & Stair climb of > 44 steps, Successful surgical outcome

  (*Holden DA et al., Chest 1992; 102:1774–1779*)

Stage-III(CPET)
Fixed Challenge Exercise Testing

Prospectively evaluated of 83 patients, complications occurred

- Who unable to climb one floor- 89%
- Who unable to climb two floor- 80%
- Inability to climb 5 floor- 32%
- Who could climb 7 floor- No complications

(Girish M et al. Chest 2001;120:1147-1151)

Stage-III (CPET)
Incremental Exercise Testing

Measurement VO2 max in patients for lung resection

- VO2 Max > 1 L/min → No mortality
- VO2 Max < 1 L/min → 100% mortality

(Eugene Jet al., Surg Forum 1982; 33:260–262)

Incidence of Postoperative complications

- VO2 Max < 15 mL/kg/min → 100% complication rate
- VO2 Max 15-20 mL/kg/min → 66% complication rate
- VO2 Max > 20 mL/kg/min → 10% complication rate

(Smith TP et al., Am Rev Respir Dis 1984; 129:730–734)

Conclusions

- Patients with thoracic surgery should undergo evaluation for surgical resectability
- Patients with FEV1and DLco >60% of predicted can be referred for surgery without undergoing other tests
- Patients with preoper.FEV1and DLco <60% of predicted need further evaluation
- Quantitative V/Q lung scan is done estimate PPO FEV1 and DLco

Conclusions

- If the PPO FEV1 and DLco are 40% of predicted, surgical risk is acceptable
- Patients with PPO FEV1 and DLco <40% should undergo exercise testing to evaluate pulmonary reserve and to assess the adequacy of oxygen transport
- Cycle ergometry with incremental workloads, which can measures Vo2, Vo2max

Conclusions

- Patients with Vo2max <10 ml/kg/min. should not undergo lung resection surgery
- Patients with PPO FEV1/ DLco < 40% of predicted, but Vo2max > 15 mL/kg/ min, can undergo surgical resection, including pneumonectomy


THANK YOU