ORIGINAL ARTICLE

Morbidity, mortality, and surgical treatment of secondary spontaneous pneumothorax

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ABSTRACT

BACKGROUND: Pneumothorax in patients with underlying lung pathology is called secondary spontaneous pneumothorax (SSP). It is an important health problem worldwide, with significant morbidity, high health-care expenses, and possibility of mortality. This study aimed to evaluate the epidemiological characteristics, risk factors for mortality and morbidity, and treatment options of SSP.

METHODS: Outcomes of 133 patients with SSP were evaluated retrospectively. Patients with SP with evidence of underlying lung disease or a smoking history over 50 years of age were considered SSP. The patients were analyzed in terms of epidemiological features, underlying diseases, treatment methods, complications, and mortality. The treatment options included thoracotomy (T), video-assisted thoracoscopic surgery (VATS), tube thoracostomy, and conservative treatment.

RESULTS: The mean age was 50.50±20.374 years, and the age range was 16–95. Ninety-three (69.9%) of the patients were smokers. The most common clinical finding was dyspnea in 77 (57.9%) patients. The most common underlying disease was chronic obstructive pulmonary disease in 62 patients (46.6%). Six (4.5%) patients received conservative treatment, a chest tube was placed in 89 (66.9%) patients, and 38 (28.6%) patients were treated with surgery. As an operative procedure, lung wedge resection was performed in 24 (18.0%) patients and bulla resection was performed in 6 (4.5%) patients. Parietal pleurectomy was performed in 27 (20.3%) patients. Axillary mini-T or T was performed more frequently in large pneumothorax, smokers, and in obstructive pulmonary disease. Tube thoracostomy was used more frequently in poor physical performance, comorbidities, and infectious diseases. Complications were observed in 55 patients (41.4%). The most common complication was persistent air leakage in 18 (13.5%) patients. Complications were associated with large pneumothorax (P=0.003), poor physical performance (P=0.009), infectious diseases (P= 0.030), and occupational risk factors (P=0.032). Recurrence was developed in 12 (9.0%) patients. Postoperative recurrence was observed in 1 patient. Four (3%) patients died. Mortality was higher in patients with poor physical performance (P=0.027), comorbidities (P=0.008), and patients with complications (P=0.027). The length of stay in the hospital was high in mini-axillary T (AT)/T (P<0.001) and VATS (P<0.001). There was no significant relationship between the mini-AT/T and VATS in terms of length of hospital stay.

CONCLUSION: Large pneumothorax, poor physical performance, and comorbidity are associated with morbidity and mortality. Conservative treatment for small pneumothorax and chest tube for large pneumothorax is the most appropriate initial treatment. Resection of the bullous region through VATS or mini-AT/T is the most appropriate surgical technique.

Keywords: Chest tubes; risk-factors; spontaneous pneumothorax; thoracotomy; video-assisted thoracoscopic surgery.

INTRODUCTION

The accumulation of air in the pleural space without trauma is called spontaneous pneumothorax (SP). Pneumothorax in patients with underlying lung pathology is named secondary SP (SSP).[1]

SSP occurs at an annual rate of 6.3–2/100,000 in men and women.[2] It is an important health problem worldwide, with significant morbidity, high healthcare costs, and potential for mortality.[3,4] There has not been enough research on the risk factors associated with morbidity and in-hospital mortality in patients with SSP and the demographic and clinical character-

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istics of patients with SSP. Many studies evaluate primary and SSP together. This study focused only on SSP.

This study aims to analyze the epidemiological characteristics of SSP, determine the risk factors associated with mortality and morbidity, and evaluate the most appropriate treatment methods.

MATERIALS AND METHODS

Our study was conducted according to the Declaration of Helsinki. Ethical approval has been received from the Clinical Research Ethics Committee of Kahramanmaraş Sütçü İmam University, Faculty of Medicine (Ethics committee date February 05, 2020/decision no: 12). A detailed informed consent form was collected from each patient who participated in the research.

Retrospective evaluations were performed on 777 hospitalized pneumothorax patients between October 2006 and March 2022. Outpatients, patients with insufficient information in hospital records, newborns, and infants were excluded from this study. As a result, 133 patients diagnosed with SSP were included in the study. Patients with SP with evidence of underlying lung disease or a significant smoking history over 50 years of age were considered SSP.[5-7] According to the WHO definitions, the age variable was categorized as being between 65 and older.[8] The Brinkman index, calculated as the number of cigarettes smoked per day multiplied by the number of years smoked, was used to determine the smoking status. For the analyses, smokers were grouped according to the median value of 600. The patient's physical performance status was determined using the Eastern Cooperative Oncology Group (ECOG) performance scale: 0 = Normal activity, 1 = Symptom present but nearly fully ambulatory, 2 = <50% of daytime in bed, 3 = More than 50% of daylight in bed, 4 = Unable to get out of bed.[9] Some analyses classified physical activity as no restriction (ECOG0-1) and limited (ECOG2-3-4).

Thoracic computed tomography was used for the diagnosis of pneumothorax. According to the British Thoracic Society Pleural Disease Guideline, a "small pneumothorax" was defined as the distance between the lung border and the chest wall at the hilus level <2 cm, and a "large pneumothorax" was defined as the distance above 2 cm.[5]

The underlying diseases were classified into four groups for analyses: (1) obstructive pulmonary diseases (chronic obstructive pulmonary diseases [COPD], emphysema, bronchiectasis, silicosis), (2) infectious diseases and tuberculosis, (3) malignant diseases, and (4) autoimmune diseases (rheumatoid arthritis, Behcet's disease, histiocytosis).

An air leak in the chest drainage system 48 h after chest tube insertion was defined as a persistent air leak (PAL).[10,11]

Indications of treatment methods are given in Figure 1. Conservative Treatment methods were preferred in clinically asymptomatic small pneumothorax. A chest tube was used as the initial treatment for large or symptomatic pneumothorax. Surgical indications include recurrent ipsilateral or contralateral pneumothorax, extensive bullous lung, PAL, massive spontaneous hemothorax, and expansion defect of the lung.[3,5] Video-assisted thoracoscopic surgery (VATS) was preferred as a surgical approach. VATS was performed via three ports. Mini-axillary thoracotomy (AT) was performed in patients with very large or multiple bullae, excessive adhesions, poor visualization of the operative field, and who could not tolerate one-lung ventilation. Mini-AT was performed using a muscle-sparing incision of approximately 4 cm from the 4th intercostal space, mid-axillary line, to the anterior axilla. Thoracotomy (T) was preferred in empyema, pleural thickening, or complicated cases. Bulla resection in single bullae, wedge resection of the bullous region in multiple bullae, and treatment for complications (decortication and empyema enucleation) were performed as surgical methods.

Patients who developed pneumothorax again after chest tube removal and the presence of lung expansion at control X-ray were considered as recurrence. Surgical treatment (AT, VATS, and T) was performed in case of recurrence in patients treated with conservative treatment or tube thoracostomy. Mechanical pleurodesis was performed on patients undergoing surgery both with VATS and mini-T to prevent recurrence. Apical pleurectomy was added to patients with a large bullous area or massive air leak, with a high probability of recurrence. Chemical pleurodesis was performed with talc or oxytetracycline through a chest tube in patients who were inoperable due to medical reasons or refused the surgical intervention. Chemical pleurodesis was performed with pleural local anesthesia using lidocaine or prilocaine solution.

The discharged patients were followed up for 2 or 3 months.

Statistical Analysis

Statistical analyses were performed using SPSS version 22.0 for Windows (SPSS, Inc.; Chicago, USA) software package. In descriptive statistics, numerical variables were presented as mean±standard deviation, median, and minimum-maximum values, while categorical variables were presented as number (n) and percentage (%). The Chi-square test or Fisher's exact test was used to compare categorical variables. The correlation of independent variables obtained by pairwise comparisons was evaluated by logistic regression analysis. "The enter method" was used for logistic regression analysis. The Hosmer–Lemeshow test was used for goodness of fit in logistic regression models. The level of statistical significance was accepted at $P<0.05$, with a confidence interval of 95%.

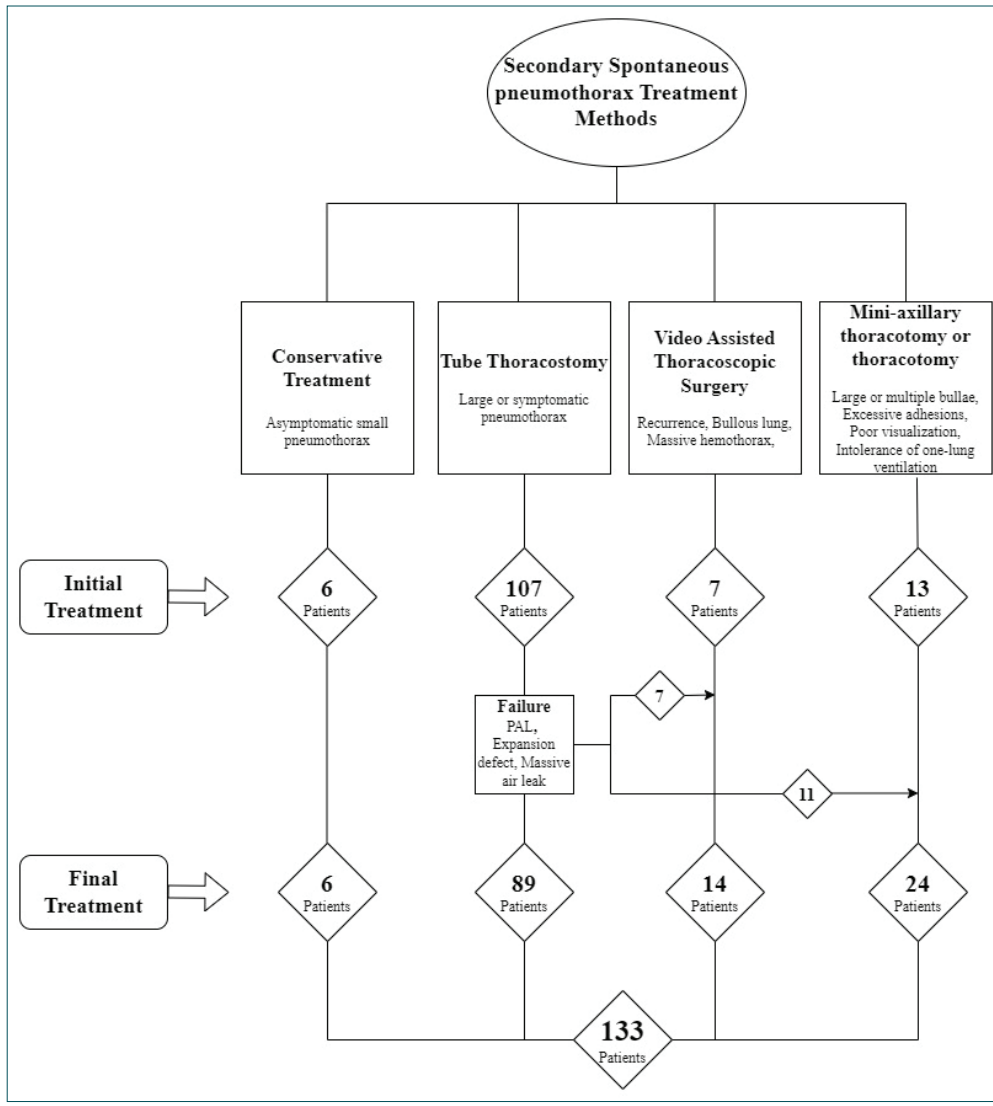

Figure 1. Secondary spontaneous pneumothorax treatment flowchart.

RESULTS

In the study, 133 patients were retrospectively analyzed. The mean age was 50.50±20.374 years, and the age range was between 16 and 95 years. The ratio of men to women was about 4 times higher. The right hemithorax involvement, left hemithorax involvement, and bilateral involvement were observed in 78 (58.7%), 47 (35.3%), and 8 (6.0%) episodes. Simultaneous bilateral pneumothorax was present in 3 (2.3%) patients. Ninety-three (69.9%) of the patients were smokers. According to the Brinkman index, the mean number of cigarettes smoked was 686.67±387.568, with a median of 600.

The most common clinical finding was dyspnea in 77 (57.9%) patients.

The most frequent underlying disease was COPD in 62 patients (46.6%). Other underlying diseases include infectious causes in 32 (24.0%) patients, tuberculosis in 14 patients (10.5%), malignant diseases in 11 (8.3%) patients, bronchiectasis in 4 (3.0%) patients, silicosis in 3 (2.3%) patients, rheumatoid arthritis in 3 (2.3%) patients, Behcet's disease in 2 (1.5%) patients, and histiocytosis in 2 (1.5%) patients. The smoking rate was higher in obstructive pulmonary diseases than in infectious diseases (P=0.013).

Occupational exposure or risk factor was present in 13 patients (9.7%). The most common occupational risk factor was denim grinding in 4 (3.0%) patients. The most common comorbidity was heart disease in 15 (11.3%) patients. Comorbidities were more common in females (P=0.029).

One hundred and nine patients (81.9%) were admitted to the emergency department.

The treatment methods performed on the patients and the flow chart are given in Figure 1. Surgical treatment was performed on 38 (28.6%) patients. As an operative procedure,

bulla resection or ligation was performed in 30 (78.9%) patients, bulla resection or ligation with pleural decortication in 2 (5.3%) patients, pleural decortication and empyema evacuation in 6 (15.8%) patients. Moreover, apical parietal pleurectomy was performed in 27 (71.0%) of the operated patients. Staples were used in 31 (81.5%) of 38 operated patients. There was no statistically significant difference in terms of postoperative recurrence and postoperative complications in patients with and without staples.

The relationship between independent variables and treatment methods is given in Table 1. In pairwise comparisons, AT/T was used more in large pneumothorax than other treatment methods. Tube thoracostomy was performed more frequently than AT/T in patients with high ECOG scores and comorbidities. On the other hand, AT/T was performed more frequently than tube thoracostomy in smokers. AT/T in obstructive lung diseases and tube thoracostomy in infectious diseases were performed more frequently. Table 2 includes

Table 1. Factors associated with treatment modalities

Variables	Treatment methods				Total	Chi-square	P-value*
	Medical	Chest tube	VATS†	AT[a]/T[b]			
	n (%)	n (%)	n (%)	n (%)	n		
Age							
Under 65 years	4 (4.3)	60 (63.8)	10 (10.6)	20 (21.3)	94	2.362	0.501
65 years and older	2 (5.1)	29 (74.3)	4 (10.3)	4 (10.3)	39		
Gender							
Male	6 (5.7)	69 (65.1)	10 (9.4)	21 (19.8)	106	3.282	0.350
Female	0 (0.0)	20 (74.1)	4 (14.8)	3 (11.1)	27		
Smoking							
(-)	1 (2.5)	34 (85.0)	3 (7.5)	2 (5.0)	40	7.768	0.005
(+)	5 (5.4)	55 (59.1)	11 (11.8)	22 (23.7)	93		
ECOG‡							
0-1	3 (3.8)	46 (59.0)	10 (12.8)	19 (24.4)	78	5.843	0.016
2-3-4	3 (5.4)	43 (78.2)	4 (7.3)	5 (9.1)	55		
Seasons							
Spring- Summer	4 (6.3)	36 (56.2)	9 (14.1)	15 (23.4)	64	6.378	0.095
Autumn - Winter	2 (2.9)	53 (76.8)	5 (7.3)	9 (13.0)	69		
Pneumothorax size							
Under 2 cm	5 (9.3)	39 (72.2)	7 (13.0)	3 (5.5)	54	13.297	0.004
2 cm and above	1 (1.2)	50 (63.3)	7 (8.9)	21 (26.6)	79		
Underlying disease							
Obstructive pulmonary diseases	4 (5.8)	37 (53.6)	10 (14.5)	18 (26.1)	62	4.350	0.037
Infectious diseases	1 (2.2)	36 (78.3)	3 (6.5)	6 (13.0)	46		
Malignant diseases	1 (9.1)	10 (90.9)	0 (0.0)	0 (0.0)	11		
Autoimmune disease	0 (0.0)	6 (85.7)	1 (14.3)	0 (0.0)	7		
Comorbidity							
(-)	4 (4.4)	54 (58.7)	12 (13.0)	22 (23.9)	92	8.245	0.004
(+)	2 (4.9)	35 (85.3)	2 (4.9)	2 (4.9)	41		
Total	6 (4.5)	89 (66.9)	14 (10.5)	24 (18.1)	133		

*Calculated by the Chi-square test or the Fisher exact test; †Video-assisted thoracic surgery; [a]Axillary mini thoracotomy; [b]Thoracotomy; ‡Eastern Cooperative Oncology Group.

Table 2. Evaluation of independent variables related to surgical treatment methods by logistic regression analysis

	B	Wald	P-value	OR*	95% C.I.†for OR	
					Min	Max
Age groups						
65 years and older (ref.=Under 65 years)	0.271	0.185	0.667	1.311	0.382	4.502
Gender						
Male (ref.=female)	-1.785	3.773	0.052	0.168	0.028	1.016
ECOG‡score						
2-3-4 (ref.=0-1	0.014	0.000	0.983	1.014	0.276	3.727
Smoking						
+ (ref.=(-))	1.984	5.010	0.025	7.270	1.280	41.297
Seasons						
Spring-Summer (ref=Autumn -Winter)	1.096	5.345	0. 021	2.994	1.182	7.584
Pneumothorax size						
2 cm and above (ref=2 cm and above)	1.010	4.033	0.045	2.746	1.025	7.362
Underlying disease		2.747	0.432			
Obstructive pulmonary diseases (ref=autoimmune diseases)	2.263	2.388	0.122	9.613	0.545	169.605
Infectious diseases (ref=autoimmune diseases)	1.813	1.488	0.223	6.131	0.333	112.976
Malignant diseases (ref=autoimmune diseases)	−18.347	0.000	0.999	0.000	0.000	
Comorbidities						
+ (ref.=(-))	−1.427	4.527	0.033	0.240	0.064	0.894
Constant	−3.827	6.371	0.012	0.022		

Hosmer-Lemeshow P=0.895; r^2=0.374; *Odds Ratio; †Confidence interval; ‡Eastern Cooperative Oncology Group.

the evaluation of relationships of independent variables with the surgical treatment methods using logistic regression analysis. According to logistic regression analysis, surgical treatment modalities were associated with spring-summer seasons, smoking, low comorbidity, and large pneumothorax.

Chemical pleurodesis was performed in 10 patients (7.5%). Among the, Talc and oxytetracycline was used in 6 (4.5%) and 4 (3.0%) patients, respectively.

When the treatment methods were compared in terms of the length of stay in the hospital, the duration of hospital stay was longer in those who underwent mini-AT/T compared to those who underwent conservative treatment (χ^2=20.625, P<0.001) or chest tube (χ^2=22.547, P<0.001). Likewise, patients who underwent VATS had a higher length of hospital stay than those who received conservative treatment (χ^2=12.857, P=0.001) or tube thoracostomy (χ^2=11.631, P=0.001). There was no significant relationship between the AT/T group and VATS in terms of length of hospital stay.

One or more complications were observed in 55 patients (41.4%). The most common complication was PAL in 18 (13.5%) patients. Other complications include recurrence in 12 (9.0%) patients, hydropneumothorax in 7 (5.3%) patients, tension pneumothorax in 3 (2.3%) patients, simultaneous bilateral pneumothorax in 3 (2.3%) patients, hemopneumothorax in 3 (2.3%) patients, expansion deficiency in 3 (2.3%) patients, subcutaneous emphysema in 2 (1.5%) patients, arrhythmia in 2 (1.5%) patients, incision infection in 1 (0.7%) patient, and pneumonia in 1 (0.7%) patient. Table 3 shows the relationship between the complications and independent variables. Poor ECOG score, large pneumothorax, and exposure to occupational risk factors were associated with the occurrence of a complication. In addition, the complication rate in the infectious diseases was higher than in obstructive pulmonary diseases. There was no significant relationship between the treatment methods in terms of complication.

The rate of patients with PAL in the AT/T group was higher than those who received chest tube treatment (χ^2=5.646, P=0.041). There was no significant relationship between the AT/T group and VATS in terms of PAL.

Postoperative complications have developed in 2 (1.5%) patients including incision site infection in one (0.7%) patient

Table 3. Factors associated with complications

Variables	Complications		Total	χ2*	P-value*
	(-) N (%)	(+) N (%)	n		
Age					
Under 65 years	58 (61.7)	36 (38.3)	94	1.234	0.267
65 years and older	20 (51.3)	19 (48.7)	39		
Gender					
Male	65 (70.8)	41 (29.2)	106	1.540	0.215
Female	13 (48.1)	14 (51.9)	27		
Smoking					
(-)	22 (55.0)	18 (45.0)	40	1.094	0.579
600 and below	31 (64.6)	17 (35.4)	48		
Over 600	25 (55.6)	20 (44.4)	45		
ECOG† score					
0-1	53 (67.9)	25 (32.1)	78	6.730	0.009
2-3-4	25 (45.5)	30 (54.5)	55		
Seasons					
Spring- Summer	40 (62.5)	24 (37.5)	64	0.755	0.385
Autumn - Winter	38 (55.1)	31 (45.9)	69		
Pneumothorax size					
Under 2 cm	40 (74.1)	14 (25.9)	54	8.922	0.003
2 cm and above	38 (48.1)	41 (51.9)	79		
Underlying disease					
Obstructive pulmonary diseases	47 (68.1)	22 (31.9)	69	4.734	0.030
Infectious diseases	22 (47.8)	24 (52.2)	46		
Malignant diseases	6 (54.5)	5 (45.5)	11		
Autoimmune diseases	3 (58.6)	4 (41.4)	7		
Comorbidity					
(-)	57 (62.0)	35 (38.0)	92	1.348	0.246
(+)	21 (51.2)	20 (48.8)	41		
Occupational risk					
(-)	74 (61.7)	46 (38.3)	120	4.617	0.032
(+)	4 (30.8)	9 (69.2)	13		
Treatment methods					
Conservative treatment	4 (66.7)	2 (33.3)	6	1.113	0.774
Tube thoracostomy	53 (59.6)	36 (40.4)	89		
VATS**	9 (64.3)	5 (35.7)	14		
AT[a]/T[b]	12 (50.0)	12 (50.0)	24		
Total	78 (58.6)	55 (41.4)	133		

*Calculated by the Chi-square test or the Fisher exact test; †Eastern Cooperative Oncology Group; **Video-assisted thoracoscopic surgery; [a]Axillary mini thoracotomy; [b]Thoracotomy.

who underwent AT/T, and recurrence in one (0.7%) patient who underwent VATS.

Twelve (9.0%) patients who received their first treatment in our clinic were admitted with recurrence. Of these, two (1.5%) patients developed recurrence without being discharged from our clinic, and the other 10 (7.5%) patients were admitted to our clinic with recurrence after discharge. In both pairwise comparisons and logistic regression analysis, there was no significant difference in terms of recurrence between independent variables (Table 4).

Four (3%) patients died. The characteristics of the patients who died are shown in Table 5. Mortality was higher in patients with poor ECOG performance (P=0.027), comorbidities (P=0.008), and patients with complications (P=0.027).

The mean hospital stay was 11.23±7.83 days, ranging from 1 to 59 days, with a median of 10 days. The mean drainage time was 9.49±6.09 days. Patients with large pneumothorax (P<0.001) and complications (P=0.027) had an increased length of hospital stay.

Table 4. Evaluation of possible independent variables related to recurrence with logistic regression analysis

	B	Wald	P-value	OR*	95% C.I.†for OR	
					Min	Max
Age groups						
65 years and older (ref.= Under 65 years)	−0.422	0.183	0.669	0.656	0.095	4.543
Gender						
Male (ref.=female)	−1.053	0.921	0.337	0.349	0.041	2.998
ECOG‡score						
2-3-4(ref.=0-1)	0.878	0.785	0.376	2.407	0.345	16.810
Smoking						
+ (ref.= (-))	1.119	0.931	0.335	3.062	0.315	29.717
Seasons						
Spring-Summer (ref.=Autumn -Winter)	−0.013	0.000	0. 987	0.987	0.194	5.013
Pneumothorax size						
2 cm and above (ref=2 cm and above)	−0.018	0.000	0.983	0.982	0.184	5.248
Underlying disease		1.978	0.577			
Obstructive pulmonary diseases (ref.=autoimmune diseases)	−1.246	0.959	0.327	0.288	0.024	3.483
Infectious diseases (ref.=autoimmune diseases)	−0.217	0.032	0.858	0.805	0.075	8.632
Malignant diseases (ref.=autoimmune diseases)	−20.060	0.000	0.999	0.000	0.000	
Comorbidities						
+ (ref.= (-))	−2.164	3.145	0.076	0.115	0.011	1.256
Treatment methods		0.915	0.822			
Tube thoracostomy (ref.=conservative treatment)	-0.792	0.286	0.593	0.453	0.025	8.268
VATS** (ref.=conservative treatment)	−1.927	0.911	0.340	0.146	0.003	7.618
AT[a]/T[b] (ref.=conservative treatment)	−20.894	0.000	0.998	0.000	0.000	
Pleurodsis						
+ (ref.= (-))	−0.153	0.012	0.913	0.858	0.055	13.448
Occupational risk factors						
+ (ref.= (-))	1.221	0.938	0.333	3.391	0.286	40.137
Constant	−5.993	2.288	0.009	0.02		

Hosmer-Lemeshow P=0.858; r^2=0.318; *Odds ratio; †Confidence interval; ‡Eastern Cooperative Oncology Group; **Video-assisted thoracoscopic surgery; [a]Axillary mini thoracotomy; [b]Thoracotomy.

Table 5. Characteristics of deceased patients

Patient	1.	2.	3.	4.
Age	68	77	80	20
Gender	Male	Female	Male	Male
Underlying disease	Pneumonia	Asthma	COPD‡	Pneumonia
Comorbidity	Ischemic heart disease	Congestive heart failure, diabetes mellitus	Atherosclerotic cardiovascular disease	Cerebral palsy
Length of stay in hospital	28 days	4 days	1 day	5 days
Treatment method	Empyema enucleation+pleural decortication	Chest tube	Chest tube	Chest tube
Complication	Arrhythmia, empyema	Hydropneumothorax	Hydropneumothorax	-
ECOG† score	3	4	4	4
Cause of death	Arrhythmia	Heart failure, respiratory failure	Cardiac	Pneumonia

‡Chronic obstructive pulmonary disease; ECOG† score.

DISCUSSION

The clinical features of SSP may also vary between populations. COPD is the most common lung disease that causes SSP.[12] In patients with emphysema, airway inflammation or coughing increases alveolar pressure and tears the alveoli, and the air reaches the intrapleural space through a defect in the pleura.[13,14]

The mean age for SSP ranges from 46 to 70 years.[12,15] There is a male predominance for SSP in the literature, and the rate of males ranges from 61% to 91%.[4,16] Ratio of mean age and gender in our study is consistent with the literature. Previous studies have shown the relationship between SP and smoking.[17] Smoking increases the number of neutrophils and macrophages, which causes the breakdown of elastic fibers in the lung.[13] In addition, the treatment of pneumothorax in smokers is more challenging, and the need for surgical treatment is higher. The most common symptom in the patients in our series was dyspnea. With an already reduced pulmonary function, the development of SSP increases symptoms and puts these patients at risk.[2]

Patients with SSP should be hospitalized because of high morbidity and mortality. The goals of treating pneumothorax are to re-expand the lung, minimize morbidity, prevent recurrence, relieve symptoms, and treat the underlying disease. Although there is a consensus on more aggressive treatment of SSP, there are differences in clinical practice.[10,13,14] Treatment options range from simple observation to surgical intervention.[15] Oxygen increases the gas absorption rate from the pleural space up to 4 times.[14] Therefore, oxygen therapy is recommended in SSP patients, but care should be taken regarding carbon dioxide retention.[3,18] We treated oxygen-supported conservative treatment in 4.5% of our patients. Although the complication rate of needle aspiration is low in SSP, many authors do not recommend it due to its low efficiency and high recurrence rate.[5,10] Needle aspiration was not used in any of our patients. Although small-bore catheters (≤14 French) have advantages such as ease of application and patient comfort, tube thoracostomy may be performed in unstable patients, in a complicated pneumothorax, or case of failure of small-diameter catheters.[19] We performed chest tube and underwater drainage in 80.4% of the patients, with 83.1% treatment success. Underwater drainage tube thoracostomy is the most appropriate initial treatment for moderate to large pneumothorax patients.

Erez et al. argued that the presence of SSP, large pneumothorax, and previous pneumothorax influences the invasive treatment procedure.[15] Similarly, in our study, COPD with emphysema and large pneumothorax were the most relevant factors for surgical treatment. The more fragile emphysematous lung and the irregularity of the visceral pleural surface cause persistent air leakage. On the other hand, it is thought that the re-expansion of the lung that has lost its elasticity is more complicated. In addition, more surgical treatment was performed in patients with large pneumothorax sizes. In contrast, patients with comorbid factors and poor physical performance received less surgical treatment. These patients were older, and surgery was considered highly risky due to comorbidities, poor physical performance, and advanced age. Therefore, less invasive treatments were preferred in these patients.

It is still controversial whether open T or VATS is the optimal access to the thorax for the surgical treatment of SSP.

While open T has the lowest recurrence rate, the obvious advantages of VATS are shorter hospital stays and superior esthetic results. Open T and VATS have a recurrence rate of 1% and 5%, respectively.[20,21] VATS procedures have a higher recurrence rate due to the increased likelihood of bleb misses and reduced mechanical pleurodesis effects.[18] Using muscle-sparing techniques, reducing the incision, and causing the least amount of damage to the ribcage, the mini AT procedure produces less intrusive outcomes that are comparable to VATS with a low recurrence rate.[20] There was no significant difference between VATS and mini-AT in our series in terms of complications, admission to the intensive care unit, and length of stay at the hospital.

Complication rates differ according to the inclusion criteria. The complications listed in the literature include PAL, recurrence, tension pneumothorax, subcutaneous emphysema, hemopneumothorax, simultaneous bilateral pneumothorax, incision site infection, pneumonia, empyema, hydropneumothorax, and expansion defects.[2,22] In our study, all of these clinical conditions were considered complications, and the overall complication rate of SSP was reported as 41.4%. In our study, complications were more common in pneumothorax due to infectious diseases. Patients, who were admitted to the hospital with infectious diseases, were already complicated. Therefore, complications such as hydropneumothorax and empyema were more common in this group of patients.

Postoperative complications have developed in 2 (1.5%) patients. The rate of postoperative complication ranges from 0% to 37.5% in the literature.[16,22] Our rates are also within these limits. Isaka et al. claimed that the closure of the bulla using staples would reduce morbidity.[22] In our study, postoperative recurrence was not observed in patients using staples, but incision infection was observed in one patient as a postoperative complication. However, statistical analyzes did not reveal a significant difference in morbidity between patients with and without staples. The reason for this was thought to be the low postoperative complication and recurrence rates.

The literature shows that the rate of recurrence ranges from 16% to 52% after the first episode.[23] In our series, 12 episodes (9.0%) of the hospitalized patients in our clinic were admitted with recurrence. In recent years, recurrence rates have decreased in patients treated with AT and VATS. Similarly, postoperative recurrence rates are low in our results. According to previous studies, the lowest rate of recurrence was observed in the "wedge resection and pleurodesis" groups.[20] In our analysis, there was no difference in terms of recurrence between the treatment methods. The reason for this was thought to be the low number of patients with recurrence. In individuals who are not candidates for surgical therapy, chemical pleurodesis may be attempted as an alternative to avoid recurrence. Inflammation of the pleural leaves caused by irritants results in pleural leaf adherence and pleural chamber obliteration. The most commonly used agents for this purpose are tetracycline and talc.[18,19] We also used both agents and did not experience any complications.

SSP-related mortality has been documented at rate as high as 18% in the literature.[16] The rate of mortality in our patient group was 3.0%. Isaka et al. reported three risk factors for higher postoperative mortality: patient age, poor ECOG performance, and preoperative pneumonia.[22] Our risk factors were consistent with Isaka's report.

Hospitalization times were longer in the AT/T and VATS groups compared to the tube/conservative group. The cause of this is that surgical techniques such as VATS or AT/T are used after tube thoracostomy or conventional therapy has failed. Waiting for the result of a tube thoracostomy or conservative treatment causes prolonged hospital stays.

Limitations

Limitations of this study are the possibility of data loss as it was retrospective and only included hospitalized patients. In addition, it may have been affected by the changes in treatment trends during the period of the study and the device facilities in the institutions where the study was conducted.

CONCLUSION

Significant factors associated with the need for surgical treatment were large pneumothorax, smoking, and obstructive pulmonary diseases. On the other hand, factors related to complications include large pneumothorax, poor ECOG performance, infectious diseases, and exposure to occupational and risky substances. Poor ECOG performance, comorbidity, and occurrence of a complication were associated with mortality. The most appropriate treatment modality for small pneumothorax is conservative treatment, and for large and symptomatic pneumothorax is a chest tube as initial therapy. In addition to VATS, axillary mini-T or T is a good option with similar outputs.

Ethics Committee Approval: This study was approved by the Kahramanmaraş Sütçü İmam University, School of Medicine Research Ethics Committee (Date: 05.02.2020, Decision No: 12).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Sekonder spontan pnömotoraksın morbidite, mortalite ve cerrahi tedavisi

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AMAÇ: Sekonder spontan pnömotoraks, altta yatan akciğer hastalığı olan kişilerde gelişen pnömotoraksı tanımlamak için kullanılan terimdir. Önemli morbidite, yüksek sağlık harcamaları ve ölüm olasılığı ile dünya çapında önemli bir sağlık sorunudur. Bu çalışma, sekonder spontan pnömotoraksın epidemiyolojik özelliklerini, mortalite ve morbidite ile ilişkili risk faktörlerini ve tedavi seçeneklerini değerlendirmeyi amaçlamaktadır.

GEREÇ VE YÖNTEM: Sekonder spontan pnömotorakslı 133 hastanın tedavi yöntemleri, morbidite ve mortalite sonuçları ve ilişkili faktörler geriye dönük olarak değerlendirildi. Altta yatan akciğer hastalığı kanıtı bulunan veya 50 yaşın üzerinde sigara içme öyküsü olan spontan pnömotorakslı hastalar sekonder spontan pnömotoraks olarak kabul edildi. Sigara içme durumu için Brinkman indeksi ve fiziksel performans durumu için Eastern Cooperative Oncology Group performans ölçeği kullanıldı. Konservatif tedavi, göğüs tüpü, video yardımlı torakoskopik cerrahi ve torakotomi uygulanan tedavi yöntemleriydi.

BULGULAR: Ortalama yaş 50.50±20.374, yaş aralığı 16-95 idi. Hastaların 93'ü (%69.9) sigara kullanmaktaydı. En sık klinik bulgu 77 (%57.9) hastada dispne idi. En sık altta yatan hastalık 62 hastada (%46.6) kronik obstrüktif akciğer hastalığı idi. Altı (%4.5) hastaya konservatif tedavi uygulandı, 89 (%66.9) hastaya göğüs tüpü takıldı ve 38 (%28.6) hastaya cerrahi tedavi uygulandı. Operatif girişim olarak 24 (%18) hastaya akciğer kama rezeksiyonu, 6 (%4.5) hastaya bül rezeksiyonu uygulandı. Hastaların 27'sine (%20.3) parietal plörektomi uygulandı. Aksiller mini-torakotomi veya torakotomi, büyük pnömotorakslarda, sigara içenlerde ve obstrüktif akciğer hastalığında daha sık uygulandı. Tüp torakostomi, zayıf fiziksel performans, komorbiditeler ve enfeksiyöz hastalıklarda daha sık kullanıldı. Hastaların 55'inde (%41.4) bir veya daha fazla komplikasyon görüldü. En sık görülen komplikasyon 18 (%13.5) hastada inatçı hava kaçağıydı. Komplikasyonlar, büyük pnömotoraks (p=0.003), zayıf fiziksel performans (p=0.009), enfeksiyöz hastalıklar (p=0.030) ve mesleki risk faktörleri (p=0.032) ile ilişkiliydi. Hastaların 12'sinde (%9) nüks gelişti. Ameliyat sonrası 1 hastada nüks görüldü. Dört (%3) hasta hayatını kaybetti. Fiziksel performansı kötü olan hastalarda (p=0.027), ek hastalığı olanlarda (p=0.008) ve komplikasyon gelişen hastalarda (p=0.027) mortalite daha yüksekti. Hastanede kalış süresi mini aksiller torakotomi/torakotomi (p<0.001) ve VATS (p<0.001) gruplarında yüksekti. Hastanede kalış süresi açısından mini aksiller torakotomi/torakotomi ile VATS arasında anlamlı bir fark yoktu.

TARTIŞMA: Büyük pnömotoraks, zayıf fiziksel performans ve komorbidite morbidite ve mortalite ile ilişkilidir. Küçük pnömotoraks için konservatif tedavi, büyük pnömotoraks için göğüs tüpü en uygun başlangıç tedavisidir. VATS veya mini-aksiller torakotomi yolu ile büllöz bölgenin rezeksiyonu en uygun cerrahi tekniktir.

Anahtar sözcükler: Spontan pnömotoraks; risk faktörleri; torakotomi; video-yardımlı torakoskopik cerrahi; göğüs tüpleri.

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