RESEARCH ARTICLE

Comparison of VATS and limited axillary thoracotomy in the treatment of spontaneous pneumothorax: A cross-sectional study

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Abstract

Objective: To compare the results of conventional mini axillary thoracotomy with video-assisted thoracic surgery in the treatment of spontaneous pneumothorax.

Method: The retrospective study was conducted at Izmit Seka State Hospital, Kocaeli, Turkey, and Canakkale Onsekiz Mart University Teaching Hospital, Çanakkale, Turkey, and comprised data from November 2011 to May 2019 of patients who underwent surgery for spontaneous pneumothorax either with video-assisted thoracic surgery, who were placed in Group A, or axillary thoracotomy, who were placed in Group B. Data gathered related to age, gender, operation side, smoking status, postoperative hospital stay, recurrence rates, and postoperative complications. Data was analysed using SPSS 25.

Results: Of the 75 patients, 60(80%) were male and 15(20%) were female. The overall mean age was 29.37±11.60 years. Group A had 41(54.7%)patients, while Group B had 34(45.3%). Postoperative recurrence was not encountered in any patient in Group B, while 2(5.4%) patients in Group A had a recurrence ($p>0.05$) who both continued smoking. Hospital stay was significantly higher in Group B ($p<0.001$).

Conclusion: Video-assisted thoracic surgery in the treatment of spontaneous pneumothorax was found to shorten hospital stay, and can be used more widely.

Keywords: Spontaneous pneumothorax, Recurrence, Video-assisted thoracoscopic surgery, Pleurodesis, Thoracotomy. (JPMA 71: 1107; 2021)

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Introduction

Pneumothorax is defined as air or gas accumulation in the pleural cavity which may affect ventilation, oxygenation or both. Pneumothorax can be asymptomatic or progress into a life-threatening pathology.[1] Spontaneous pneumothorax (SP) can be classified as primary or secondary. Primary spontaneous pneumothorax (PSP) occurs when the patient does not have an underlying history of pulmonary disease, and secondary spontaneous pneumothorax (SSP) is associated with some underlying pulmonary disease history. In the course of the disease, the most feared complication is tension pneumothorax. Treatment of this disease is associated with many factors, such as the patient's stability, size of pneumothorax, recurrence and its type.[2] On the other hand, the treatment of SP is still controversial. There are different opinions not only among chest physicians and thoracic surgeons, but also between geographical locations, such as the United States, the United Kingdom and Europe. These disagreements are also reflected in different guidelines.[3,4]

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SP continues to be a health concern due to its recurrence rates after thoracic drainage and conservative treatments.[5] Conservative first-line treatments of SP include rest, needle aspiration and tube drainage called thoracostomy. These procedures are safe, but the high recurrence rates (60%) may necessitate later thoracotomy.[4,6] The standard surgical intervention in pneumothorax was by axillary or lateral thoracotomy.[7]

Recently, video-assisted thoracoscopic surgery (VATS) has become the gold standard for surgical treatment of pneumothorax,[8] making it the preferred procedure for the treatment of PSP, including blebectomy and bullectomy, by many centres.[9]

The current study was planned to compare VATS and axillary thoracotomy (AT) in terms of surgical technique, outcome and complications of SP.

Materials and Methods

The retrospective study was conducted at Izmit Seka State Hospital, Kocaeli, Turkey, and Canakkale Onsekiz Mart University (COMU) Teaching Hospital, Çanakkale, Turkey, and comprised data from November 2011 to May 2019 of patients who underwent surgery for SP. Data was retrieved after approval was obtained from the institutional ethics review board of COMU.

For SP treatment, the British Thoracic Society (BTS) criteria[3] was used. Surgery indications included having a second pneumothorax on the ipsilateral side, first pneumothorax on the contralateral side, synchronous bilateral pneumothorax, resistant air leak for more than 5-7 days despite tube thoracostomy, spontaneous haemothorax, expansion defect in the lung, professional occupational risk, like in divers and pilots, and pregnancy.[8-10]

All patients who underwent VATS or AT for SP at the two study sites were included. Patients excluded were those having traumatic or iatrogenic pneumothorax, a history of continuous drug use, or history of thoracic surgery (Figure).

In addition to demographic data, operation type, operation side, postoperative hospital stay, recurrence rates and other complications were recorded from patient files. Patients who smoked at least one cigarette per day were categorised as smokers. Primary and secondary pneumothoraxes were merged under one category.

At the time of admission, tube thoracostomy had been applied to all patients to preserve respiratory function and haemodynamic stability. Preoperatively, all patients had undergone posteroanterior/lateral (PA/L) chest X-ray, computed tomography (CT), electrocardiography, complete blood count (CBC), and basic biochemical tests including sodium, potassium, chloride, bicarbonate, blood urea nitrogen (BUN), magnesium, creatinine and glucose.

All patients had been intubated with double-lumen tubes under general anaesthesia. In the AT group, muscle-sparing mini-AT was performed, with the arm suspended 90 degrees in the lateral decubitus position, using an approximately 4cm oblique incision from the 4th intercostal space, middle axillary line to the anterior axilla. Patients in the VATS group were operated upon while entering from the mid-axillary line at the 5th intercostal space using a uniport and/or multiport, 10-mm, 30-degree endoscope, endoscopic grasper, and endoscopic linear stapler. In both groups, pleural adhesions were removed by blunt and sharp dissection. In the AT group, bullae or bleb were resected with a linear stapler, while linear endoscopic staplers were used in the VATS group. Parietal pleurectomy was performed using a thoracoscopic forceps in the VATS group from the apical pleural region up to the 7th intercostal space, and with the aid of a long-curved clamp in the AT group. The wedge-resected lung tissue was sent for histopathological examination. At the end of the procedure, a 28F polyethylene drain was placed for postoperative drainage, and re-expansion of the lung was achieved with 30-mmHg pressure. The patients were discharged from hospital one day after the chest tube withdrawal when no residual pneumothorax was detected on the control chest X-rays.

All the collected data was double-checked by two researchers. Also, a phone call with the patients was arranged to clarify data when necessary. Additionally, error checking and debugging was performed after entering data into the computer.

The sample size calculation was performed after data collection, using GPower v3.1[11] to calculate the power of the study in estimating the significance of the duration of hospitalisation between the groups with independent samples t-test. The sample size was calculated for a power of 90% comparing the groups with a two-sided hypothesis and an effect size of 0.8.

Data were analysed using SPSS 25. Findings were presented as frequencies, percentages, means and standard deviations (SDs). Kolmogorov-Smirnov test was performed to test if the numerical variables were normally distributed. Independant samples t-test was used to compare data meeting parametric assumptions. Mann-Whitney U test was used for skewed variables, and chi-square test, or Fisher's exact test, was used for categorical variables.

As patients in the AT group had a significantly higher age, data was weighted for age when necessary to prevent confounding. A linear regression analysis was performed to check for variables independantly affecting the duration of hospitalisation. $P<0.05$ was considered statistically significant.

Results

Of the 75 patients, 60(80%) were male and 15(20%) were female. The overall mean age was 29.37±11.60 years (range: 17-65 years). VATS group had 41(54.7%) patients, while AT group had 34(45.3%).

Of the total, 43(57.3%) patients had ipsilateral pneumothorax, 25(33.3%) had prolonged air leak, 4(5.1%) had bullae detectable on the chest X-ray, and 3(4%) had a contralateral pneumothorax. One (1.33%) patient had a persistent air leak >5 days and occupational indication, being a sponge hunterdiver, together. Overall, 46(61.3%) patients were operated on the right side, and 29(38.7%) on the left side.

Postoperative recurrence was not encountered in any patient in the AT group, while 2(5.4%) patients in the VATS group had a recurrence ($p>0.05$); both patients had

Table-1: Comparison of demographic features and study outcomes between axillary thoracotomy (AT) and with video-assisted thoracic surgery (VATS) groups.

	AT	VATS	Test	p
Mean Age	33.00±13.52	26.36±8.81	2.350*	0.019
Mean Duration of hospitalization	5.02±1.15	3.81±0.96	4.909**	<0.001
Gender	**n (%)**	**n (%)**		
Male	30 (88.2)	30 (73.2)	2.636#	0.104
Female	4 (11.8)	11 (26.8)		
Smoking status				
Yes	29 (85.3)	29 (70.7)	2.249#	0.134
No	5 (14.7)	12 (29.3)		
Side of the lesion				
Right	24 (70.6)	10 (29.4)	2.246	0.134
Left	22 (53.7)	19 (46.3)		
Indication				
Ipsilateral recurrence	19 (55.9)	24 (58.5)	2.281#	0.516
Contralateral recurrence	2 (5.9)	1 (2.4)		
PAL	10 (29.4)	15 (36.6)		
Bullae on X-ray	3 (8.8)	1 (2.4)		
Recurrence				
Yes	0	2 (4.9%)	1.704#	0.192
No	34 (100)	39 (95.1)		
Postoperative complication				
Absent	28 (82.4)	37 (90.2	1.002&	0.497
Present	6 (17.6)	4 (9.8)		
Type of postoperative complication				
None	28 (82.4)	37 (90.2)	5.306&	0.155
Chronic pain and paraesthesia	4 (11.8)	2 (4.9)		
Winging scapula	2 (5.9)	0		
Subcutaneous emphysema	0	2 (4.9)		

SD: Standard deviation. #Chi-Square test. *Student t-test. &Fisher's exact test. §Corrected by age. **Mann-Whitney U test. PAL: Prolonged air leak.

Table-2: Factors affecting the duration of hospitalisation.

	B	t	p	95.0% CI	
				Lower	Upper
(Constant)	3.307	7.902	<0.001	2.472	4.142
Age	0.007	0.643	0.523	-0.015	0.029
Indication for surgery (ipsilateral recurrence)	-0.664	-2.766	0.007	-1.142	-0.185
Surgical intervention (AT)	1.019	4.165	<0.001	0.531	1.508
Gender (male)	0.643	1.737	0.087	-0.096	1.381
Tobacco user	0.162	0.455	0.650	-0.547	0.871
Presence of postoperative complication	0.444	1.288	0.202	-0.244	1.132

B: Unstandardized coefficients. CI: Confidence interval. AT: Axillary thoracotomy.

been continuing postoperative smoking. One (50%) of these two patients was re-operated with VATS and discharged on the 3rd postoperative day, while the other (50%) did not accept the operation, and was released on the 5th day after tube thoracostomy. No recurrence was observed in both patients during the follow-up visits. The duration of hospitalisation was significantly higher in the AT group (p<0.05).

There were no per-operative complications in both the groups. Postoperative pain and paresthesia were seen in 4(11.8%) patients after AT and 2(4.9%) after VATS. Also, 2(5.9%) AT patients had a winging scapula, and 2(4.9%) VATS patients had subcutaneous emphysema (Table-1).

Linear regression analysis was done with the duration of hospitalisation as the dependent variable. Age was entered into the model as a numerical variable, while having an ipsilateral recurrence, having an AT intervention, being male, using tobacco, and the presence

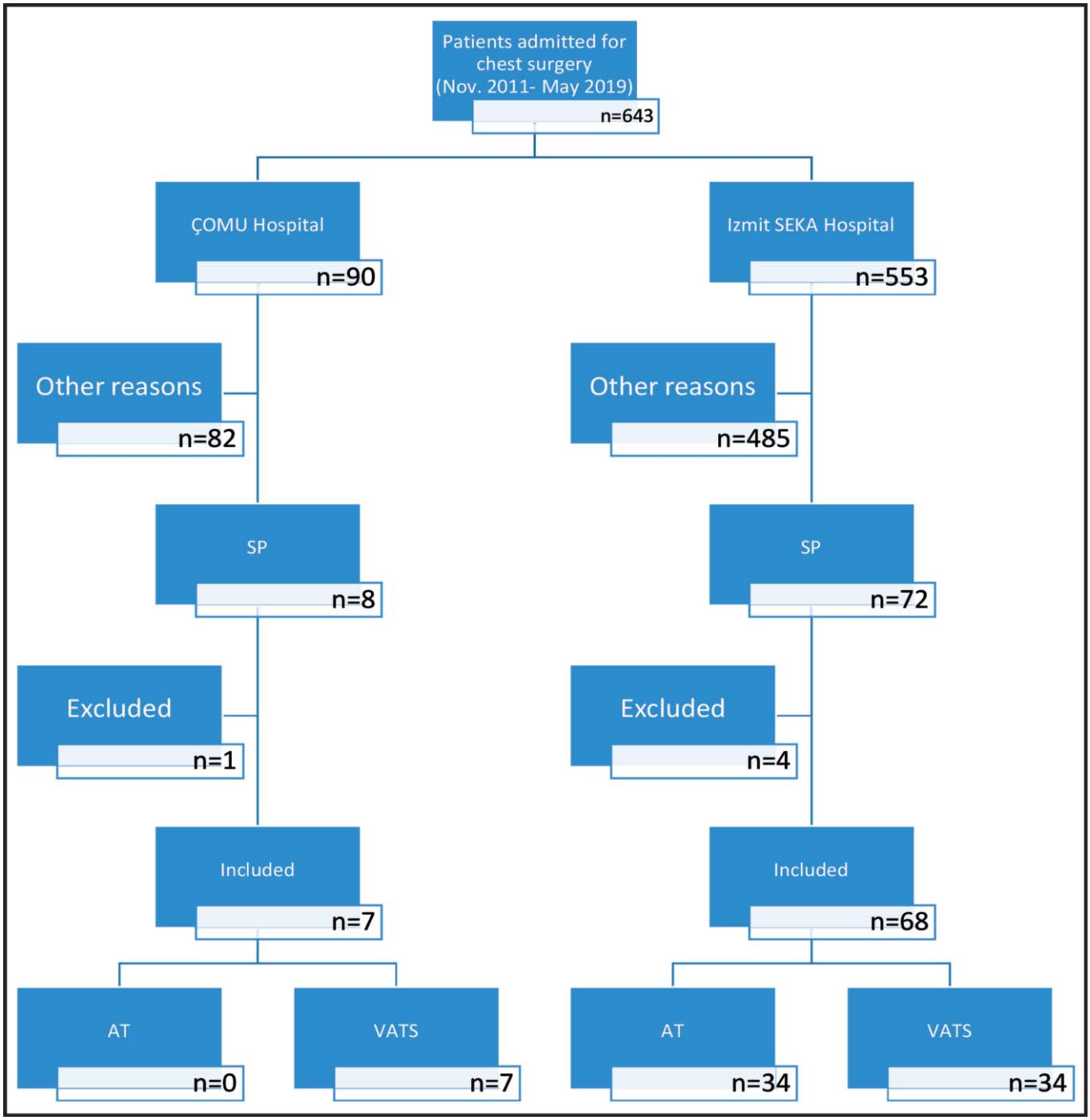

Figure: Study flow-chart.

SP: Spontaneous pneumothorax. AT: Axillary thoracotomy. VATS: Video-assisted thoracic surgery.

of complications were entered as dummy variables. The model revealed an R^2 of 39.5% with the indication for surgery and the type of surgical intervention as independent predictors of the duration of hospitalisation. Having an ipsilateral recurrence decreased the length of hospitalisation, while an AT intervention was associated with a positive effect on hospital stay (Table-2).

Discussion

Findings showed a significant association of the type of surgical intervention with the duration of hospitalisation. Among the studied variables, the type of intervention and the indication for surgery were the only factors independently affecting the duration of hospital stay.

Pneumothorax is most commonly seen among young people in their early 20s.[12] Non-traumatic air accumulation in the pleural space is referred to as SP. The condition is defined as SSP if it happens due to an underlying lung disease, or otherwise as PSP.[5] Recurrence rates of PSP and SSP are similar, but due to pulmonary pathology and low pulmonary reserves, mortality in SSP is higher.[3] Surgical options in SP are still under discussion. Among the surgical options, all forms of VATS (standard 3 ports, 2 ports and/or uniportal), anterolateral-posterolateral thoracotomy, and mini-AT are well-studied.[13,14] Most surgeons prefer blebectomy/bullectomy and parietal pleurectomy or abrasion to prevent recurrence, and use thoracotomy, multiport VATS, and, more recently, uniportal VATS techniques.[15] A recent systematic review reported that the lowest recurrence rates after SP treatment were observed in the "wedge resection + mechanical pleurodesis + chemical pleurodesis" group compared to other combined therapies.[16] In a retrospective multi-centre study concerning recurrence rates, no significant difference was found between chemical and mechanical pleurodesis.[17] Recurrence rates of pleurectomy with thoracotomy were reported as less than 1%, while the recurrence rate for VATS was reported as 4-5%.[3] Horio et al. claimed that those operated with VATS had a higher recurrence rate compared to AT, attributed to the presence of undetected bullae or bleb.[18] However, Sawada et al. found no significant difference between the two groups.[6]

Nevertheless, there may be significant differences in the recurrence rates of individual VATS practices. Bertrant et al., for example, reported the recurrence rate after VATS as 4%, while Chang et al. found a recurrence rate of 11.4%.[19,20] By practising muscle-preserving methods, minimising the incision as much as possible, exposing the ribs to a small amount of trauma, AT provides a good field of view, a large pleurectomy site, and the advantage of less postoperative pain. This method is a good alternative in the surgical treatment of SP compared to the standard posterolateral thoracotomy.[18,21] However, it has been reported that N. Thoracicus longus may be damaged in 30% of the procedures involving surgical dissection in the axilla.[22] Although not statistically different from the VATS group, we observed winging scapula after AT in two cases due to N. Thoracicus longus injury. VATS is currently preferred by thoracic surgeons worldwide for the treatment of pneumothorax. Shorter hospital stay and better cosmetic results lead to less psychological distress in patients, which are prominent advantages of VATS.[13,23] However, there might be other benefits of shorter hospitalisation, such as lower hospital costs, and less nosocomial complications, pneumonia, or deep vein thrombosis (DVT).[24] On the other hand, the Turkish universal health coverage system allows only secondary and tertiary health centres to afford the necessary surgical tools and instruments to perform VATS, and the procedure requires additional resources which might be difficult to arrange in communities with financial restraints. In the current study, postoperative hospital stay was significantly lower in patients operated with VATS. However, comparing the cosmetic outcomes of VATS and mini-AT, the advantage of VATS is not clear because the incision of AT is small and hidden in the axillary region. A prospective randomised study in 2012 supported this view and stated that the greatest advantage of VATS was patient satisfaction due to the early mobilisation of the arm and early return to daily activities.[13]

Treasure et al. defined persistent air leakage as a leak lasting 4-5 days.[25] In the current study, the duration >5 days was accepted as a persistent air leak, which was the most frequent indication for operation. The operation aims at providing adequate bullae/bleb resection to prevent air leakage and recurrence and to assist adhesion by performing apical pleurectomy. Parietal pleurectomy is considered to be the best method to achieve pleurodesis, but there is a disadvantage of possible bleeding, resulting in haemothorax[13]. In the current study, both centres employed apical pleurectomy in all patients, and there was no patient undergoing abrasion. Postoperative haemothorax was also not observed in any of the cases.

Although some studies argue that there is no significant association between smoking and recurrence, others have reported that smoking increases the recurrence rate.[19,26] In the current study, although both postoperative relapse patients continued to smoke, no statistically significant association was found between smoking and recurrence. Despite the absence of a statistically significant relationship, it is suggested that patients with pneumothorax should stop smoking.

Neuropathic pain after thoracotomy is quite common and sometimes debilitating. The pain may become chronic, and is characterised by a burning sensation, numbness or paresthesia, pressure-like feeling, and tenderness.[27] Although VATS is generally less invasive than thoracotomy and is considered a less painful approach,[28] in a prospective randomised study, no significant difference was found between muscle-protective thoracotomy and posterolateral thoracotomy in the level of neuropathic pain.[29] In the current study, postoperative pain and paresthesia were observed in 4 patients who underwent AT and 2 who underwent VATS. Only one patient with AT did not benefit from medical treatment and was referred to the pain clinic.

The current study has some limitations, including its retrospective nature and the relatively small smaple size.

Conclusion

VATS as the first-line treatment for SP allowed low morbidity/mortality rates, short hospitalisation, and excellent quality of life. Thus, considering the rapid developments in surgical instruments and techniques, it should be regarded as a safe and effective method from the perspectives of patient outcomes as well as costs. In smaller thoracic surgery clinics, on the other hand, where VATS is not possible, muscle-sparing mini-AT seems an easily applicable and appropriate method in the surgical treatment of SP.

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Conflict of Interest: None.

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