

Analysis of Recurrence and Influencing Factors of Spontaneous Pneumothorax After Thoracoscopic Surgery

Duo Zhang, Shaoyong Dong, Wei Li, Hefei Li*

Thoracic Surgery Department, Affiliated Hospital of Hebei University, Baoding 071000, China

*Corresponding author: Hefei Li, 13831275950@163.com

Copyright: © 2022 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: This study was conducted to explore the factors that are influencing the recurrence of spontaneous pneumothorax after thoracoscopic surgery. Around 110 patients with spontaneous pneumothorax who underwent thoracoscopic bullectomy in Hebei Hospital from May 2017 to May 2021 were included in this study. The patients were divided into the recurrence group (15 cases) and the non-recurrence group (95 cases), and the influences of gender, age, smoking history, height, weight, operation time, the weight of the excised tissue, number of excised pulmonary bullae, postoperative chest tube maintenance time, duration of air leakage, and length of hospital stay on the recurrence of spontaneous pneumothorax after thoracoscopic surgery were investigated. This study found that the height/weight, operation time, duration of air leakage, number of pulmonary bullae removed, weight of the removed tissue, postoperative chest tube maintenance time, and duration of hospital stay in the recurrence group was 3.2 ± 0.4 , 50.9 ± 1.2 , 2.1 ± 0.4 , 1.6 ± 0.2 , 4.2 ± 1.3 , 2.4 ± 1.5 and 7.2 ± 1.5 , respectively. Meanwhile, the recurrence group was 2.6 ± 0.3 , 50.8 ± 1.3 , 1.3 ± 0.2 , 1.8 ± 0.9 , 4.4 ± 1.2 , 4.1 ± 1.7 and 6.9 ± 1.6 , respectively. After comparing the relevant factors between the recurrence group and the non-recurrence group, it was found that there was comparability between age, height/weight, duration of air leakage and postoperative chest tube maintenance time, where these factors were shown to affect the recurrence of spontaneous pneumothorax after thoracoscopic surgery, while gender, smoking, operation time, number of resected bullae, weight of resected tissue and length of hospital stay had no effect on recurrence after spontaneous pneumothoraxoscopic surgery. In short, thoracoscopic bullectomy is the best clinical treatment for spontaneous pneumothorax, however the occurrence of recurrence of spontaneous pneumothorax after the operation, which is mainly influenced by the patient's height/weight, postoperative air leakage duration, and chest tube maintenance time. Therefore, it is essential to pay attention to the surgical treatment of the patients, and fully identify the related factors of postoperative recurrence, thereby the follow-up clinical treatment can be carried out effectively.

Keywords: Spontaneous pneumothorax; Thoracoscopy; Recrudescence

Online publication: July 28, 2022

1. Introduction

Spontaneous pneumothorax (SP) is one of the more common clinical diseases in surgery, where it is mainly caused by the rupture of pulmonary bullae. The incidence population of this clinical disease is mainly concentrated in young and middle-aged people, meaning that the rupture of the important organs such as pleura and lung is not affected by other external factors^[1]. Based on the presence or absence of primary disease, it can be divided into secondary and primary SP^[2]. The primary SP tends to occur in middle-aged and elderly people, and patients are often accompanied by pleural and pulmonary parenchymal diseases,

while the secondary SP tends to occur in young people. Patients have no basic lung disease and exogenous factors; however, pulmonary bullae rupture can happen spontaneously. As SP is prone to recurrent attacks, therefore it is easy to cause death if it is not diagnosed and treated in time. At present, conservative treatment (relief of pneumothorax symptoms) and surgical treatment (removal of primary pulmonary bullae) [3] are mainly performed in patients with SP. In addition, due to the relatively high recurrence rate of conservative treatment, such as closed thoracic drainage and thoracic puncture, active surgical treatment is usually conducted, however, there is still controversy about the choice of surgical method. For example, it is reported that thoracotomy (TH) surgery has a large incision, which is easy to damage the chest wall, and the postoperative chest pain lasts for a longer time, and the video assisted thoracoscopic surgery (VATS) will not easily damage the lung function, and the postoperative recovery is faster. Further, with the development of VATS technology, the surgery method has gradually developed from four hole operation to a single hole operation [4-6]. At present, the clinical treatment of spontaneous pneumothorax is mainly surgical treatment, such as thoracocentesis, thoracoscopic bullectomy, and other methods. Although the surgical effect is accurate, however the postoperative recurrence rate is higher. Therefore, it is necessary to identify the relevant factors which may influence the occurrence of the postoperative recurrence, in order to formulate a more safe and effective treatment plan. This study analyzed the related factors which contribute to the development of recurrence of spontaneous pneumothorax after thoracoscopic bullectomy.

2. Data and methods

2.1. Study subjects

Around 101 patients with SP who underwent thoracoscopic bullectomy in Hebei Hospital from May 2017 to May 2021 were included in this study. The patients were divided into recurrent group (13 cases) and non-recurrent group (88 cases). There was no statistical difference between these two groups ($P > 0.05$), indicating the data obtained from these two groups are comparable.

2.2. Methods

All patients underwent chest X-ray and CT examination, and the indications of operation with continuous air leakage for more than 3 days after thoracic closed drainage, lung atrophy after more than 2 operations, and pulmonary bullae were found by CT examination. All patients underwent thoracoscopic bullectomy procedure as described below:

- (1) The healthy side decubitus position was taken, double-lumen endotracheal intubation was performed under general anesthesia, and single-lung ventilation was performed. Thoracoscopy was performed at the 7th or 8th intercostal space of the axillary midline, and an operation hole trocar was placed in the equilateral triangle between the 5th or 6th intercostal space at the anterior axillary line and the 6th or 7th intercostal space at the posterior axillary line. If there is a small amount of adhesion, it will be completely removed with an electric knife, and the bullae of the lung can be completely removed with a cutting suture device.
- (2) The air leakage test was performed under the air pressure of 25cmh₂o. The absorbable oxidized cellulose was directly covered on the excised part of the patient's pulmonary bulla, and an appropriate amount of fibrin gel was applied on the surface. At the same time, a Fr28 drainage tube was placed. After all the lungs on the surgical side were inflated, the incision was closed, and the operation was over.
- (3) After the operation, the medical staff carefully checked whether the drainage tube of the patient had air leakage, whether the drainage fluid was less than 50ml, if there was residual gas in the chest film, and whether the drainage tube was completely removed.

2.3. Observation indicators

Information on gender, age, smoking history, height, weight, operation time, the weight of the excised tissue, the number of the excised pulmonary bullae, postoperative chest tube maintenance time, duration of the air leakage, and length of hospital stay were taken and noted.

2.4. Statistical analysis

SPSS19.0 and GraphPadPrism6.0 statistical software was used for the data analysis. The experimental data were expressed as mean \pm standard deviation ($\bar{x} \pm s$), one-way ANOVA was used to compare the mean of each group, and snk-q test was used to compare the data. A p value less than 0.05 ($P < 0.05$), indicating statistical significance between the two tested groups.

3. Results

It was found that the height/weight, operation time, duration of air leakage, the number of the pulmonary bullae removed, the weight of the removed tissue, postoperative chest tube maintenance time, duration of hospital stay in the recurrence group were 3.2 ± 0.4 , 50.9 ± 1.2 , 2.1 ± 0.4 , 1.6 ± 0.2 , 4.2 ± 1.3 , 2.4 ± 1.5 and 7.2 ± 1.5 , respectively; meanwhile the recurrence group was 2.6 ± 0.3 , 50.8 ± 1.3 , 1.3 ± 0.2 , 1.8 ± 0.9 , 4.4 ± 1.2 , 4.1 ± 1.7 and 6.9 ± 1.6 , respectively (**Table 1**). After comparing the relevant factors between the recurrence group and the non-recurrence group, it was found that age, height/weight, duration of air leakage and postoperative chest tube maintenance time, are the factors that may affect the recurrence of SP after thoracoscopic surgery, in contrast gender, smoking, operation time, the number of the removed bullae, the weight of the removed tissue, and length of hospital stay had no effect on recurrence after spontaneous pneumothoracoscopic surgery.

Table 1. Analysis of factors influencing the recurrence of SP after thoracoscopic surgery

Group		Recurrence group (n=13)	No recurrence group (n=88)	T/X ²	p
Gender	Male	10 (76.9)	68 (77.3)	0.7443	> 0.05
	Female	3 (23.1)	20 (22.7)		
Age	< 25	4 (30.8)	39 (44.3)	4.8997	< 0.05
	\geq 25	9 (69.2)	49 (55.7)		
Smoking	Yes	7 (53.8)	42 (47.7)	0.1698	> 0.05
	No	6 (46.2)	46 (52.3)		
Height/weight		3.2 ± 0.4	2.6 ± 0.3	6.4346	< 0.05
Operation time		50.9 ± 1.2	50.8 ± 1.3	0.2612	> 0.05
Duration of air leakage		2.1 ± 0.4	1.3 ± 0.2	11.5282	< 0.05
Number of bullae removed		1.6 ± 0.2	1.8 ± 0.9	0.7951	> 0.05
Weight of excised tissue		4.2 ± 1.3	4.4 ± 1.2	0.5551	> 0.05
Postoperative chest tube maintenance time		2.4 ± 1.5	4.1 ± 1.7	3.4116	< 0.05
Length of stay		7.2 ± 1.5	6.9 ± 1.6	0.6357	> 0.05

4. Discussion

SP is a common clinical disease emergency, if it is not handled in time, it can easily endanger the safety of the patients. In the past, patients with SP were usually treated with TH, but the amount of bleeding and injury were large, and it was difficult to recover after the operation. In addition, the incidence of complications was higher using this treatment method. In recent years, some scholars have pointed out that

VATS can be used to treat SP patients, however, there is still a dispute about whether to use single or double operation holes ^[9].

On the one hand, there are many VATS incisions surgeries with double operation holes, showing the patients have long postoperative chest pain and heavy pain ^[10] with a prolong recovery time. In addition, young patients are often worried about the surgical scar which may will affect their beauty ^[11]. Meanwhile, the elderly patients could not tolerate the surgical trauma, therefore the acceptance of the patients towards operation is not high. In contrast, the single hole VATS surgery does not need a secondary hole, additionally the operation hole is arranged between the third or fourth intercostals at the axillary front. The intercostals are wide and the chest wall muscle thickness is small ^[12], therefore it is not easy to bleed, and the operation can be easily conducted, with no damage on to intercostal nerve. On the other hand, white blood cells (WBC) and C-reactive protein (CRP) are important immune indicators, which can reflect the immune function of the body. The single hole VATS operation is less traumatic, not easy to affect the immune function of the patient, can reduce the immune response, and encourage the patient recovery faster.

Although the micro single hole VATS operation reduces the intraoperative bleeding compared with the traditional operation ^[8], due to the small single hole and interference between instruments, it is difficult to ideally expose the focus near or on the dorsal side of the diaphragm. The repeated exchange of instruments, combined with the influence of the number of pulmonary bullae, and the involvement of pulmonary lobes, may increase the operational bleeding. In addition, it is difficult to deal with massive hemorrhage under this operation condition, which is easy to cause damage to the surrounding tissues and increase the risk of postoperative pulmonary complication (PPC) ^[9]. Therefore, the operator should fully and strictly master the cooperation of thoracoscopic instruments, accurately and skillfully use the lens angle and orientation, and cooperate with the cooperator to overcome the defects. In addition, some scholars have also placed a thruster on the chest wall to improve the interference of the instruments, which is of significant reference. In addition, previous studies ^[10,11] have confirmed that intraoperative hypothermia will affect coagulation function, increase stress response, and then increase the amount of bleeding, therefore, measures such as heating blanket, covering non operation area with insulation blanket, preheating treatment during liquid infusion should be taken to strengthen the insulation prevention, and further the blood transfusion support should be provided if necessary. For patients with large amount of bleeding, it is important to strengthen the thermal insulation intervention and nutritional support after the operation.

Previous studies ^[14] have suggested that the risk of PPC increases with age, especially in elderly patients. This is related to the change of the tissue function, the decline of reserve function, body immunity and resistance, and the low ability to repair and compensation in the elderly patients. In addition, some patients have different degrees of basic diseases, and the weakening of body defense mechanism further increases the risk of PPC. The combination of asthma, emphysema, and other lung diseases may also increase the burden of the body, and the risk of PPC.

For pulmonary bullae, the causes of recurrence may cause by the blood supply of the visceral pleura, where the bulla that is located is at the visceral pleura worse than bulla that is located at the normal pleura. It is not easy to adhere to the parietal pleura, which is easy to cause recurrence. In view of the factor of pleural friction, the purpose of pleural friction is to ensure that the pleural fixation is firm, give sufficient physical stimulation, and the application of adhesive agent can further improve the pleural fixation effect ^[6]. However, there is also a potential risk when carrying out pleural friction, which is the postoperative drainage volume is relatively large, which can lead to a great controversy on whether to carry out pleural friction or not. For the factor of drainage time > 3D, with the continuous extension of drainage time, the probability of pleural inflammation is higher, and pleural adhesion symptoms are easy to occur. If the residual cavity occurs again, the pleural fixation effect will be affected, subsequently the treatment effect will be reduced ^[7]. In addition, after the operation, the patient was unwilling to cough actively or lacked

active cough awareness because of fear of pain, resulting in incomplete lung expansion and prolonged drainage time, which indirectly increased the recurrence rate. In view of the above situation, it is essential to strengthen preoperative education, improve patients' awareness on the importance of active cough after operation, and give necessary analgesic intervention to prevent the patients from refusing to cough due of fear of pain^[8].

In addition, the consensus of Chinese experts on lung protection during the perioperative period of thoracic surgery (2019 version)^[15] mentioned that "The probability of PPC in smokers was 1.4~4.3 times higher, than in non-smokers, and Prolonged surgery increases the risk of PPC." However, the results of this study do not show the impact of smoking history and operation time on PPC of patients. It is considered that this condition is only related to the selected range of cases, operation methods, sample size, individual differences of cases, and other factors, which need to be further investigated.

In conclusion, in the clinical treatment of SP, thoracoscopic bullectomy is the best choice. The recurrence of this operation is easily affected by the patient's height/weight, postoperative air leakage duration, and chest tube maintenance time. Therefore, it is important to pay attention to the surgical treatment of patients, and fully identify the related factors of postoperative recurrence, thereby the follow-up clinical treatment can be carried out effectively.

Funding

Baoding Science and Technology Planning Project (Project Number: 1941ZF088)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Cai A, Shen Z, Han Z, et al., 2019, Discussion on the Strategy of Video-Assisted Thoracoscopic Treatment of Postoperative Recurrence of Primary Spontaneous Pneumothorax. *Journal of Aerospace Medicine*, 30(05): 535–537.
- [2] Chen Y, Deng Y, Liu L, 2019, Application of Single Hole Thoracoscopic Surgery in the Treatment of Spontaneous Pneumothorax. *World Latest Medical Information Abstracts*, 19(27): 111 + 119.
- [3] Qin C, 2018, Analysis of Contralateral Recurrence Characteristics and Influencing Factors After Primary Spontaneous Pneumothorax Thoracoscopy. *World Latest Medical Information Digest*, 18(50): 65–66.
- [4] Fu M, 2018, Comparison of the Efficacy and Recurrence of Thoracoscopic Pneumonectomy Versus Suturing in the Treatment of Spontaneous Pneumothorax in the Elderly. *International Journal of Medicine and Health*, 24(10): 1507–1509.
- [5] Fan J, Cheng L, Feng Q, et al., 2018, Effectiveness of Different Thoracoscopic Procedures in Spontaneous Pneumothorax. *Laboratory Medicine and Clinical*, 15(07): 976–978.
- [6] Chen J, 2018, Risk Factors and Nursing Countermeasures for Postoperative Infection After Thoracoscopic Treatment of Spontaneous Pneumothorax. *The Great Physician*, 3(Z1): 203 + 219.
- [7] Kang Z, 2017, Comparison of Thoracoscopic-Assisted Small-Incision Open-Heart Surgery and Total Thoracoscopic Surgery for Spontaneous Pneumothorax. *Journal of Contemporary Clinical Medicine*, 30(03): 3043–3044.

- [8] Yang Z, Yan T, He W, 2017, Current Status of Research on Prognostic Factors Associated with Recurrence of Spontaneous Pneumothorax After Television Thoracoscopy. *Chinese Journal of Minimally Invasive Surgery*, 17(05): 461–465.
- [9] Li J, 2017, Analysis of Risk Factors for Recurrence of Primary Spontaneous Pneumothorax After Thoracoscopy. Tianjin Medical University.
- [10] Zhang D, Miao J, Hu X, et al., 2017, Prevention and Treatment of Air Leakage After Primary Spontaneous Pneumothorax and Thoracoscopy. *Chinese Journal of Thoracic and Cardiovascular Surgery*, 33(04): 212–215.
- [11] Wu G, Wu X, Peng C, et al., 2017, Clinical Study on Controlling Postoperative Pulmonary Infection and Long-Term Recurrence of Spontaneous Pneumothorax Treated by Thoracoscopy. *Chinese Journal of Nosocomial Infection*, 27(04): 861–863 + 871.
- [12] Xiang J, Li X, 2016, Single-Port Thoracoscopic Treatment of Spontaneous Pneumothorax in the Elderly and Evaluation of Postoperative Serological Indicators. *China Medical Equipment*, 13(07): 84–87.
- [13] Zhang F, 2016, Study on the Surgical Treatment of Thoracoscopic Surgery in the Recurrence of Primary Spontaneous Pneumothorax After Surgery. *Chinese Practical Medicine*, 11(15): 107–108.
- [14] Li L, Ma Z, 2016, Analysis of Recurrence After Spontaneous Pneumothorax Thoracoscopy and its Influencing Factors. *Medical Review*, 22(10): 2015–2018.
- [15] Li H, Xia H, Zhang X, et al., 2016, Analysis of the Risk Factors of Contralateral Pneumothorax After Thoracoscopic Treatment of Primary Spontaneous Pneumothorax. *Journal of Harbin Medical University*, 50(02): 134–138.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.