The Prevention and Management of Air Leaks Following Pulmonary Resection

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KEYWORDS

• Pulmonary resection • Postoperative • Air leak • Alveolar pleural fistula

KEY POINTS

- Based on preoperative risk factors, selected patients should be considered for intraoperative techniques to minimize air leaks and the residual spaces that predispose to prolonged air leaks, including pleural tenting and pneumoperitoneum.
- There is insufficient evidence for the routine use of surgical sealants following pulmonary resection; we recommend buttressing staple lines in nonanatomic pulmonary resections for patients with moderate to severe emphysema (forced expiratory volume in 1 second <60% of predicted) to prevent prolonged air leaks.
- In postoperative patients with less than a large air leak and no more than a small pneumothorax, algorithms incorporating no applied external suction or alternating suction likely reduce the duration of air leak.
- Initial evaluation of digital drainage systems suggest that their use may result in shorter duration of air leak, duration of chest tube, and length of stay.
- Most prolonged alveolar air leaks resolve with time and tube drainage alone, and a trial of a few weeks of watchful waiting incorporating a Heimlich valve is reasonable in the outpatient setting.

INTRODUCTION

Alveolar air leaks after pulmonary resection are a common problem in thoracic surgery. A variety of reports have shown that an air leak is present immediately on completion of a routine pulmonary resection in 28% to 60% of patients, after both lobectomies and lesser resections. On the morning of postoperative day 1, an air leak is present in 26% to 48% of patients; on the morning of postoperative day 2, an air leak is present in 22% to 24% of patients; and on the morning of postoperative day 4, an air leak is present in 8% of patients.[1]

A contemporary, practical definition of prolonged air leak (PAL) is an air leak that persists beyond postoperative day 5. This definition is used by the Society of Thoracic Surgeons database and represents a leak whose duration exceeds the average length of stay (LOS) for lobectomy. Several studies have found that PAL is associated with an increased rate of postoperative complications following routine pulmonary resection. Brunelli and colleagues[2] reported an 8.2% to 10.4% rate of empyema in patients who had an air leak lasting more than 7 days, compared with a 0% to 1.1% in patients with lesser air leaks. Similarly,

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Thorac Surg Clin 25 (2015) 411–419

http://dx.doi.org/10.1016/j.thorsurg.2015.07.002

1547-4127/15/$ – see front matter Published by Elsevier Inc.

Varela and colleagues[3] found that air leaks lasting at least 5 days postoperatively were associated with increased pulmonary morbidity, including atelectasis, pneumonia, or empyema. In the lung volume reduction surgery (LVRS) population, postoperative complications occur more often in patients experiencing air leak (57%) than in those who do not (30%).[4]

Several risk factors for PAL following pulmonary resection have been identified. The most consistently identified risk factor for PAL is chronic obstructive pulmonary disease (COPD). Preoperative tests reflecting the severity of COPD and that are associated with PAL include reduced postoperative predicted forced expiratory volume in 1 second (FEV_1), FEV_1 less than 79% of predicted, FEV_1 less than 1.5 L, FEV_1 less than 70%, and both FEV_1 and forced vital capacity less than 70%.[1] Other risk factors with proven associations with PAL include carbon monoxide diffusion in the lung less than 80%, presence of adhesions, upper lobectomy and bilobectomy, presence of a pneumothorax coinciding with an air leak, and steroid use.[1]

THERAPEUTIC OPTIONS AND CLINICAL OUTCOMES

Intraoperative Prevention of Air Leaks

Because PALs are common, clearly increase LOS, and likely cause associated complications, several surgical strategies have been developed to prevent them. The general principles underlying these surgical techniques involve an elimination of residual space and achieving apposition of the visceral pleura, either to the parietal pleura or to transposed tissue (**Table 1**). Other techniques include addressing pulmonary resection beds and staple lines with adhesives and/or buttressing material.

Routine performance/use of these techniques is not advisable; not all patients are expected to benefit from these intraoperative adjuncts, which can be time consuming and/or costly. A careful selection of patients for such techniques should be based on underlying risk factors and probability of PAL and pleural space problems. For example, small or moderate residual spaces after pulmonary resection in many patients are physiologic and inconsequential; they resolve over time without ill effect. However, a large residual space in the context of a patient at high risk for air leak, which may result in infection of that space, can lead to a cascade of untoward events and morbidity. There are several intraoperative measures for preventing residual air spaces with which a thoracic surgeon should be familiar and many of these have randomized studies establishing their effectiveness.

Table 1
Intraoperative procedures to manage residual thoracic air spaces

Anatomic Structure	Intraoperative Procedure
Parietal pleura	Pleural tent Pleurectomy or pleurodesis
Visceral pleura	Adhesiolysis Decortication
Diaphragm	Pneumoperitoneum Phrenic nerve paralysis
Muscular chest wall	Intrathoracic transposition of muscle
Osteotendinous chest wall	Rib resection at thoracotomy level Tailored thoracoplasty
Omentum	Omental transposition

Lung mobilization

Although less often a problem after sublobar resection compared with lobectomy, attaining pleural apposition without having to resort to high levels of suction seems to be an effective strategy for preventing PALs. There are several techniques that are commonly used to minimize residual space. Mobilization of all intrapleural adhesions and division of the inferior pulmonary ligament are the simplest of these, and should be routinely practiced because they are helpful. Similarly, decortication of the remaining lung, in rare instances and when required, may facilitate pleural apposition.

Pleural tent

Creation of an apical pleural tent at the time of upper lobectomy or upper bilobectomy (resection of upper and middle lobes) is a proven technique for decreasing PAL. A pleural tent is created by detachment of the parietal pleura from the endothoracic fascia, usually beginning at the level of the thoracotomy or one of the upper thoracoscopic port sites. The pleura is elevated circumferentially along the chest wall, being careful not to tear it. The resulting pleural tent falls directly onto the staple lines along the interlobar fissures. It compartmentalizes the chest cavity by separating the caudally located, fully drained space, which contains the residual lung, from the cranially located undrained space, which is allowed to fill