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Original Article

Necessity of Multi-Step Surgical Treatment for Patients with Interstitial Lung Disease and a Pneumothorax

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Purpose: A pneumothorax occurs in 3%–8% of patients with idiopathic pulmonary fibrosis. A pneumothorax may predict a poor outcome in patients with interstitial lung disease (ILD), and it is difficult to treat patients with ILD and a pneumothorax.
Patients and Methods: We retrospectively studied data from all 12 patients with ILD and a pneumothorax who underwent surgical treatment at Toho University Omori Medical Center Hospital between 2009 and 2021.
Results: Of the 12 patients, 2 had home oxygen therapy preoperatively and were classified with grade IV interstitial pneumonia (IP). Six patients had preoperative pleurodesis and two had postoperative one using auto-blood. Three patients (25%) had multi-step surgery ≥2, and 5 patients had surgical resection of bullae. No patients had postoperative acute exacerbations and all were discharged from the hospital in a stable condition. The 5-year overall survival rate for all patients was 70.0%. The median survival time was not reached. One patient with unclassified IP was doing well 116 months after surgery.
Conclusion: Patients with ILD and a pneumothorax were shown to require multi-step surgical treatment and can anticipate long-term survival.

Keywords: pneumothorax, ILD, treatment

Introduction

Interstitial lung disease (ILD) is featured by a damaged lung parenchyma associated with variable patterns of inflammation and fibrosis.[1] Patients with ILD typically have co-existing diseases with variable pathophysiologic features and undergo a variety of treatments.[1] Lung cancer, for example, occurs in 3%–48% of patients with idiopathic pulmonary fibrosis (IPF).[2] Indeed, peritreatment acute exacerbation of ILD in patients with ILD and lung cancer has appeared as a serious problem.[2]

The incidence of spontaneous pneumothorax is 17–24/100000 for men and 1–6/100000 for women.[3–5] A pneumothorax occurs in 3%–8% of patients with IPF.[6] A pneumothorax may predict a poor outcome in patients with ILD,[7] and it is difficult to treat the pneumothorax due to ILD.[8]

Herein we report favorable results, including multi-step surgical treatment, of patients with ILD and a pneumothorax.

Patients and Methods

The ethics committee of Toho University Omori Medical Center approved this study (M22012 20033).

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We excluded patients with ILD, a pneumothorax, and lung or gastric cancer in this study because we wanted to determine the prognosis of only patients with ILD and a pneumothorax. Patients with malignant tumors and ILD have a very poor prognosis; the prognosis of patients with ILD may be affected by malignant tumors.[2)]

We retrospectively examined data from all patients with ILD and a pneumothorax who received surgical treatment at Toho University Omori Medical Center Hospital between 2009 and 2021.

We performed surgical treatments for a pneumothorax in patients with ILD and a pneumothorax if chest drainage with or without preoperative pleurodesis using auto-blood was not effective for a pneumothorax and the patients could undergo general anesthesia. Pulmonologists, thoracic surgeons, and sometimes anesthesiologists were involved in the decision on the indications for surgery.

The following parameters were extracted from the medical records: gender, age, ILD type, ILD grade,[9)] combined emphysema, blood gas analysis, preoperative treatment for ILD, portion of air leakage, preoperative pleurodesis, perioperative rehabilitation, surgical time, intraoperative bleeding, surgical methods, intraoperative covering for bulla or staple line, frequency of surgery, postoperative complication, and postoperative acute exacerbation of ILD.

Statistical analysis

Survival time was calculated from the date of surgery until death or last follow-up evaluation and was assessed using the Kaplan–Meier method.

Results

Of the 12 patients, 5 had IPF, 2 had pleuroparenchymal fibroelastosis, 2 had collagen vascular disease–interstitial pneumonia (IP), 1 had fibrotic non-specific IP, and 2 had others. **Table 1** lists the demographic factors.

Two patients had home oxygen therapy preoperatively and were classified with grade IV IP (**Table 1**).

The portion of air leakage intraoperatively was known for all patients except one (**Table 2**). Six patients had preoperative pleurodesis using auto-blood (**Table 2**). Six patients had perioperative rehabilitation (**Table 2**).

Three patients (25%) had multi-step surgery ≥2 (**Table 3**). Only 5 patients had surgical resection of bullae. All patients had additional covering with surgery (**Table 3**).

Table 1 Clinical characteristics of patients with ILD and a pneumothorax

Clinical factor	Data	%
Patient number	12	
Age, mean (range)	65 (57–72)	
Gender (male:female)	10:2	
Side (right:left)	7:5	
Type of IP		
IPF	5	41.7
PPFE	2	16.7
CVD–IP	2	16.7
f-NSIP	1	8.3
Others	2	16.7
Combined emphysema		
Yes:no	6:6	
Blood gas analysis		
Room air in 11 cases (range)	79.2 torr (45.1–92.5)	
Under 1 L nasal in 1 case	76.0 torr	
Grade of IP		
I	6	50.0
II	3	25.0
III	1	8.3
IV	2	16.7
Preoperative treatment for ILD		
Prednisolone	2	16.7
Nintedanib + prednisolone	1	8.3
N-acetylcysteine	1	8.3
No	8	66.7

ILD: interstitial lung disease; IP: interstitial pneumonia; IPF: idiopathic pulmonary fibrosis; PPFE: pleuroparenchymal fibroelastosis; CVD–IP: collagen vascular disease–interstitial pneumonia; f-NSIP: fibrotic non-specific interstitial pneumonia

No patients had postoperative acute exacerbations. Two patients needed postoperative pleurodesis using auto-blood because of postoperative air leakage. All patients were discharged from the hospital in a stable condition (**Table 4**). Two patients had a postoperative ipsilateral recurrence after discharge from the hospital; however, one patient improved with chest drainage alone and the other patient only required observation (**Table 4**).

The median duration of follow-up for all patients was 27 months. Postoperatively, two patients died of IP. The 5-year overall survival rate for all patients was 70.0% (**Fig. 1**). The median survival time was not reached. One patient with unclassified IP was doing well 116 months after surgery.

Table 2 Treatments of patients with ILD and a pneumothorax

Clinical factor	Number	%
Portion of air leakage		
Upper lobe	7	58.3
Middle lobe	1	8.3
Lower lobe	3	25.0
Could not specify	1	8.3
Preoperative pleurodesis		
Yes	6	50.0
Auto-blood (2 times)	2	16.7
Auto-blood (3 times)	1	8.3
Auto-blood (5 times)	1	8.3
Auto-blood (6 times)	1	8.3
Auto-blood (2 times) + glucose (1 time)	1	8.3
No	6	50.0
Perioperative rehabilitation		
Yes	6	50.0
No	6	50.0

ILD: interstitial lung disease

Table 3 First-operative findings in patients with ILD and a pneumothorax

Clinical factor	Number	%
Surgical time, mean (range, minute)	140.2 (86.0–240.0)	
Bleeding, mean (range, ml)	24.1 (0–121)	
Number of surgery		
1	9	75.0
2	2	16.7
4	1	8.3
Surgical method		
Resection	5	41.7
Covering only	5	41.7
Ligation	2	16.7
Covering		
Fibrin	11	91.7
Fibrinogen–thrombin patch	8	66.7
Oxidized cellulose	8	66.7

ILD: interstitial lung disease

Discussion

The treatment of pneumothorax in patients with ILD is difficult because of postoperative complications. Ichinose et al.[10] defined surgery without hospital mortality, postoperative complications, death within 6 months, or ipsilateral pneumothorax recurrence within 2 years as treatment success and reported that only 9 of 20 patients (45%) with IP and a pneumothorax had treatment success. Moreover, Ichinose et al.[10] referred to postoperative pneumothorax recurrence and showed that 7 of 20 patients (35%) with IP had a recurrence (ipsilateral, 3 patients [15%]; contralateral, 4 patients [20%]). These results highlighted the difficulty in managing a pneumothorax in patients with ILD.

Nakajima et al.[8] reported that 3 patients with ILD had difficulty with one-lung ventilation during surgery. In addition, 2 patients with ILD had postoperative air leakage (>14 days).[8] In the current study, 50% of patients had preoperative pleurodesis using auto-blood, 3 patients (25%) had multi-step surgery ≥2, and 2 patients had postoperative auto-blood pleurodesis for postoperative air leakage. No patients had postoperative acute exacerbations and all patients were discharged from the hospital in a stable condition. We did not experience difficulty with respect to intraoperative one-lung ventilation. These

Table 4 Postoperative complications in patients with ILD and a pneumothorax

Clinical factor	Number	%
Postoperative complications		
Air leakage	2	16.7
Contralateral pneumothorax	1	8.3
HOT	1	8.3
Postoperative acute exacerbation	0	0
Discharge	12	100
Postoperative ipsilateral recurrence after discharge	2	16.7

ILD: interstitial lung disease; HOT: home oxygen therapy

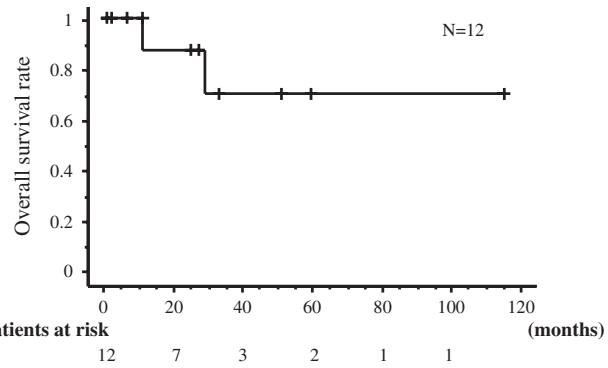

Fig. 1 Five-year overall survival rate for all patients was 70.0%. The median survival time was not reached. One patient with unclassified IP did well 116 months after surgery. IP: interstitial pneumonia

may be due to preoperative stable condition and postoperative controlled air leakage. It is very important for their prognoses to control air leakage caused by IP, and multi-step treatment using pre- and postoperative auto-blood pleurodesis and multi-step surgery may be necessary to be performed for patients with IP and a pneumothorax.

In patients with ILD, postoperative acute exacerbation is a severe problem in patients with not only surgery for lung cancer[2] but also surgical lung biopsy for the diagnosis of ILD.[11] Nakajima et al.[8] reported that 3 of 14 patients (21.4%) with ILD and a pneumothorax died of postoperative acute exacerbations (2 patients) and empyema (1 patient). Moreover, postoperative acute exacerbations are associated with intra- and perioperative management in spite of the extent of surgical resection of the lung.[2,11]

Ogawa et al.[12] reported that pleurodesis using OK-432 was associated with acute exacerbations in 4 of 39 patients; 2 patients died of the acute exacerbations. We primarily use auto-blood rather than OK-432. As a result, our patients did not experience acute exacerbations associated with pleurodesis.

Although polyglycolic acid mesh is used for directly covering the staple line after bullectomy, the mesh provokes an inflammatory reaction and adhesions between the parietal and visceral pleura.[8] Because inflammation may be associated with the onset of postoperative acute exacerbations,[2] we did not use polyglycolic acid mesh as a covering during surgery. We used fibrin glue, a fibrinogen–thrombin patch, or oxidized cellulose for all patients with ILD and a pneumothorax in this study because of the known efficacy and safety for air leak management in thoracic surgery.[13]

Postoperative acute exacerbation occurred within 30 days of pulmonary resection in 9.3% of the patients with ILD and lung cancer.[14] The risk factors for acute exacerbations were identified based on univariate analysis as follows: gender, Krebs von den Lungen-6 (KL-6), percent vital capacity, findings of computed tomography, past acute exacerbations, preoperative use of steroids, and surgical procedures.[14] Of note, there is no definitive prophylaxis or treatment for postoperative acute exacerbations,[2] although several trials involving lung cancers have been conducted.[2] Although pirfenidone may prevent postoperative acute exacerbations in patients with ILD and lung cancer,[2] pirfenidone was not used in the current study. We managed the invasiveness of surgery for the treatment of patients with ILD and a pneumothorax as follows: the timing of surgery before the development of an empyema; perioperative rehabilitation for preventing postoperative complications, such as pneumonia; short duration of surgery; minimal bleeding during surgery; surgical methods, including multi-step surgery; or postoperative care. As a sequel to these treatments, no patients had postoperative acute exacerbations and no patients had an in-hospital mortality.

Our study had some limitations. First, this was a retrospective study. Second, only a small number of patients with ILD and a pneumothorax were enrolled. Nevertheless, we believe that we have reported significant findings despite these limitations.

Conclusions

Patients with a pneumothorax due to ILD need to have multi-step surgical treatment including preoperative/postoperative auto-blood pleurodesis, surgery, and intra/postoperative care. Although the patients required special management for intra/postoperative air leakage and prophylaxis of postoperative acute exacerbation of ILD, they could anticipate long-term survival.

Author Contributions

YA, TS, SK, HO, AS, and AI were implied in the conception and design of the study. AI wrote the manuscript. YA, TS, SK, HO, and AS gathered data. The final manuscript was read and approved by all authors.

Disclosure Statement

The authors have no conflicts of interest related to this study.

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