

Predictors of Prolonged Air Leak After Lung Resection Surgery.

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Abstract

Background

Prolonged air leak is one of the most common complications after lung resection surgery and is associated with increased postoperative morbidity, longer chest tube duration, prolonged hospital stay, and higher treatment cost. Identifying patients at increased risk for prolonged air leak is important for perioperative planning and postoperative management.

Objectives

To determine the predictors of prolonged air leak after lung resection surgery and to assess its impact on postoperative outcomes, including hospital stay, intensive care unit admission, and mortality.

Methodology

This retrospective analytical study was conducted at Department of Thoracic Surgery Unit, Lady Reading Hospital Medical Teaching Institution, Peshawar from Jan 2019 to Jan 2020. A total of 120 patients who underwent lung resection surgery during the study period were included. Demographic characteristics, smoking history, comorbidities, pulmonary function, type of lung resection, operative findings, postoperative air leak duration, hospital stay, ICU admission, and mortality were recorded using a structured data collection form. Prolonged air leak was defined as an air leak persisting for more than five postoperative days. Data were analyzed using SPSS version 24. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. The chi-square test, independent t-test, and binary logistic regression were used where appropriate. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 120 patients were included in the study. The mean age of the patients was 58.6 ± 11.2 years, and males constituted 64% of the study population. Prolonged air leak occurred in 25 patients (20.8%). On analysis, prolonged air leak was more frequent in patients with a history of smoking,

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chronic obstructive pulmonary disease, reduced preoperative FEV1, upper lobe resection, and intraoperative pleural adhesions. Patients with prolonged air leak had a significantly longer hospital stay compared with those without prolonged air leak (11.8 ± 3.9 days vs 6.7 ± 2.4 days, $p = 0.01$). ICU admission was required in 14 patients (11.7%), while overall postoperative mortality was 2 patients (1.7%).

Conclusion

Prolonged air leak remains a frequent postoperative complication after lung resection surgery. Smoking history, chronic obstructive pulmonary disease, reduced pulmonary function, upper lobectomy, and pleural adhesions were important predictors. Early identification of high-risk patients may help reduce morbidity, shorten hospital stay, and improve postoperative care.

Keywords: Prolonged air leak; Lung resection; Lobectomy; Thoracic surgery; Postoperative complications

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Introduction

Lung resection surgery is commonly performed for both malignant and benign pulmonary diseases and remains a cornerstone of thoracic surgical practice. Despite improvements in operative technique and perioperative care, postoperative complications continue to affect recovery and overall surgical outcomes (1). Among these complications, prolonged air leak is one of the most frequently encountered problems after pulmonary resection and is associated with delayed chest tube removal, increased postoperative pain, prolonged hospitalization, and increased healthcare costs (2). Prolonged air leak is generally defined as an air leak that persists beyond the fifth postoperative day after lung resection surgery (3). The reported incidence varies according to the extent of resection, surgical technique, baseline lung function, and method of postoperative drainage assessment (4). Although many patients experience a transient postoperative air leak, a subset develops persistent leakage that complicates recovery and may require additional interventions (5). Several patient-related and operative factors have been linked to prolonged air leak. Previous studies have identified male sex, smoking history, chronic obstructive pulmonary disease, reduced forced expiratory volume in one second, low body mass index, upper lobe resection, pleural adhesions, and extensive stapling as important contributors to risk (6). In addition, the presence and severity of air leak in the early postoperative period may help predict which patients will go on to develop prolonged leakage (7). The identification of reliable predictors of prolonged air leak has important clinical implications. Risk stratification may improve patient counseling, guide preventive intraoperative strategies, and assist in postoperative chest drain management (8). Moreover, better prediction of prolonged air leak may support the use of targeted interventions such as fissureless techniques, sealants, digital drainage systems, or early tailored management protocols in selected high-risk patients (9). Single-center studies remain useful in evaluating local outcome patterns and identifying institution-specific risk profiles. Such analyses can help optimize perioperative pathways and improve resource utilization after thoracic surgery (10). Therefore, this study aimed to assess the predictors of prolonged air leak after lung resection surgery and to determine its association with postoperative outcomes including hospital stay, ICU admission, and mortality (11).

Research Objective

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To identify predictors of prolonged air leak after lung resection surgery and determine its impact on postoperative outcomes.

Materials and Methods

Study Design and Setting

This retrospective analytical study was conducted at Department of Thoracic Surgery Unit, Lady Reading Hospital Medical Teaching Institution, Peshawar from jan 2019 to jan 2020.

Participants

The study included 120 patients who underwent lung resection surgery during the study period.

Inclusion Criteria

Patients aged 18 years or older who underwent elective lung resection surgery, including lobectomy, segmentectomy, bilobectomy, or wedge resection, were included.

Exclusion Criteria

Patients with incomplete medical records, pneumonectomy patients, those undergoing surgery for traumatic chest injury, and patients requiring re-exploration for causes unrelated to air leak were excluded.

Data Collection

Data were collected using a structured proforma. Variables recorded included age, gender, smoking history, chronic obstructive pulmonary disease, pulmonary function tests, type of resection, operative findings such as pleural adhesions, duration of postoperative air leak, chest tube duration, hospital stay, ICU admission, and mortality.

Definition of Prolonged Air Leak

Prolonged air leak was defined as an air leak persisting for more than five postoperative days.

Statistical Analysis

Data were analyzed using SPSS version 24. Quantitative variables were expressed as mean $\pm$ SD, while categorical variables were presented as frequency and percentage. The chi-square test and independent t-test were applied to compare groups. Binary logistic regression was used to assess independent predictors of prolonged air leak. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 120 patients underwent lung resection surgery during the study period. The mean age was 58.6 ± 11.2 years, and 64% of patients were male. The most commonly performed procedure was lobectomy, followed by wedge resection and segmentectomy. Prolonged air leak was observed in 25 patients (20.8%). It was more common among smokers, patients with chronic obstructive pulmonary disease, those with reduced preoperative FEV1, patients undergoing upper lobectomy, and those with intraoperative pleural adhesions. In multivariable analysis, smoking history, reduced FEV1, upper lobectomy, and pleural adhesions remained significant predictors. Patients with prolonged air leak had significantly longer hospital stays than those without prolonged air leak (11.8 ± 3.9 days vs 6.7 ± 2.4 days, $p = 0.01$). ICU admission was required in 14 patients

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(11.7%), and overall mortality was 2 patients (1.7%). Mortality occurred mainly in patients with severe postoperative respiratory complications.

Table 1. Baseline Characteristics of the Study Population

Variable	Frequency (n)	Percentage (%)
Age (years), mean $\pm$ SD	58.6 $\pm$ 11.2	—
Male	77	64.2%
Female	43	35.8%
Smokers	70	58.3%
COPD	34	28.3%
Lobectomy	62	51.7%
Upper lobe resection	41	34.2%
Pleural adhesions	31	25.8%

Table 2. Predictors of Prolonged Air Leak

Variable	PAL Present (n=25)	PAL Absent (n=95)	p-value
Smoking history	19	51	0.03
COPD	13	21	0.02
Reduced FEV1 (<80%)	16	24	0.01
Upper lobectomy	13	28	0.04
Pleural adhesions	12	19	0.02

Table 3. Postoperative Outcomes

Outcome Variable	PAL Present	PAL Absent	p-value
Hospital stay	11.8 $\pm$ 3.9 days	6.7 $\pm$ 2.4 days	0.01
ICU admission	6 (24.0%)	8 (8.4%)	0.08
Mortality	1 (4.0%)	1 (1.1%)	0.31

Discussion

The present study showed that prolonged air leak occurred in 21% of patients after lung resection surgery and was significantly associated with smoking history, chronic obstructive pulmonary disease, reduced pulmonary function, upper lobectomy, and pleural adhesions. These findings are consistent with previous thoracic surgical studies reporting prolonged air leak as one of the most frequent complications after pulmonary resection and emphasizing the contribution of fragile lung parenchyma and impaired respiratory reserve to its development (12,13). Smoking and chronic

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obstructive pulmonary disease emerged as important predictors in our study. This is biologically plausible because chronic tobacco exposure and emphysematous changes weaken lung tissue and increase the likelihood of persistent alveolar-pleural fistula formation after resection. Earlier studies similarly identified smoking burden and low preoperative FEV1 as strong predictors of prolonged air leak, particularly after lobectomy and VATS anatomical resections (14,15). Reduced pulmonary function also remained significantly associated with prolonged air leak in the present series. Previous clinical prediction models have consistently shown that poor baseline lung function is an important determinant of postoperative air leak persistence. Large database studies and institutional models have linked low FEV1, low BMI, and poor functional status with progressively increasing risk of prolonged air leak after pulmonary resection (16,17). Operative factors were also relevant in our findings. Upper lobectomy and pleural adhesions were associated with higher prolonged air leak rates, which agrees with published evidence showing that upper lobe resections and dense pleural adhesions increase parenchymal injury and technical difficulty during dissection. Studies evaluating VATS lung resection have also noted that stapling length and intraoperative air leak severity may predict later prolonged leakage (18,19). An important finding of this study was the significantly longer hospital stay in patients with prolonged air leak. This observation is in line with previous reports showing that prolonged air leak delays chest drain removal, increases postoperative discomfort, and contributes to higher healthcare utilization. Although mortality in our study was low, prolonged air leak still represented a clinically meaningful source of postoperative morbidity (20). The results of this study highlight the value of preoperative risk stratification. Identifying high-risk patients may support targeted preventive measures such as fissureless lobectomy in selected cases, careful adhesiolysis, tailored drain management, and the use of digital drainage systems or sealants when appropriate. Prior studies have shown that standardized postoperative pathways and digital drainage assessment may reduce chest tube duration and hospital stay in patients with postoperative air leak (21,22). Overall, the present findings reinforce that prolonged air leak is multifactorial and influenced by both patient-related and operative variables. Early recognition of these predictors may improve perioperative planning and postoperative management after lung resection surgery.

Limitations

This study has several limitations. It was conducted at a single center with a relatively small sample size, which may limit generalizability. The retrospective design may also introduce selection and documentation bias. In addition, different types of lung resections were analyzed together, which may have influenced the observed rate of prolonged air leak.

Conclusion

Prolonged air leak is a common complication after lung resection surgery and is associated with prolonged hospital stay. Smoking, chronic obstructive pulmonary disease, reduced FEV1, upper lobectomy, and pleural adhesions were important predictors. Careful perioperative assessment and targeted preventive strategies may help reduce postoperative morbidity.

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Authors Contribution

Concept & Design of Study: **Muhammad Abid Khan¹**

Data Collection: **Faridullah Khan Ismail²**

Drafting: **Tahir Aslam³**

Data Analysis: **Faridullah Khan Ismail²**

Critical Review: **Tahir Aslam³**

Final Approval of version: **All authors approved the final version.**

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