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ORIGINAL INVESTIGATION

Video-Assisted Thoracoscopic Pleurectomy in Spontaneous Pneumothorax Surgery

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Abstract

OBJECTIVES: Published experiences with thoracoscopic apical or total pleurectomy for patients with a pneumothorax are limited. We aimed to evaluate the long-term results and effectiveness of pleurectomy in our patients, that vast majority of whom underwent thoracoscopic apical or total pleurectomy.

MATERIAL AND METHODS: Between January 2001 and December 2010, in the Istanbul University Medical School Department of Thoracic Surgery, 67 patients, consisting of 52 patients with a primary spontaneous pneumothorax and 15 with a secondary spontaneous pneumothorax who underwent 72 processes of thoracoscopic resection of blebs or bullae and pleural symphysis, consisting of 43% total pleurectomy, 42% apical pleurectomy plus pleural abrasion, and 15% non-pleurectomy pleurodesis procedures due to prolonged air leak or recurrent spontaneous pneumothorax, were analyzed retrospectively. The applied pleural procedures were: 1. total pleurectomy 2. apical pleurectomy and pleural abrasion for the remaining parts and 3. non-pleurectomy pleurodesis procedures. The long-term outcomes of patients undergoing the three different pleural procedures were compared.

RESULTS: Total pleurectomy process, apical pleurectomy and abrasion process for remaining parietal pleura, and non-pleurectomy pleurodesis procedures were performed 31, 30, and 11 times, respectively. No recurrence was observed in the total pleurectomy group, 1 recurrence was observed for the apical pleurectomy plus pleural abrasion group, and 2 recurrences were observed for the non-pleurectomy group.

CONCLUSION: Video-assisted thoracoscopic pleurectomy is a safe and effective method in spontaneous pneumothorax surgery. Especially, total pleurectomy has efficient results in the prevention of recurrences.

KEY WORDS: Pneumothorax, thoracoscopic/VATS, outcomes, emphysema/bullae

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INTRODUCTION

Pneumothorax, which occurs in the absence of traumatic or iatrogenic causes (puncture, catheterization, ventilation, biopsy) is called spontaneous pneumothorax (SP) [1]. SP is divided into two sub-groups: primary spontaneous pneumothorax (PSP) and secondary spontaneous pneumothorax (SSP). PSP, while the lung parenchyma is normal, occurs as a result of the rupture of a subpleural bleb. SSP arises as a result of an underlying parenchymal disease [2]. In general, tube drainage is an acceptable treatment strategy in the first episode of SP. There is no consensus on the timing of surgery and the type of operation for the recurrence of SP and inadequate treatment of the first episode of SP. Recurrence of pleural drainage and surgical treatment are the treatment options. In recent years, the importance of video-assisted thoracoscopic surgery (VATS) has been increasing in pneumothorax surgery [3]. In this study, we aimed to present, in general, the long-term results of pleurectomy and, in particular, the role of total pleurectomy in the prevention of recurrence in our patients in whom we performed three different pleural processes with VATS due to recurrent or persistent SP.

MATERIAL AND METHODS

The patients, who were referred to our clinic due to a first-episode or recurrent SP and treated with VATS during January 2001 to December 2010, were included in the study. Four patients without follow-up were excluded from the analysis. The medical records of 67 patients, consisting of 52 patients with PSP and 15 SSP undergoing a total of 72 procedures, consisting of 31 total pleurectomies, 30 apical pleurectomies plus pleural abrasion, and 11 non-pleurectomy pleurodesis procedures, were reviewed retrospectively. Long-term results were obtained by letter, telephone, and outpatient controls. Follow-up completion rates in the PSP group and SSP group were 95% and 94%, respectively. The PSP and SSP groups

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were evaluated secondarily in terms of age, gender, affected side, surgical indication, primary diseases, length of stay with tube, length of stay in the hospital, parenchymal pathologies, morbidity, and mortality. All patients were compared and evaluated statistically in terms of the parenchymal pathologies of the patients with PSP and SSP and the mean age, gender, type of pneumothorax, postoperative complications, and long-term results of the 3 different pleural processes applied. Prolonged air leak was considered a time of 7 days. Also, 40% of patients underwent the first tube thoracostomy intervention in our clinic; 60% of patients underwent the first tube thoracostomy intervention in the emergency surgery clinic and were then transferred to our clinic. The patients with recurrent SP underwent the operation within 24 hours after admission. In all patients, the diagnosis of pneumothorax was performed with radiographs and/or computed tomography. The patients whose diameter of pneumothorax did not exceed 20% of the hemithorax (according to the Light index) and was not progressive did not undergo any interventional procedure before the operation. If there was a wide pneumothorax that led to respiratory distress and bad patient comfort during the application, pleural drainage was obtained with a number 28 drain placed through the 5th intercostal space (ICS)-midaxillary line (MAL). Then, each patient was treated with VATS. All of the patients instruced and gave written consent for the surgical procedure.

Endoscopic observation of all of the pleural cavity and the lung parenchyma was performed. Pathological lesions that were diagnosed during the endoscopic examination were classified according to Vanderschueren's classification, as follows: stage I: no endoscopic abnormalities; stage II: pleuropulmonary adhesions; stage III: blebs/bullae of <2 cm; and stage IV: bullae of >2 cm**.**

Basically, 3 pleural symphysis techniques were used: non-pleurectomy procedures (Group 1), apical pleurectomy plus pleural abrasion (Group 2), and total pleurectomy (Group 3).

Group 1: 4 grams of asbestos-free talcum powder was sprayed to the lung and the surface of the parietal pleura in 2 patients for talc pleurodesis. Three patients underwent argon cauterization to the parietal pleura. In 4 patients, all parietal pleura underwent pleural abrasion. Two patients received Pleuraseal to the suture line of the wedge resection.

Group 2: In apical parietal pleurectomy, pleurectomy was performed from 5. ICS, both at the front and back side. Abrasion was performed for the rest of the parietal pleura.

Group 3: In total parietal pleurectomy, pleurectomy was performed from the apex, anterior, posterior, and lateral to the diaphragmatic sinuses.

Statistical Analysis

Data analysis was performed using the computer software Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) for Windows, version (16.0). Pearson's X^2 test was used to determine whether there was any significant difference between groups. The X^2 test was replaced by Fisher's exact test if the cell frequencies of any of the 2 x 2 contingency tables went below 5. We used Kruskal-Wallis test for comparing continuous variables.

RESULTS

It has been observed that male gender was dominant in both the PSP and SSP groups, and the mean age was lower in the PSP group. Five patients were treated with VATS for both the right and left sides. The features and the distribution of patients, such as gender, median age, the type of pneumothorax, and affected side, are given below (Table 1). The mean age was 31.3 years in the total pleurectomy group, 32.7 years in the apical pleurectomy and pleural abrasion group, and 35.6 years in the non-pleurectomy group. There was no statistically significant difference between the three groups in terms of age (p=0.73). The total pleurectomy group consisted of 3 patients (9.7%) with SSP and 28 patients (90.3%) with PSP. The apical pleurectomy and pleural abrasion group consisted of 7 patients (23.3%) with SSP and 23 patients (76.7%) with PSP. The non-pleurectomy group consisted of 7 patients (63.6%) with SSP and 4 patients (36.4%) with PSP. There was a statistically significant difference between the three groups in terms of the type of pneumothorax (p=0.001). The total pleurectomy group included 11 females (35%) and 20 males (65%). The apical pleurectomy and pleural abrasion group included 3 (10%) females and 27 males (90%). The non-pleurectomy group included 3 females (27%) and 8 males (73%). There was no statistically significant difference between the three groups in terms of the rate of gender (p=0.06).

Basically, our operation indications consisted of prolonged air leak that was longer than 7 days or recurrent pneumothorax on the ipsilateral or contralateral side. Also, giant bullae formation was an indication for operation for 2 patients. In the PSP group, while 17 patients experienced the first pneumothorax episode with persistent air leak, recurrent pneumothorax was an issue in 35 patients. On the other hand, in 3 patients, pneumothorax developed on both the left and right sides at different times. In 2 of these 3 patients, while the first PSP episode developed on one side, recurrent PSP developed on the other side. In the SSP group, 7 patients had their first episode with persistent air leak, and in 6 patients, recurrence developed. In 2 patients, simultaneous bilateral SSP developed. Nine different indications were the issue for the operation. Recurrent pneumothorax consisted of 65% of the PSP group and 42% of the SSP group (Table 2).

The underlying diseases in the SSP group were as follows: 10 (58%) bullous emphysema, 2 (12%) interstitial lung disease, 2 (12%) bronchial asthma, 1 (6%) bronchiectasis, 1 (6%) tuberculosis, and 1 (6%) Langerhans cell histiocytosis.

Thirty-one (43%) patients underwent apical wedge resection and/or bullae and/or bleb resection plus total parietal pleurectomy procedures, and 30 (42%) patients underwent api-

Table 1. Patient characteristics

Type of pneumothorax	PSP	SSP	P
Gender (Male/Female)	40/12	11/4	0.78
Median age (distribution)	29 (17-68)	42 (21-63)	<0.001
Side (right/left)	28/27	12/5	0.25

PSP: primary spontaneous pneumothorax; SSP: secondary spontaneous pneumothorax

cal wedge resection and/or bullae and/or bleb resection plus apical parietal pleurectomy plus pleural abrasion procedures. These two surgical procedures consisted of 85% of the surgical procedures. Eleven patients underwent non-pleurectomy methods (Table 3).

In all patients, pulmonary parenchyma was evaluated intraoperatively. Multiple bullae were observed in a total of 29 (42%) patients, multiple blebs were observed in 9 (13%) patients, one or two ruptured bullae were observed in 9 (13%) patients, normal parenchyma was observed in 7 (10%) patients, multiple bullae and blebs were observed in 5 (7%) patients, ruptured bleb was observed in 4 (6%) patients, giant bullae formation/giant bullae formation plus a bulla or bleb were observed in 4 (6%) patients, and diffuse nodules in pulmonary parenchyma was observed in 1 (1%) patient. The surgery report was not obtained for 4 patients (Table 4). In 25 patients in the PSP group (n=51) and in 9 patients in the SSP group (n=17), widespread bullous involvement was observed. No statistically significant difference was found between the two groups (p>0.05). In 7 (13.7%) patients in the PSP group, patho-morphological changes were not detected. In all patients in the SSP group, lung lesions were found to be present. However, no statistically significant difference was found between the two groups (p>0.05).

None of the patients required open thoracotomy and the intensive care unit. Morbidity and mortality were not observed. None of the patients had postoperative or intraoperative hemorrhage requiring blood transfusion. In only 6 patients, prolonged postoperative air leak was observed (>7 days); 2 of them (3.6%) were in the PSP group, and 4 (23.5%) of them were in the SSP group. Two patients in the SSP group were discharged with a Heimlich valve. Prolonged air leak in other patients with SSP was stopped on the 9th and 10th days with negative aspiration. Postoperative prolonged air leak in the patients with PSP was stopped on the 9th day with negative pressure aspiration. Of the 6 patients with postoperative prolonged air leak, 3 of the patients (27.3%) underwent non-pleurectomy methods, 1 of them (3.3%) underwent apical parietal pleurectomy and pleural abrasion, and 2 of them (6.5%) underwent total parietal pleurectomy. There was a statistically significant difference between non-pleurectomy methods and the other 2 groups (p=0.043). The overall mean chest tube drainage and hospitalization were, respectively, 4 days (range: 1-17 days) and 7 days (range: 3-33 days). Mean duration of tube drainage in the PSP and SSP groups was 3.4 days (range: 1-10 days) and 5.9 days (range: 2-17 days), respectively. Mean postoperative hospital stay in the PSP and SSP groups was 6.4 days (3-33 days) and 9.1 days (3-30), respectively. Mean follow-up time was 53.6 months (range: 9-114 months). Recurrence rates were in general 4% (n=3), 18% in the group of non-pleurectomy pleural procedures (n=2), 3% in the group of apical pleurectomy plus pleural

Table 2. The distribution of indications for operation

Indications	PSP (%)	SSP (%)
First recurrence	29 (52.7)	6 (35.2)
Prolonged air leak	13 (23.6)	4 (23.5)
The second recurrence	7 (12.7)	1 (5.8)
The recurrence in the opposite side	3 (5.4)	0
Two-sided pneumothorax	0	3 (17.6)
Previous pneumothorax on the opposite side	2 (3.6)	1 (5.8)
Two-sided blebs and bullae	1 (1.8)	0
Giant bullae formation	0	1 (5.8)
Volume reduction surgery	0	1 (5.8)
Total	55 (100)	17 (100)

PSP: primary spontaneous pneumothorax; SSP: secondary spontaneous pneumothorax

Table 3. Surgical procedures

Surgical Procedures	Number of Procedures	%
AWR and/or bullae and/or bleb resection plus TPP	31	43
AWR and/or bullae and/or bleb resection plus APP plus PA	30	41.7
AWR and/or bullae and/or bleb resection plus PA	3	4
AWR and/or bullae and/or bleb resection plus PAC	2	2.6
VATS exploration plus air leakage control with Pleuraseal	2	2.6
VATS exploration plus air leakage control with Pleuraseal plus TP	1	1.3
Bullectomy plus implementation of Pleuraseal to the stapler line plus PAC	1	1.3
Decortication plus wedge resection of the superior lingula plus PA	1	1.3
AWR plus TP	1	1.3
Total	72	100

VATS: video-assisted thoracoscopic surgery; AWR: apical wedge resection; TPP: total parietal pleurectomy; APP: apical parietal pleurectomy; PA: pleural abrasion; PAC: pleural argon cauterization; TP: talc pleurodesis

Table 4. Distribution of the lesions observed intraoperatively

Lung lesions	PSP (%)	SSP (%)
Endoscopic abnormalities (-)	7 (13.7)	0 (0)
Multiple bullae	22 (43)	7 (41)
A ruptured bleb	4 (7.8)	0 (0)
Multiple blebs	9 (17.6)	0 (0)
Multiple bullae and blebs	3 (5.8)	2 (11.7)
One or two ruptured bullae	5 (9.8)	4 (23.5)
Giant bullae formation	1 (1.9)	3 (17.6)
Widespread nodules in the lung parenchyma	0 (0)	1 (5.8)
Total	51 (100)	17 (100)

PSP: primary spontaneous pneumothorax; SSP: secondary spontaneous pneumothorax

abrasion (n=1), and 0% in the total pleurectomy group (n=0). Recurrence rates between these three categories were statistically significantly different (p<0.05). All of the patients with recurrence were in the SSP group. The recurrence rate of patients with SSP was 17%; the recurrence rate of patients with PSP was 0% (Table 5).

Recurrences developed 11, 14, and 24 months after VATS treatment. The first patient underwent bullectomy and apical parietal pleurectomy with open thoracotomy. The second patient underwent bullectomy with VATS plus wedge resection of the lingular segment and Pleuraseal. The third patient underwent bullectomy with VATS plus wedge resection of the lingular segment and apical parietal pleurectomy.

DISCUSSION

Thoracoscopic surgery can be used safely and effectively in the treatment of recurrent and persistent PSP [4]. VATS allows the observation of the entire lung, detection of blebs and bullae, and resection of bullous disease. There is generally a good consensus between surgeons about VATS bullectomy plus pleurodesis or partial pleurectomy. Mostly, the purpose is lung re-expansion to stop air leaks and to prevent recurrence [5]. Many surgical techniques have been described, such as the stapler, loop technology, or electrocoagulation, for the resection of blebs and bullae [5-8]. For all of these reasons, today, many surgeons use VATS in the treatment of PSP [9]. VATS treatment has excellent long-term results and low recurrence rates in both SSP and PSP [10]. Also, it must be the first option in the surgical treatment of recurrent SP due to lower postoperative morbidity, lower analgesic requirement, a lower rate of chronic pain in the long term, better cosmetic results, and a high degree of patient satisfaction [11]. In the vast majority of publications on VATS treatment in PSP, blebectomy plus pleurodesis is recommended more than pleurectomy. The reason for this is because pleurectomy is performed insufficiently with VATS and, as it is seen in the meta-analysis of comparative studies, the rate of recurrence may become 4 times higher compared to thoracotomy (4.73 relative risk of recurrence after VATS compared to thoracotomy, 7.1% average recurrence rate in patients undergoing VATS; 1.0% in patients undergoing thoracotomy) [12]. A small number of researchers have published their experiences with VATS in apical and complete pleurectomy [4,13-15].

Our cases, in which we applied apical or total pleurectomy 61 times, consisted of patients with both SSP and PSP. In our clinic, with the aim of pleural symphysis, a total of 61 total pleurectomies or partial pleurectomies plus pleural abrasion and 11 non-pleurectomy methods were performed. There was no statistically significant difference between these three groups in terms of age and rates of gender. But, there was a statistically significant difference between the non-pleurectomy method and other two groups in terms of the rates of PSP and SSP. In the PSP (n=55) group, the non-pleurectomy method was used only for 4 patients. In the PSP group, total pleurectomy or partial pleurectomy plus pleural abrasion was applied 51 times. In the SSP (n=17) group, non-pleurectomy methods was applied 7 times, and total pleurectomy or partial pleurectomy plus pleural abrasion was applied 10 times. These 7 patients with bullous emphysema and recurrence were mostly cases that were being shown a palliative surgical approach due to the possibility of further lung transplantation. In all cases, blebs/bullae plus apical wedge resection were performed for lung parenchyma. Our intra-operative endoscopic observations demonstrated widespread bullous involvement (stage 4) in half of the patients in the PSP group (n=25). In the SSP (n=17) group, widespread bullae (stage 4) were observed in 9 patients. Inderbitzi et al. [6] showed in a study of 79 cases that there were no pathomorphological changes in only 5.1% of the cases. Cardillo et al. [4] detected normal lung parenchyma in only 30 (6.94%) of the 432 patients. In our study, according to Vanderschuren classification [16], stage 3 and stage 4 pulmonary lesions were present in 44 (86.3%) patients in the PSP group; pathomorphological changes were not detected in only 7 (13.7%) patients. In the SSP group, it was detected that all patients had lung lesions. This observation is supported by articles that reported that blebs and bullae were detected in over 80% PSP patients treated with VATS [17-19]. In addition, there are some studies that reported that emphysema-like changes were detected by high-resolution CT in 80% of patients with a first episode of PSP [20,21].

In our study, the morbidity rate, length of stay with tube, and length of stay in the hospital were consistent with other studies in the literature [6,17,18,22]. Morbidity in the non-pleurectomy group was higher than in the pleurectomy groups. There was a significant difference between the 2 pleurectomy groups and non-pleurectomy group in terms of postoperative complications. Our study is one of the two longest studies in the literature, with a mean follow-up of 53.6 months [4,14,18,19,21]. In our study, the overall recurrence rate was 4% with 3 patients. This recurrence rate is lower than the recurrence rates of other studies in which VATS treatment was applied due to PSP [12]. In the study conducted by Nathan et al. [23], consisting of 39 patients who underwent total thoracoscopic pleurectomy, the recurrence rate was 2.5%. In this study, the median follow-up time was 24.1 months. In the mentioned study, Nathan et al. indicated that the following should be made aware of for total pleurectomy: the potential pitfalls of total parietal pleurectomy include several things. First, if one inadvertently enters a plane deep to the endothoracic fascia, troublesome capillary bleeding or even neurovascular injury may occur. Second, we have found that taking the pleurectomy only as far anteriorly as approximately 2 cm from the mammary vessels and only as far posteriorly as 2 cm from the sympathetic chain is advisable; we did incur one

Table 5. Recurrence rates according to pleural procedures applied

	NPM/ Recurrence	AP plus PA/ Recurrence	TP/ Recurrence	p*
PSP group	4/0	23/0	28/0	
SSP group	7/2	7/1	3/0	
Total	11/2	30/1	31/0	<0.05

P value is determined for comparison of recurrence rates. PSP: primary spontaneous pneumothorax; SSP: secondary spontaneous pneumothorax; NPM: non-pleurectomy method; AP: apical pleurectomy; PA: pleural abrasion; TP: total pleurectomy

troublesome unilateral sympathectomy early in our experience. Third, care must be taken to keep the pleura intact over the critical structures at the junction of the mediastinum and the apex and the mediastinum proper. If these guidelines are followed, the procedure is fast and easy and incurs little morbidity. In the long term, there is no doubt that a total pleurectomy will render any future chest operation (eg, lung cancer resection) difficult in these patients. However, this issue would come into play in only very few individuals, because most PSP patients are healthy nonsmokers, and even heavy long-term smokers have a lung cancer risk of only approximately 15% to 20% [23].

On the other hand, in a study conducted by Sheaikrezai et al. [10] with 644 patients, aggressive pleurodesis methods, such as pleurectomy, have not been recommended for younger patients. In combination with bullectomy, the pleurodesis efficacy of abrasion and poudrage is not significantly different from pleurectomy. This would suggest that the least traumatic pleurodesis technique of abrasion might be the best first choice for younger patients in association with bullectomy, unless there are pressing reasons to choose a more aggressive pleurodesis approach [10]. Nevertheless, in the study in which Leo et al. [24] performed VATS-limited pleurectomy for 54 patients and wide pleurectomy with open thoracotomy for 36 patients, the recurrence rates in the VATS group and thoracotomy group were 4% and 0, respectively. In the meta-analysis of Bille et al. [25] consisting of 29 studies, the following conclusions were obtained: the most important factor influencing the results of pneumothorax surgery is the surgical entry. VATS has a 4 times higher recurrence rate compared with open surgery. Compared with pleurectomy, despite pleural abrasion having a higher relative risk of recurrence, it was not statistically significant, and further studies are needed in this regard [25]. Two of the patients observed in our study were patients with SSP who underwent a method of non-pleurectomy: In one of them, no pleural procedures were applied; in the other, argon cauterization was performed in the parietal pleura. The third patient was a patient with SSP who underwent apical parietal pleurectomy plus pleural abrasion as a pleural process. In the patients who underwent non-pleurectomy pleural procedures, the recurrence rate (18%) was quite high. In the pleurectomy group (total plus apical), the recurrence rate was at very low (1.6%) levels, and the absence of recurrence in the total pleurectomy group was remarkable. On the other hand, Merino et al. [26], in a study including 787 cases, talc poudrage was applied to half of the cases, while pleural abrasion was applied to other half of cases. These authors detected a 2.8% recurrence rate for the pleural abrasion group and a 1.03% recurrence rate for the talc poudrage group [26]. In a study, Shaikhrezai et al. [10] applied bullectomy plus abrasion, bullectomy plus talc pleurodesis, or bullectomy plus pleurectomy and compared PSP and SSP groups; they found no significant difference between the two groups. Although all of the patients with recurrence were in the SSP group, we consider that the high recurrence rate of the non- pleurectomy group was associated with the process, due to the presence of parenchymal lesions that we observed in the PSP group, which was also supported by other studies [4,6,17-21].

As a result, today, VATS is a safe and effective treatment approach in the treatment of recurrent SP and persistent SP. Although patients with PSP and SSP were present in different numbers in the three groups, there was no statistically significant difference between PSP and SSP in terms of parenchymal lesions in our study and in other studies. We think that total pleurectomy is the most effective method of pleural symphysis, with a very low recurrence rate; in particular, it is a treatment approach that should be used in experienced centers for recurrent and persistent SP. Our study is remarkable because we performed total pleurectomy for approximately half of the total cases.

Ethics Committee Approval: Because of retrospective design, ethics committee approval was not received for this study.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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Conflict of Interest: No conflict of interest was declared by the authors.

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