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REVIEW

Lung cancer: Preoperative pulmonary evaluation of the lung resection candidate

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ABSTRACT: Lung resection provides the best chance of cure for individuals with early stage non–small cell lung cancer. Naturally, lung resection will lead to a decrease in lung function. The population that develops lung cancer often has concomitant lung disease and a reduced ability to tolerate further losses in lung function. The goal of the preoperative pulmonary assessment of individuals with resectable lung cancer is to identify those individuals whose short- and long-term morbidity and mortality would be unacceptably high if surgical resection were to occur. Pulmonary function measures such as the forced expiratory volume in 1 second and the diffusing capacity for carbon monoxide are useful predictors of postoperative outcome. In situations in which lung function is not normal, the prediction of postoperative lung function from preoperative results and the assessment of exercise capacity can be performed to further clarify risks. Published guidelines help to direct the order of testing, permitting us to offer resection to as many patients as possible.

The pre–lung resection pulmonary evaluation of an individual with lung cancer is designed to minimize perioperative and long-term morbidity and mortality. At the same time, the internist must recognize that surgical resection provides by far the greatest chance of cure for this deadly disease.

The prognosis for lung cancer when surgery is not an option is poor, even if it found in the earliest stage. The median survival for clinical stage I lung cancer patients who are not surgically treated is 25 months if the cancer is screen detected, and 13 months if it is symptom detected.[1] Five- and 10-year survival rates in screen-detected, non-surgically treated, clinical stage I lung cancer are 16.6% and 7.4%, respectively.[2] Unfortunately, only approximately 20% of individuals with lung cancer are determined to be candidates for lung resection.[3] For those eligible for resection, operative mortality has been described in the 3%–4% range,[3,4] with postoperative complications ranging widely, depending on their definition.[4]

Pulmonary function is affected by lung resection. The decline in lung function varies with the extent of the resection. The greatest decline has been seen with a pneumonectomy. The forced expiratory volume in 1-second (FEV1) has been shown to fall an average of 34%–36%, the forced vital capacity (FVC) 36%-40%, and the maximum oxygen consumption (VO_2 max) 20-28%.[5,6] If a lobectomy is performed, the FEV1 has been shown to fall an average of 9%-17%, the FVC 7%-11%, and the VO_2 max 0%–13%.[5,6] Measures of pulmonary function may underestimate functional capacity after resection as determined by exercise testing. The degree of functional loss appears to be less in individuals with poor baseline lung function.[7,8]

With this background—extremely poor prognosis without resection, low operative mortality, and modest declines in lung function post resection—the internist must help decide who can safely tolerate lung resection. This literature

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Table 1 Series of lung resection in the elderly

Author	Years 19--	Patients	Age (years)	Operative mortality (%)	Complications	Survival %, Years
Breyer[9]	69–78	218	>70	3	16% minor 18% major	42,5 L 13,5 P
Ishida[10]	74–89	185	>70	3	21% pulm	48,5
Massard[11]	83–92	223	>70	6.6 – L 10 – P	26.9%	33,5
Pagni[12]	80–95	54	>80	3.7	42% overall 11% major	86,1 43,5
Port[13]	90–03	61	>80	1.6	38% overall 13% major	38,5 82,5 IA

L = lobectomy, P = pneumonectomy, pulm = pulmonary, IA = stage IA.

review assesses the factors considered in this decision: age, pulmonary function, and exercise capacity. The published guidelines are summarized at the end.

Age

Age has been identified as an independent predictor of complications from lung resection. Reports have shown that operative mortality is greater in the elderly, operative risks for pneumonectomy are relatively high, and complications may be increased. Despite this, survival after surgery is much higher than reported in those who cannot undergo surgery (Table 1). The sum of the evidence suggests that surgery should not be withheld on the basis of age alone.

Pulmonary function testing

Most available pulmonary function tests have been studied as predictors of risk for lung resection. Both absolute values and percent predicted normal values have been studied. In addition, techniques have been used to predict postoperative values based on preoperative tests and the extent of surgery. This section describes methods used to predict postoperative values as well as the evidence surrounding the use of the 2 most commonly applied tests—the FEV1 and diffusing capacity for carbon monoxide (DLCO).

Methods to predict postoperative pulmonary function

Segment methods

The simplest methods to predict postoperative pulmonary function involve calculating the portion of all bronchopulmonary segments that will remain after resection. The postoperative lung function should be approximated by the preoperative value multiplied by this portion. One study suggested that 19 total segments should be used as the starting value (10 on the right and 9 on the left). Using this, the predicted postoperative lung function was found to correlate well with actual function for those undergoing lobectomy ($r = 0.867$) and have a fair correlation for pneumonectomy ($r = 0.677$).[14] The actual lung function was consistently underestimated using this technique (by 250 cc's for lobectomy and 500 cc's for pneumonectomy). A second method used the number of subsegments, corrected for those that were obstructed preoperatively, and calculated the predicted postoperative value based on the extent of resection. A regression equation relating the predicted and measured lung function was developed from this method (measured = 0.85 predicted + 0.286 +/− 0.296, $r = 0.821$).[15]

Radionuclide scanning techniques

The general principle of the radionuclide scanning techniques is the same as for the segment methods. With these techniques, the relative function of the portion of lung to be resected is estimated by quantifying the perfusion to that area. Postoperative lung function is then estimated to be the product of the preoperative function and the portion of lung function that will remain after resection as estimated by the scan. Using this method, the r-value for correlation between predicted and actual postoperative FEV1 has been as high as 0.88.[16,17] That for DLCO has been as low as 0.68.[17]

The accuracy of these techniques has been questioned. A study from the 1980s using Xenon scintigraphy found that only 41 of 159 predicted postoperative values were within 5% of actual values.[18] A more recent study using technetium scanning calculated values of imprecision from 18%-21% despite showing reasonable correlation.[19] The FEV1 was consistently underestimated, particularly if the starting value was lower.

Quantitative computed tomography

Quantitative computed tomography scanning has been studied as a technique to estimate postresection lung function. The volume of lung with attenuation between −500 and −910 Hounsfield units was used to estimate functional lung volume. The portion of lung remaining postresection was predicted by calculating lung volume in the area to be resected as a portion of total lung volume and using the