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Original Contribution

Secondary spontaneous pneumothorax: which associated condition is benefit for pigtail catheter treatment?☆

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Abstract

Objective: The study aimed to assess the clinical efficacy of pigtail catheter drainage for patients with a first episode of secondary spontaneous pneumothorax (SSP) and different associated conditions.

Methods: We retrospectively reviewed the records of patients with SSP who received pigtail catheter drainage as their initial management between July 2002 and October 2009. A total of 168 patients were included in the analysis; 144 (86%) males and 24 (14%) females with a mean age of 60.3 ± 18.3 years (range, 17-91 years). Data regarding demographic characteristics, pneumothorax size, complications, treatments, length of hospital stay, and associated conditions were analyzed.

Results: In total, 118 (70%) patients were successfully treated with pigtail catheter drainage, and 50 (30%) patients required further management. Chronic obstructive lung disease was the most common underlying disease (57% of cases). Secondary spontaneous pneumothorax associated with infectious diseases had a higher rate of treatment failure than SSP associated with obstructive lung conditions (19/38 [50%] successful vs 78/104 [75%] successful, $P = .004$) and malignancy (19/38 [50%] successful vs 13/16 [81%] successful, $P = .021$). Moreover, patients with SSP associated with infectious diseases had a longer length of hospital stay than those with obstructive lung conditions (23.8 vs 14.5 days, $P = .003$) and malignancy (23.8 vs 12.1 days, $P = .017$). No complications were associated with pigtail catheter drainage.

Conclusions: A higher rate of treatment failure was noted in SSP patients with infectious diseases; thus, pigtail catheter drainage is appropriate as an initial management for patients with SSPs associated with obstructive lung conditions and malignancy.

1. Introduction

Spontaneous pneumothoraces, in contrast to iatrogenic or traumatic pneumothoraces, can be divided into primary and secondary. Primary spontaneous pneumothorax (PSP) arises

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in healthy individuals without any lung disease; however, secondary spontaneous pneumothorax (SSP) often occurs in patients with an underlying lung disease such as pulmonary emphysema, pneumonia, malignancy, bronchial asthma, pulmonary fibrosis, and cystic fibrosis. Treatment recommendations for the first episode of PSP included simple observation, oxygen supplementation, and aspiration and chest tube drainage depending on the severity of pneumothorax [1,2]. The British Thoracic Society published guidelines recommending that observation alone or simple aspiration is sufficient for the initial treatment of minimal, asymptomatic SSP, and intercostal tube drainage should be the initial treatment for large pneumothoraces [3].

Previously, we reported our experience in treating SSPs using pigtail tube drainage and the results were promising [4,5]. However, it is still not known whether pigtail catheter treatment is particularly beneficial for patients with SSPs and specific associated conditions. In this study, we report our experience and results using the pigtail catheter drainage in the treatment of SSPs and various associated conditions.

2. Materials and methods

2.1. Patients

We retrospectively collected and reviewed the data of patients with a first episode of SSP treated at the China Medical University Hospital from July 2002 to October 2009. The study was approved by the internal review board of the hospital (DMR96-IRB-122), and the requirement for informed consent was waived. The study population was determined by reviewing the charts of patients who were discharged with the diagnosis of SSP; patients with a diagnosis of primary spontaneous, traumatic, and iatrogenic pneumothoraces were excluded. Only symptomatic patients with a confirmed diagnosis, adequate follow-up chest radiograph, and initial treatment with a pigtail catheter were included in the final study population.

A total of 1426 patients were diagnosed as having pneumothoraces; and of those, 342 patients had a diagnosis of SSP. Of those with SSP, 147 were excluded because of the following reasons: age less than 16 years (n = 17), observation only (n = 13), underwent large-bore chest tube drainage (n = 49), mechanical ventilation–associated barotrauma (n = 79), incomplete follow-up (n = 5), and pyopneumothorax (n = 11). Thus, 168 patients were included in the analysis; 144 (86%) males and 24 (14%) females with a mean age of 60.3 ± 18.3 years (range, 17-91 years). Of these patients with SSP, 101 (60.1%) received pigtail catheter drainage at the emergency department (ED) by the decision of ED physicians and 67 (39.9%) patients received pigtail catheter drainage at the general ward by the decision of a pulmonologist.

2.2. Pigtail catheter drainage

The choice of treating SSP patients with observation, pigtail catheter insertion, or large-bore chest tube drainage was determined by the treating physician and based on their clinical assessment. In patients undergoing pigtail catheter drainage, a chest ultrasound examination was performed first for guidance. Then, after local anesthesia, the pigtail catheter (10-16 F) was inserted into the superior part of the fourth to sixth intercostal space at the middle axillary line using a trocar system. For drainage, the patients were usually positioned sitting [6], and after drainage the catheter was connected to a one-way (Heimlich) valve drainage bag. Air, and sometimes a small amount of pleural effusion, was released from the bag when full, and chest radiographs were performed immediately after the procedure, at 24 and 48 hours after, and then as necessary. Once there was no longer air drainage and the lung had reached full expansion, as revealed by chest radiograph, the pigtail was removed. Patients were discharged when no clinical symptoms were present and/or no air was noted in the pleural space on chest radiograph.

2.3. Data collection

The clinical data collected included sex, age, initial symptoms, vital signs recorded just before tube insertion, the size of the pneumothorax based on chest radiograph (with Light index) [7], the involved side, underlying diseases, follow-up pneumothorax size, length of hospital stay, length of time catheter was in place, recurrent episodes, complications, and reasons for changing treatment.

2.4. Statistical analysis

Demographic and descriptive data are presented as mean ± SD and compared with the 2-tailed Student t test. Categorical variables were compared using χ^2 or Fisher exact test, when appropriate. All analyses were performed with SPSS statistical software for Windows (SPSS Inc, Chicago, Ill). A P value of <.05 was considered to indicate statistical significance.

3. Results

Associated conditions of the 168 patients were chronic obstructive pulmonary disease (COPD, n = 96), acute bacterial pneumonia (n = 19), malignancy (n = 16), pulmonary tuberculosis (TB, n = 11), bronchial asthma (n = 8), *Pneumocystis jerovici* pneumonia (n = 6), Marfan syndrome (n = 4), fungal pneumonia (n = 2), catamenial pneumothorax (n = 2), lymphangioleiomyomatosis (n = 2), pulmonary fibrosis (n = 1), and pneumoconiosis (n = 1)

Table 1 Associated conditions among 168 patients with SSP

Etiology	Number	Percentage
Obstructive lung disease	104	61.9
COPD	96	
Asthma	8	
Infection	38	22.6
P. jerovici pneumonia	6	
Fungal pneumonia	2	
TB	11	
Acute bacterial pneumonia	19	
Malignancy	16	9.5
Primary lung carcinoma	11	
Pulmonary metastasis	5	
Interstitial lung disease	4	2.4
Idiopathic pulmonary fibrosis	1	
Lymphangioleiomyomatosis	2	
Pneumoconiosis	1	
Connective tissue disease	4	2.4
Marfan syndrome	4	
Other	2	1.2
Catamenial pneumothorax	2	

(Table 1). The causative pathogen was identified in 10 of the 19 patients with acute bacterial pneumonia: *Staphylococcus aureus* (n = 4), *Klebsiella pneumoniae* (n = 2), *Pseudomonas aeruginosa* (n = 2), *Streptococcus pneumoniae* (n = 1), and *Nocardia* spp (n = 1). As in Table 1, COPD was the most common condition associated with SSP and seen in 57% of the cases. Because of the small sample size, we consolidated the associated conditions into 4 groups for further analysis: obstructive lung disease (n = 104, 62%), infectious disease (n = 38, 23%), malignancy (n = 16, 9%), and other conditions (n = 10, 6%).

Table 2 presents the demographic characteristics of the patients with the 4 groups of associated conditions. There were no differences in sex, body height, body weight, and initial symptoms between different groups of associated conditions. However, patients with SSP associated with obstructive lung conditions had more advanced age than those with infectious diseases ($P = .009$) and other conditions ($P < .001$), and a greater number of smokers than those with infectious diseases ($P = .005$), malignancy ($P = .004$), and other conditions ($P < .001$). Patients with SSP and infectious diseases had lower systolic and diastolic pressure than those with obstructive lung conditions ($P = .001$ and $P = .022$, respectively); greater pulse rate than those with obstructive lung conditions ($P = .002$), malignancy ($P < .001$), and other conditions ($P < .001$); and a greater respiratory rate than those with obstructive lung conditions ($P = .008$) and malignancy ($P = .015$).

The outcomes of patients with the 4 groups of associated conditions are summarized in Table 3. There were no differences in size and side of SSP, size of pigtail catheter inserted, and days of catheterization between the 4 groups. However, SSP associated with infectious conditions had higher rate of treatment failure than seen with obstructive lung conditions (19/38 [50%] successful vs 78/104 [75%] successful, $P = 0.004$) and malignancy (19/38 [50%] successful vs 13/16 [81%] successful, $P = .021$). Moreover, patients with SSP associated with infectious conditions had a longer length of hospital stay than those with obstructive lung conditions (23.8 ± 23.5 vs 14.5 ± 14.6 days, $P = .003$),

Table 2 Demographic characteristics of SSP patients with different associated conditions treated with pigtail catheters

	All patients	Associated condition			
		Obstructive lung conditions	Infection	Malignancy	Others
Number	168	104	38	16	10
Age	60.3 ± 18.3	64.6 ± 16.3	56.0 ± 18.5	58.1 ± 15.5	36.1 ± 20.5
Sex					
Male	144 (85.7)	94 (90.4)	34 (89.5)	11 (68.8)	5 (50.0)
Female	24 (14.3)	10 (9.6)	4 (10.5)	5 (31.2)	5 (50.0)
Body height (cm)	165.3 ± 7.7	165.0 ± 7.7	166.3 ± 6.6	163.1 ± 6.8	168.0 ± 12.4
Body weight (kg)	55.2 ± 10.3	55.8 ± 10.8	53.5 ± 10.5	56.5 ± 7.7	53.1 ± 7.3
Smoking	133 (79.2)	96 (92.3)	25 (65.8)	9 (56.3)	3 (30.0)
Major symptoms					
Chest pain	48 (28.6)	32 (30.8)	5 (13.2)	5 (31.3)	6 (60.0)
Dyspnea	109 (64.9)	68 (65.4)	28 (73.7)	9 (56.3)	4 (40.0)
Vital sign					
Systolic blood pressure (mm Hg)	129 ± 26	134 ± 24	118 ± 30	125 ± 26	134 ± 18
Diastolic blood pressure (mm Hg)	76 ± 14	77 ± 13	71 ± 14	74 ± 22	80 ± 13
Pulse rate (/min)	92 ± 21	89 ± 18	106 ± 28	88 ± 13	81 ± 11
Respiratory rate (/min)	22 ± 4	21 ± 4	24 ± 5	21 ± 1	22 ± 2
Body temperature (°C)	36 ± 0.7	36 ± 0.6	37 ± 0.9	37 ± 0.6	36 ± 0.4

Data presented as mean ± SD or number (percentage).

Table 3 Comparison of outcomes in SSP patients with different associated conditions treated with pigtail catheters

	All patients	Associated condition			
		Obstructive lung conditions	Infection	Malignancy	Others
Number					
Size of pneumothorax (%)	168	104	38	16	10
Side of pneumothorax	55.2 ± 20.9	56.5 ± 21.9	53.8 ± 19.7	49.5 ± 15.0	58.8 ± 23.3
Right	109 (64.9)	71 (68.3)	22 (57.9)	9 (56.3)	7 (70.0)
Left	59 (35.1)	33 (31.7)	16 (42.1)	7 (43.7)	3 (30.0)
Successful treatment	118 (70.2)	78 (75.0)	19 (50.0)	13 (81.3)	8 (80)
Size of pig tail (F)	12.4 ± 1.2	12.3 ± 1.0	12.8 ± 1.6	12.3 ± 0.6	12 ± 0.0
Length of drainage (d)	6.9 ± 4.3	7.1 ± 4.5	6.7 ± 4.0	6.7 ± 4.1	5.0 ± 3.7
Length of hospital stay (d)	16.0 ± 16.8	14.5 ± 14.6	23.8 ± 23.5	12.1 ± 6.1	7.1 ± 5.6

malignancy (23.8 ± 23.5 vs 12.1 ± 6.1 days, $P = .017$), and other conditions (23.8 ± 23.5 vs 7.1 ± 5.6 days, $P = .004$).

Of the 168 patients, 118 (70%) were successfully treated with pigtail catheter drainage, and the remaining 50 (30%) patients required further management (Fig. 1). Of the patients with SSP associated with obstructive lung conditions, 26 required further treatment; 17 received large-bore chest tube drainage and 9 underwent video-assisted thoracoscopic surgery (VATS) with pleurodesis. Large-bore chest tube drainage was successful in 11 of the 17 patients, and the remaining 6 subsequently underwent surgical treatment (VATS). Video-assisted thoracoscopic surgery was successful in all 15 patients who underwent the procedure. Of the patients with SSP associated with infectious conditions, 19 required further treatments; 14 received large-bore chest tube drainage and 5 patients underwent VATS. Large-bore chest tube drainage was successful 10 of the 14 patients receiving large-bore chest tube drainage and the remaining 4 underwent VATS. Video-assisted thoracoscopic surgery was performed successfully in 9 patients; however, 1 patient died of complications from his underlying disease. Of the patients with SSP associated with malignancy, 3 required further treatment; 2 patients received large-bore chest tube drainage and one patient underwent VATS. Large-bore chest tube drainage was successful in 1 patient and the other subsequently underwent VATS. Of the patients with SSP associated with other conditions, 2 patients required further treatment; 1 patient received large-bore chest tube drainage and 1 patient underwent VATS, and both procedures were successful. No major complications occurred in patients who received pigtail catheter drainage, large-bore chest tube drainage, or VATS.

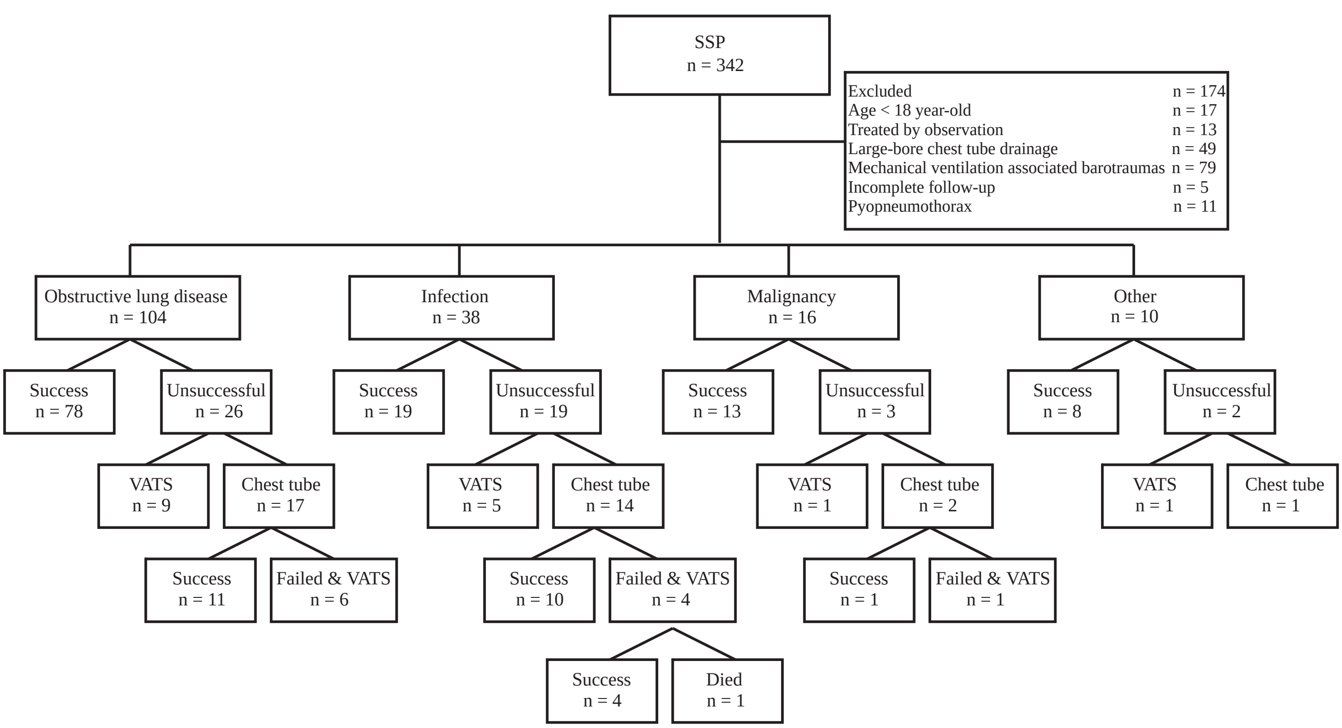

Fig. 1 Flow diagram of the progress through the treatment allocations and outcome according to different associated conditions.

4. Discussion

Previous literature had recommended that small-bore chest tube (pigtail) drainage offers effective treatment for both primary and secondary pneumothoraces. However, it is still not known which specific associated conditions in patients with SSP is particularly beneficial for pigtail catheter treatment [8-9]. In our study, the overall success rate of pigtail catheter drainage in patients with SSP was 70%. A higher success rate was noted in SSP patients with obstructive lung conditions and malignancies than those with infectious conditions (75% and 81.3% vs 50%, $P = .004$ and $P = .021$, respectively).

Common associated conditions were COPD, pneumonia, malignancy, bronchial asthma, pulmonary fibrosis, and TB. The predominant etiology of SSP may depend on the prevalence of these diseases in the population under study. In a large Japanese study of pneumothoraces, TB was the most common cause of SSP in women, whereas data from the United Kingdom, United States, and our series indicate that COPD is the most common condition associated with SPP [10-12].

Our data indicate that the overall success rate of pigtail catheter drainage in SSP patients with obstructive lung conditions and malignancy was 76%, which is similar to previous reports treating SSP with large-bore chest tube drainage [13]. Therefore, pigtail catheter with one-way valve bag drainage appears to be a safe and promising technique in the treatment of a first episode of SSP associated with obstructive lung conditions and malignancy. However, our data indicated a lower success rate when SSP was associated with infectious diseases. The reason is likely because of a greater degree of pleural inflammation and necrosis present with infectious diseases. In our series, 6 patients with SSP had *P. jerovici* pneumonia and only one patient was successfully treated with pigtail catheter drainage. The mechanism of pneumothorax due to *P. jerovici* pneumonia may be direct tissue destruction by *P. jerovici* pneumonia, release of elastase and proteolytic enzymes by macrophages and neutrophils, and remodeling of the pulmonary architecture secondary to interstitial fibrosis [14,15]. Greater destruction of lung tissue allows more air leakage, even after small-bore chest tube drainage, which may be the reason for failure in these cases.

The pathogenesis of pneumothoraces in patients with cavitary TB can be explained by the rupture of the cavities into the pleural space [16,17]. Another possible mechanism is a confluent inflammation of lung parenchyma with caseation necrosis, and subsequent rupture into the pleural space [16]. As in SSP due to *P. jerovici* pneumonia, necrosis of lung tissue plays an important role in the failure of small-bore chest tube drainage.

Acute bacteria pneumonia is a common condition associated with the development of pneumothoraces in patients with HIV infection [18]. *Staphylococcus aureus* and *Streptococcus pneumoniae* cause necrotizing pneumonia [19,20], and it is thought that this results in pneumatoceles where there is necrosis at the bronchial and bronchiolar walls leading to rupture, interstitial emphysema, and pneumothoraces [21]. In the current study, *Staphylococcus aureus* was the most common pathogen causing acute bacterial pneumonia associated with the development of SSP, and high incidence of necrotizing pneumonia may be the reason for the higher failure rate of pigtail catheter drainage.

Patients with bronchopleural fistulas in the setting of chest trauma or acute respiratory distress syndrome due to pneumonia may have air leaks ranging from <1 L/min to as large as 16 L/min [20,21]. Hence, SSP patients with infectious diseases may have large air leaks [22,23]. Reported success rates of large-bore chest tube drainage for SSP associated with infectious diseases range from 67% to 82% [24,25]. Thus, we recommend that large-bore chest tube drainage rather than pigtail catheter drainage should be the initial treatment for patients with SSP associated with infectious diseases.

In previous reports, VATS for SSP has been shown to be associated with a higher morbidity than VATS for PSP [26]. This is likely because patients with SSP typically have underlying lung disease and usually have limited cardiopulmonary reserve. In our series, 27 patients (16%) required VATS after failure of initial pigtail or subsequent chest tube drainage. Although patients who underwent VATS had a longer hospital stay than those who did not require surgery, no complications were associated with VATS; and although one patient who underwent VATS died, it was due to complications of the underlying disease and not of the surgical procedure.

There are some limitations to this study that should be considered. First, this was a retrospective study and the initial selection of patients for pigtail catheter drainage may have influenced the results and success rates. Second, the use of pigtail catheter drainage has increased gradually with the successful clinical experience at our hospital. This is the reason why the number of patients initially treated with large-bore chest tube drainage was smaller than the number treated with pigtail catheters. Because of small number of SSP patients with infectious disease condition with initial treatment of large-bore chest tube, we could not further analyze the success rate of SSP patients associated with infection compared with those initially treated with large-bore chest tube.

In conclusion, this is the first report regarding the utility of pigtail catheter drainage in the management of patients with a first episode of SSP associated with different conditions. In SSP patients with obstructive lung conditions and malignancy, pigtail catheter with one-way valve bag drainage appears to be a safe and promising technique for the treatment of a first episode of SSP. A higher failure rate of pigtail catheter drainage was noted in SSP patients with infectious diseases; thus, large-bore chest tube should be the initial treatment of choice in these patients. Further study, with a large prospective and randomized trial, is necessary to compare the results between pigtail and large-bore chest tube in patients with SSPs.

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Chia-Hung Chen: concept, design, data collection, analysis, interpretation, and manuscript draft. Dr Chen had access to and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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