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Original Article / Özgün Makale

Management of primary spontaneous pneumothorax: Our single-center, five-year experience

Primer spontan pnömotoraks tedavisi: Tek merkezli, beş yıllık deneyimimiz

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ABSTRACT

Background: In this study, we aimed to analyze the effects of admission time to the hospital and different variables on the treatment efficiency and to evaluate the recurrence during the clinical management process in patients with the diagnosis of primary spontaneous pneumothorax.

Methods: A total of 149 patients with primary spontaneous pneumothorax (131 males, 18 females; mean age: 24.8±6.8 years; range, 17 to 35 years) treated in our clinic between January 2015 and December 2019 were retrospectively analyzed. Time from symptom onset to hospital admission (admission time) was classified as three periods: <24 h, between 24 and 72 h, and >72 h. Data including admission time, demographic and clinical characteristics, smoking history, body mass index, the use of pleurectomy or pleural abrasion during surgery were collected from the charts of the patients.

Results: Admission time had no statistically significant effect on the length of hospital stay, recurrence, and the need for surgery. Male sex, smoking history, and lower body mass index had no significant effect on the recurrence. Recurrence and length of hospital stay did not significantly differ between the patients in whom pleurectomy or pleural abrasion added to the procedure during the operation.

Conclusion: A longer interval between symptom onset and hospital admission and lower body mass index have no adverse effect on treatment outcomes and the recurrence in patients with primary spontaneous pneumothorax. Despite the fact that surgical treatment significantly decreases the recurrence rate, pleurectomy and pleural abrasion techniques have no significant difference on the clinical influence and recurrence of these patients.

Keywords: Minimally invasive surgery, recurrence, pleural abrasion, pneumothorax.

ÖZ

Amaç: Bu çalışmada primer spontan pnömotoraks tanılı hastalarda hastaneye başvuru ve çeşitli değişkenlerin tedavi etkinliği üzerine etkisi incelendi ve klinik tedavi sürecinde nüks değerlendirildi.

Çalışma planı: Ocak 2015 - Aralık 2019 tarihleri arasında primer spontan pnömotoraks nedeniyle kliniğimizde tedavi edilen toplam 149 hasta (131 erkek, 18 kadın; ort. yaş: 24.8±6.8 yıl; dağılım, 17-35 yıl) retrospektif olarak değerlendirildi. Semptom başlangıcı ile hastaneye başvuru süresi (başvuru süresi) üç zaman diliminde ele alındı: <24 saat, 24 ila 72 saat ve >72 saat. Başvuru süresi, demografik ve klinik özellikler, sigara içme öyküsü, vücut kütle indeksi, cerrahi tedavi sırasında plörektomi veya plevral abrazyonun uygulanması dahil olmak üzere veriler hasta kayıtlarından alındı.

Bulgular: Başvuru süresinin hastanede kalış süresi, nüks ve cerrahiye gereksinim üzerinde istatistiksel olarak anlamlı bir etkisi izlenmedi. Erkek cinsiyet, sigara öyküsü ve düşük vücut kütle indeksi varlığının nüks üzerinde istatistiksel olarak anlamlı bir etkisi yoktu. Plörektomi veya plevral abrazyon tekniklerinin cerrahi tedaviye eklenmiş olduğu hastalar arasında nüks ve yatış süreleri açısından anlamlı bir fark görülmedi.

Sonuç: Semptom başlangıcı ile hastaneye başvuru arasındaki sürenin uzun olması ve düşük vücut kitle indeksinin primer spontan pnömotorakslı hastaların tedavi etkinliği ve nüks üzerinde olumsuz bir etkisi yoktur. Cerrahi tedavinin nüks oranını belirgin şekilde azaltmış olduğu gerçeğine rağmen, plörektomi ve plevral abrazyon tekniklerinin klinik etki veya nüks açısından anlamlı bir etkisi yoktur.

Anahtar sözcükler: Minimal invaziv cerrahi, nüks, plevral abrazyon, pnömotoraks.

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Pneumothorax is characterized by the accumulation of air in the pleural space and subsequent lung collapse. It is classified as spontaneous, traumatic, and iatrogenic. Spontaneous pneumothorax is further classified as primary or secondary.[1] Primary spontaneous pneumothorax (PSP) usually occurs in young, healthy individuals between 10 and 30 years of age, in the absence of any lung diseases.[2]

The annual incidence of PSP per 100,000 persons is 7.4 to 8 (age-related incidence) in men and 1.2 to 6 among women. Risk factors for PSP demonstrated in previous studies include male sex, smoking, tall and lean body shape, mood lability, changes in atmospheric pressure, and low body mass index (BMI).[3-5] Currently, the connection between BMI and pneumothorax is a topic of substantial interest. A correlation between BMI and recurrence was demonstrated in some studies, but not others, and, thus, remains a subject of controversy.[6,7]

Although PSP is a relatively common disease in the population, heterogeneity can be addressed about the effectiveness of preclinical, clinical and demographic data and also the treatment methods on the course and the recurrence rates of the disease. On the other hand, beside the treatment options are clearer for patients with recurrence, debate continues regarding PSP patients presenting with their first episode. Recurrence rates of 13 to 49% within the first year and over 50% in five-year follow-ups have been reported.[8-10]

The most common reasons for surgical intervention are prolonged air leak during the initial PSP episode and recurrence. Apical pleurectomy via thoracotomy is considered the most optimal option due to its low recurrence rates. Currently, one of the most debated topics in PSP treatment is the superiority of pleurectomy or pleural abrasion after bulla or bleb excision via video-assisted thoracoscopic surgery (VATS) in reducing recurrence.[11,12]

To date, a vast number of studies focused on various aspects of pneumothorax were designed. However, the effect of the admission time (AT) on the clinical course of these patients was not studied. In the present study, we aimed to analyze the effects of AT of the patients to the hospital and the other variables on the treatment efficiency and to evaluate recurrence during the clinical management process in patients with the diagnosis of PSP.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Recep Tayyip Erdoğan University Training and Research Hospital, Department of Thoracic Surgery between January 2015 and December 2019. A total of 149 patients with PSP (131 males, 18 females; mean age: 24.8±6.8 years; range, 17 to 35 years) treated in our clinic were included. Patients under 17 or over 35 years of age and those with missing data were excluded. Data including age, sex, PSP side, length of hospital stay, treatment received, type of pleurodesis, time from symptom onset to hospital admission, BMI, and recurrence rates were recorded. Treatment decisions were made based on examination, hospital follow-up, number of episodes, and radiological findings. Time from symptom onset to the hospital AT was classified as three periods as follows: <24 h, between 24 and 72 h, and >72 h. A written informed consent was obtained from each patient. The study protocol was approved by the Clinical Research Ethics Committee of Recep Tayyip Erdogan University, Faculty of Medicine (No: 2020/193, Date: 03.09.2020). The study was conducted in accordance with the principles of the Declaration of Helsinki.

According to the World Health Organization (WHO), BMI <18.5 kg/m^2 is classified as underweight, 18.5 to 24.9 kg/m^2 as normal, 25 to 29.9 kg/m^2 as overweight, and ≥30 kg/m^2 as obese. For our analysis of the relationship between recurrence and BMI, the patients were divided into two groups as underweight and normal/overweight.

In patients presenting with an initial episode, pneumothorax with apex-to-cupola distance of ≤3 cm or interpleural distance <2 cm at the hilum on chest X-ray was considered minimal pneumothorax. These patients were followed with nasal oxygen (2 to 3 L/min) and daily chest X-rays and were discharged after 48 to 72 h of clinical stability. A chest drain was placed in patients with progressive pneumothorax. Patients whose pneumothorax volume was uncertain were evaluated using thoracic computed tomography (CT).

After the air leak resolved and oscillation was reduced, the drain remained clamped for 6 to 12 h; when consistent expansion was observed on control chest X-ray, the drain was removed and the patient discharged. Patients with air leak lasting five days or more were treated surgically. Surgical technique included wedge resection of bullae and/or blebs and mechanical pleurodesis (by using two different techniques; pleurectomy or pleural abrasion) via VATS or axillary thoracotomy (Figure 1). The VATS was performed using two or triportal technique. The third port was preferred when adhesions accompanied. Thoracotomy was used only in

Figure 1. Figure demonstrating the biportal video-assisted thoracoscopic surgery technique.

presence of excessive pleural adhesion and redo surgery. Patients who presented with recurrence and consented to surgery also underwent chest tube drainage followed by surgical intervention as soon as possible.

Statistical analysis

Statistical analysis was performed using the SPSS version 18.0 software (SPSS Inc., Chicago, IL, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. The distribution characteristics of continuous data were tested using the Kolmogorov-Smirnov test. The relationship between surgical procedure used and the patient's length of hospital stay was evaluated with the Mann-Whitney U test. The chi-square test and Fisher exact tests were used to analyze relationships between the patients' sociodemographic and clinical characteristics and their recurrence rate and time from symptom onset to hospital admission. A p value of <0.05 was considered statistically significant.

RESULTS

Of a total of 149 patients with PSP, 70 (46.9%) were treated surgically. The mean length of hospital stay in non-surgical patients (those managed with tube thoracostomy or observation) was 6.4±2.3 (range, 2 to 15) days, while that of patients who underwent surgery was 10.6±4.0 (range, 2 to 19) days. The mean BMI was 21.5±3.3 kg/m^2 and 109 patients (73.2%) had a history of smoking. The most common presenting symptoms were chest pain (91.7%), shortness of breath (16.7%), and cough (3.4%). Pneumothorax was on the right side in 88 (59.1%) patients. Reasons for surgery were recurrence (51.4%), prolonged air leak (47.1%), and prolonged air leak and hemopneumothorax (1.5%) (Table 1).

Relationships between recurrence and patient age, sex, smoking history, pneumothorax side, BMI, and surgical/nonsurgical treatment were examined. There was no significant difference in recurrence based on sex or smoking history. No significant relationship was detected between recurrence and BMI. Pneumothorax patients treated surgically had a significantly lower recurrence rate ($p<0.001$) (Table 2).

Comparison of cases in which thoracotomy and VATS were used revealed no significant difference between the surgical techniques in terms of recurrence or length of stay. Comparison of patients who underwent pleurectomy and pleural abrasion also revealed no significant difference in length of stay or recurrence. The recurrence rate among patients treated surgically was 2.86% (Table 3). The mean operative time was 56.8±12.4 min in the pleurectomy group

Table 1. Characteristics of patients with primary spontaneous pneumothorax (n=149)

	n	%	Mean±SD
Age (year)			24.8±6.8
Sex			
Male	131	87.9	
Female	18	12.1	
Smoker	109	73.2	
Mean BMI (kg/m^2)			21.5±3.3
Side of PSP			
Right	88	59.1	
Left	61	40.9	
Length of hospital stay			
Surgical patients			10.6±4.0
Nonsurgical patients			6.4±2.3
Reason for surgery			
Recurrence	36	51.4	
Prolonged air leaked	33	47.1	
Hemopneumothorax	1	1.5	

SD: Standard deviation; BMI: Body mass index; PSP: Primary spontaneous pneumothorax.

Table 2. Comparison of PSP patients' demographic and clinical characteristics based on recurrence

Parameter	Recurrence			No recurrence			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			23.0±6.8			25.4±6.7	**0.011**
Sex							0.246
Male	31	23.7		100	76.3		
Female	7	38.9		11	61.1		
Smoking history							0.235
Yes	25	22.9		84	77.1		
No	13	32.5		27	67.5		
BMI							0.134
Underweight	11	34.4		21	65.5		
Normal/overweight	25	21.6		91	78.4		
Side							0.581
Left	17	27.9		44	72.1		
Right	21	23.9		67	76.1		
Treatment							**<0.001**
Surgical	2	17.1		68	82.9		
Nonsurgical	26	32.9		53	67.1		

PSP: Primary spontaneous pneumothorax; SD: Standard deviation; BMI: Body mass index.

Table 3. Comparison of length of hospital stay and recurrence rate based on surgical procedure

	Length of hospital stay (days)		Recurrence		No recurrence		Re *vs*. noRe
Surgical procedure	Mean±SD	*p*	n	%	n	%	*p*
Thoracotomy	12.6±6.2	0.589	0	0	5	100	*
VATS	10.5±3.8		2	3.2	63	96.8	
Pleurectomy	10.7±4.6	0.854	1	2.5	39	97.5	0.835
Pleural abrasion	10.1±3.5		1	3.3	29	96.7	
			(All=2.86%)				

VATS: Video-assisted thoracoscopic surgery; Re: Recurrence, noRe: No recurrence; SD: Standard deviation; * As there were no recurrences in the thoracotomy group, statistical comparison was not possible.

Table 4. Relationship between time from symptom onset to hospital admission and length of hospital stay, need for surgery, and recurrence

	<24 hours (n=121)			24-72 hours (n=17)			>72 hours (n=11)			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Length of hospital stay (days)			8.5±3.7			7.1±4.4			8.6±4.5	0.127
Need for surgery										0.415
Yes	60	85.7		6	8.6		4	5.7		
No	61	77.2		11	13.9		7	8.9		
Recurrence										0.471
Yes	31	86.1		4	11.1		1	2.8		
No	90	79.6		13	11.5		10	8.8		

SD: Standard deviation.

Table 5. Comparison of length of hospital stay and postoperative drainage values in terms of the surgical technique of patients with pneumothorax

	Biportal VATS (n=14)	Triportal VATS (n=51)	
	Mean±SD	Mean±SD	*p*
Length of hospital stay (day)	11.1±3.4	10.3±3.9	0.476
Drainage (mL)	355.6±156.6	387.7±129.4	0.605

VATS: Video-assisted thoracoscopic surgery; SD: Standard deviation.

and 46.2±11.2 min in the abrasion group. The patients were divided into three groups according to time from symptom onset to hospital admission: less than 24 h, 24 to 72 h, or more than 72 h. The mean time to admission was 21.4±16.4 (range, 2 to 448) h. There were no significant differences between the groups in terms of length of hospital stay, need for surgery, or recurrence rate (Table 4).

Surgery was performed using triportal VATS in 51 (78.4%) patients and biportal VATS in 14 (21.6%), with no significant difference in length of stay and the drainage volume between the groups (Table 5).

Wound infection occurred in three patients; two in thoracotomy and one in VATS procedure. Postoperative air leak occurred in one patient who underwent VATS. The patient with air leak was managed successfully with a suction chest tube system, while the patients with infection received conservative treatment and follow-up.

DISCUSSION

Pneumothorax is characterized by the accumulation of air in the pleural space with subsequent lung collapse and is usually treated with tube thoracostomy. For patients with minimal pneumothorax (<3 cm between lung apex and cupola), the American College of Chest Physicians (ACCP) recommends discharge, if no progression is observed during follow-up at 3- to 6-h intervals. For patients with larger pneumothorax (apex-to-cupola distance >3 cm), air drainage methods are recommended, and surgical intervention is advised for patients with recurrence and prolonged air leak.[13] Rates of recurrence after an initial episode have been reported in different studies as 14 to 49% and 50% in one- and five-year follow-up, respectively.[8-10] In our study, the recurrence rate within the first year was 21% for patients not treated surgically during the initial episode.

The most recent and up-to-date guidelines from the British Thoracic Society (BTS) in 2010 and European Respiratory Society (ERS) in 2015 state that the patient groups requiring surgery are those with recurrence, treatment failure, hemopneumothorax, bilateral pneumothorax, and occupational risk.[5] Chambers and Scarci[14] have shown that performing VATS in patients with an initial episode of pneumothorax reduces the duration of chest intubation and hospital stay, resulting in a substantial decrease in the rate of recurrence. Furthermore, many authors reported that young patients prefer to have surgery rather than live with the risk of a recurrence that may happen at any time.[15] Treatment options are better defined for patients with recurrence, but there is still a lack of consensus regarding treatment for an initial episode. In our study, we observed a significant difference in the rate of recurrence between patients who underwent surgery or not in the first episode. Therefore, for patients presenting with an initial episode of pneumothorax, we recommend surgery if there are clear signs of bleb or bulla formation even in the absence of prolonged air leak.

In their review, Vuong et al.[16] reported that performing pleural abrasion or pleurectomy together with thoracotomy in cases of recurrent and persistent pneumothorax was the most effective method for preventing postoperative pneumothorax recurrence. They also found that VATS with talc poudrage (chemical pleurodesis) was as effective as mechanical pleurodesis and that VATS was superior to thoracotomy due to shorter hospital length of stay, less pain, and fewer complications. In our study, there was no significant difference between thoracotomy and VATS in terms of length of hospital stay in patients operated due to recurrence. As few patients were treated with thoracotomy, we could not perform statistical analysis in terms of recurrence. We believe the similar hospital length of stay in the surgical and nonsurgical patients in our study is attributable to our predetermined follow-up time for patients with prolonged air leak and the fact that the operating room is available on certain days of the week for patients with recurrence. We did not evaluate postoperative

length of stay specifically in our study. Ocakcıoğlu and Kupeli[17] observed in their study that length of hospital stay was shorter with pleural abrasion than with pleurectomy due to less bleeding and pain and shorter time to drain removal. The authors also reported that pleural abrasion had the same effectiveness and was safer in terms of complications when compared to pleurectomy, although another study suggested that pleurectomy was more effective than abrasion and resulted in lower recurrence rates.[18] However, Chang et al.[19] reported that operative time was shorter in the patient group that underwent abrasion and, similarly, Kocatürk et al.[20] observed that the abrasion group had significantly shorter operative times compared to the pleurectomy group. In our study, no significant differences in length of hospital stay or recurrence were detected between PSP patients who underwent pleurectomy and those who had pleural abrasion (mechanical pleurodesis), but operative time was significantly shorter when pleural abrasion was performed. We also observed no significant difference in effectiveness between pleural abrasion and pleurectomy, and we believe that, as pleural abrasion has less potential to cause problems in thoracic and cardiac surgeries that the patient may undergo in the future, this technique can be preferred when possible. Additionally, chemical pleurodesis is also an option reported to have comparable effectiveness in the literature.

Previous studies evaluated patients who underwent VATS according to port number and reported their length of hospital stay, drainage volume, and pain scale scores.[21] In our study, there was no difference between triportal and biportal VATS procedures in terms of drainage volume and length of hospital stay. However, pain scores were not evaluated in this study.

Postoperative recurrence rates have been discussed in numerous studies. These rates vary between 0 and 11% in the literature.[22] In their large-scale study, Cardillo et al.[23] compared 618 patients who underwent wedge resection and chemical pleurodesis with 720 patients who underwent chemical pleurodesis alone and determined that recurrence rates during 24-month follow-up were 2.58% and 0.69%, respectively. In a 2018 study, Kutluk et al.[21] studied 135 patients who underwent wedge resection and pleurectomy and reported a recurrence rate of 5%. In their 2011 study, Shaikhrezie et al.[24] performed wedge resection and pleurectomy on 41 patients, wedge resection and pleural abrasion on 255 patients, and wedge resection and chemical pleurodesis on 189 patients and found that recurrence rates were 0%, 3.14%, and 1.06%, respectively, at the end of 73-month follow-up. Based on these studies, chemical pleurodesis appears to be at least as effective as pleurectomy and pleural abrasion. In our study, the recurrence rate was 3.3% in patients who underwent pleural abrasion and 2.5% in patients who underwent pleurectomy. The recurrence rate among all surgical patients was 2.86%, consistent with the literature. In terms of postoperative recurrence, it can be seen that pleurectomy, pleural abrasion, and chemical pleurodesis have nearly the same effectiveness.

Studies on the relationship between BMI and pneumothorax have demonstrated a correlation between low BMI and PSP development and recurrence.[25] There are several hypotheses regarding this association. One is that imbalanced development of the body structures in individuals with low BMI increases intrathoracic negative pressure, and since this most affects the lung apices, blebs and bullae form in that area, increasing the risk of developing pneumothorax.[26] Another explanation involves alpha-1 antitrypsin deficiency due to the energy-nutrition relationship and deficiency and consequent emphysematous changes in the lung tissue.[27] Alpha-1 antitrypsin deficiency is also closely associated with abnormalities of the bronchial structures that can lead to bilateral recurrence.[5,7] Another hypothesis is that the rapid increase in height and consequent lengthening of the thoracic cage due to abnormal bone mineral density in individuals with low BMI increases intrathoracic negative pressure and the risk of PSP.[28] In individuals with high BMI (overweight/obese), this condition is a risk factor for metabolic diseases, coronary artery disease, diabetes mellitus, and hypertension, while in individuals with low BMI it has been associated with immune-deficiencies related to malnutrition and increased infection risk.[29] In our study, there was no significant difference in recurrence between patients with low and high BMI.

The patients in this study were evaluated in three groups based on the time from symptom onset to hospital admission. Our objective was to compare these patients; who presented immediately (within the first 24 h after symptom onset), the ones presented after the epithelization began (within 24 to 72 h) and those presented after the onset of visceral pleural thickening associated with collapse (after 72 h). In the light of our results, surprisingly, we can deduce that longer interval between symptom onset and hospital admission

and lower BMI had no adverse effect on treatment outcomes and the recurrence in PSP patients. In the other words, time of admission did not have significant effect in recurrence, need for surgery and length of hospital stay. Despite the fact that surgical treatment significantly decreased the recurrence rate, we conclude that pleurectomy or pleural abrasion techniques have no difference on the clinical influence and recurrence of the patients with PSP. Our results confirm the need of further studies with larger series and more data to further examine this issue.

The single-center, retrospective design and the inability to conduct multivariate analyses due to the small number of patients are the main limitations of our study.

In conclusion, a consensus has not been reached regarding therapeutic approaches for patients with an initial episode of primary spontaneous pneumothorax, yet. The results of our study are largely consistent with the literature data, although we did not detect a higher frequency of pneumothorax recurrence in males, smokers, and underweight patients in our study. On the other hand, the fact that we observed no significant difference in effectiveness between pleurectomy and pleural abrasion strengthens our belief that pleural abrasion should be the preferred approach, considering operative times are shorter, there is less bleeding, and there would be less adverse impact on future thoracic surgeries. In addition to these surgical techniques, chemical pleurodesis was also an effective method in our study that should be used in the clinical practice. We recommend surgical treatment for patients presenting with an initial episode of primary spontaneous pneumothorax even in the absence of prolonged air leak if imaging shows obvious bulla or bleb formation. The video-assisted thoracoscopic surgery technique is as effective as thoracotomy as the surgical technique, and this minimally invasive method is more appropriate for patients who require surgery. Our results suggest that delayed hospital admission after the onset of the symptoms is not a factor that adversely affects pneumothorax treatment and recurrence. Further multi-center studies may provide more definitive results.

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