Lung Resection in Patients with Marginal Pulmonary Function

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KEYWORDS

• Non–small cell lung cancer • Surgery • VATS • Elderly • COPD • Preoperative assessment

KEY POINTS

- Newer techniques in intraoperative and postoperative management allow surgeons to successfully treat patients that were not eligible for surgery in the past.
- Evidence supports the use of minimally invasive surgery or video-assisted thoracic surgery techniques to minimize the risk of complications in marginal patients.
- Factors that affect or modify the patients' true forced expiratory volume of air in 1 second in the immediate postoperative period may be more important than the predicted postoperative physiologic parameters.
- The surgical approach needs to be a deciding factor in the treatment of marginal patients.
- Marginal patients should be seen in a multidisciplinary setting with the input of thoracic surgeons that can provide the full suite of surgical options.

INTRODUCTION

In this day and age of minimally invasive surgery (MIS), cyber knives, computed tomography (CT) screening, and increasing life expectancy (as well as increasing patient expectations), the question of defining the limits of resection in terms of pulmonary function is more germane than ever before. Classic guidelines, or cutoffs, from historical controls have been circumvented by newer techniques in intraoperative and postoperative management and have allowed surgeons to successfully treat patients who were not eligible for surgery in the past.

HISTORICAL CONTEXT

Dr King from Massachusetts General Hospital may have been one of the first surgeons to comment on what is now intuitively obvious to us: pulmonary complications are the most common cause of early postoperative morbidity and mortality.[1] He noted in his paper in 1932 that following laparotomy, a "…condition of hypoventilation apparently allows the collection of secretion in the bronchi and atelectasis and pneumonia may result."[1] Further, it was shown that abdominal operations were followed by pulmonary physiologic changes, including marked reductions in vital capacity.

From these observations made in the general surgery arena, the advent of spirometry in the 1950s enabled a relatively repeatable and quantifiable assessment of pulmonary function to be performed.[2,3] The next breakthrough in the effects of marginal lung function on patient outcomes came with Gaensler and colleagues'[3] seminal work published in 1955, which showed the value of preoperative spirometric assessment in patients undergoing surgery for

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pulmonary tuberculosis.[4] In particular, FEV_1 came to predominance as a predictor of postoperative risk.

Further refinement was required, however, as pointed out by Kohman and colleagues[5] in the 1980s. In analyzing predictable risks for mortality following thoracotomy for lung cancer, they were only able to account for 12% of observed mortality, with the remaining mortality being ascribed to chance or, more likely, to previously unrecognized factors.

Enter diffusion capacity. Ferguson and colleagues[6] discovered that diffusion capacity of carbon monoxide (DLCO) was the most important predictor of mortality after pulmonary resection. This discovery led to the widespread evaluation of DLCO and not just spirometry in patients undergoing pulmonary resection.

CURRENT GUIDELINES

The current guidelines from the American College of Chest Physicians (ACCP), the British Thoracic Society (BTS), and the European Respiratory Society (ERS) are shown in **Figs. 1–3**, respectively.[7–9] These recommendations, which would be familiar to any thoracic surgeon who has practiced in the past 30 years, are based largely on 3 case series published in the 1970s with a total of more than 2000 patients. These guidelines certainly serve as the gold standard, but there have clearly been several changes in practice that are not necessarily addressed.

Previous iterations of these guidelines were less comprehensive, but the current set does acknowledge the limitations of the guideline process and offers some instructive suggestions as to when it may be possible to identify specific patient subgroups that have a differing risk profile. For example, in the BTS' guidelines, it is noted that lung volume reduction surgery (LVRS) criteria should be considered, as some patients may actually have improved lung function following resection.

However, there is some question regarding the significance of these guidelines.

WORST-CASE FORCED EXPIRATORY VOLUME IN THE FIRST SECOND OF EXPIRATION

The guidelines all rely heavily on the calculation of the predictive postoperative (ppo) values of FEV_1 and DLCO. But as noted earlier, this validation was based on retrospective data. An elegant series of studies performed by Varela and colleagues[10,11] adds another dimension to the problem. In their first study, they prospectively examined 125 patients that underwent lobectomy and compared their $ppoFEV_1$ with actually measured FEV_1 at the bedside on postoperative days (POD) 1 through 6.[10] The hypothesis was that postoperative complications generally occur in the first few POD; therefore, a measure of the true FEV_1 at that time may be valuable. The results are shown in **Fig. 4**. True FEV_1 was lowest on POD 1 (the worst-case FEV_1), when the mean was 71% of the $ppoFEV_1$ and increased each day, though it did not meet the $ppoFEV_1$ even on POD 6. There was also an inverse correlation between the true FEV_1 and pain scores.

In a follow-up study, they hypothesized that true measured FEV_1 was a better predictor of postoperative complications than $ppoFEV_1$.[11] They prospectively followed 198 patients that underwent anatomic resections and correlated the occurrence of cardiorespiratory complications with several variables. The results are shown in **Table 1**. True FEV_1 correlated most strongly with the development of complications, whereas $ppoFEV_1$ was less important than patient age and of similar importance to pain scores on POD 1 and type of analgesia.

An interesting point is that they also examined the effect of video-assisted thoracic surgery (VATS) versus thoracotomy and found it to be relatively unimportant as a predictor of complications. This finding may be a result of several reasons. First, the study was multi-institutional and there were no VATS guidelines. Second, there are no data on how many of the cases were VATS procedures. Third, there is no description of the actual VATS techniques used (ie, whether these were true thoracoscopic procedures with no rib spreading or whether they were video-assisted operations whereby the camera acts largely as a light source and the ribs are still spread to a degree).

SPECIFIC CONSIDERATIONS

These insights suggest that the picture is not simple. Factors that affect or modify patients' true FEV_1 in the immediate postoperative period may be more important than the predicted postoperative physiologic parameters that are the foundations of the guidelines. Other studies have gone on to suggest what some of those factors may be.

MINIMALLY INVASIVE SURGERY

Nakata and colleagues[12] looked specifically at the role of MIS or VATS techniques in postoperative lung function. In a nonrandomized study they