



## A comparison of axillary thoracotomy versus video-assisted thoracoscopic surgery in the surgical treatment of primary spontaneous pneumothorax

*Primer spontan pnömotoraksın cerrahi tedavisinde aksiller torakotomi ile video yardımcı torakoskopik cerrahinin karşılaştırılması*

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### ABSTRACT

**Background:** This study aims to compare the results of video-assisted thoracoscopic surgery and axillary thoracotomy in the surgical treatment of primary spontaneous pneumothorax.

**Methods:** Between January 2009 and December 2015, a total of 199 patients (178 males, 21 females; mean age 21.3±7.1 years; range 13 to 35 years) with primary spontaneous pneumothorax who were operated at Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital, Department of Thoracic Surgery and Kadıköy and Kozyatağı Acibadem hospitals were retrospectively analyzed. Of these patients, 48 underwent axillary thoracotomy, wedge resection, apical pleurectomy, and tissue adhesives, while 151 were administered video-assisted thoracoscopic surgery, wedge resection, apical pleurectomy, and tissue adhesives. Both groups were compared in terms of age, gender, the amount of long-term analgesic use, duration of surgery, length of hospitalization, recurrence, complication, and mortality rates.

**Results:** The patients were followed for one year. No mortality was observed in any patient. There was no significant difference in the age and gender distributions of the patients, postoperative length of hospital stay, recurrence rates, and complication rates according to the type of operation. However, the duration of operation was longer in the video-assisted thoracoscopic surgery patients.

**Conclusion:** Video-assisted thoracoscopic surgery is associated with less pain and higher patient satisfaction and allows returning to daily activities in a shorter time period. Based on our study results, we suggest that video-assisted thoracoscopic surgery is more suitable, compared to axillary thoracotomy, owing to its advantages, such as being less invasive and providing a better angle of view.

**Keywords:** Axillary thoracotomy; primary spontaneous pneumothorax; video-assisted thoracoscopic surgery.

### ÖZ

**Amaç:** Bu çalışmada primer spontan pnömotoraksın cerrahi tedavisinde video yardımcı torakoskopik cerrahi ile aksiller torakotomi sonuçları karşılaştırıldı.

**Çalışma planı:** Ocak 2009 - Aralık 2015 tarihleri arasında Dr. Siyami Ersek Göğüs Kalp ve Damar Cerrahisi Eğitim ve Araştırma Hastanesi Göğüs Cerrahisi Kliniği ile Kadıköy ve Kozyatağı Acibadem Hastanelerinde primer spontan pnömotorakslı olan ve ameliyat edilen toplam 199 hasta (178 erkek, 21 kadın; ort. yaş 21.3±7.1 yıl; dağılım 13-35 yıl) geriye dönük olarak incelendi. Hastaların 48'ine aksiller torakotomi, kama rezeksiyon, apikal plörektomi ve doku yapıştırıcısı uygulanır iken, 151'ine video yardımcı torakoskopik cerrahi, kama rezeksiyon, apikal plörektomi ve doku yapıştırıcısı uygulandı. İki grup yaş, cinsiyet, uzun süre analjezik kullanım miktarı, ameliyat süresi, hastanede kalış süresi, nüks, komplikasyon ve mortalite oranları açısından karşılaştırıldı.

**Bulgular:** Hastalar bir yıl süreyle takip edildi. Hiçbir hastada mortalite gözlenmedi. Ameliyat tipine göre hastaların yaş ve cinsiyet dağılımları, ameliyat sonrası hastanede kalış süreleri, nüks oranları ve komplikasyon oranları açısından istatistiksel olarak anlamlı bir farklılık görülmedi. Ancak, ameliyat süresi yardımcı torakoskopik cerrahi yapılan hastalarda daha uzundu.

**Sonuç:** Video yardımcı torakoskopik cerrahi daha az ağrı ve daha yüksek hasta memnuniyeti ile ilişkilidir ve günlük aktivitelere daha kısa sürede dönüş yapılmasına olanak sağlar. Çalışma sonuçlarımıza göre, video yardımcı torakoskopik cerrahinin, daha az invaziv olması ve daha iyi görüş açısı sağlaması gibi avantajları sayesinde, aksiller torakotomiye kıyasla daha uygun olduğu kanaatindeyiz.

**Anahtar sözcükler:** Aksiller torakotomi; primer spontan pnömotoraks; video yardımcı torakoskopik cerrahi.

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Pneumothorax is defined as the accumulation of air in the pleural cavity.<sup>[1]</sup> Hippocrates and Galen were aware of the disease involving the pleural space.<sup>[2]</sup> The term pneumothorax was first used by Laennec's student, Itard in 1803. Spontaneous pneumothorax is usually associated with rupture of subpleural blebs (primary spontaneous pneumothorax) or associated with an underlying lung disease such as bullous emphysema (secondary spontaneous pneumothorax). Surgical treatment of spontaneous pneumothorax involves the resection of blebs or stapling the apex of the lung when there are no obvious lesions and pleurectomy or pleurodesis in order to create pleural adhesion for the prevention of recurrence.<sup>[3,4]</sup>

The incidence of pneumothorax in men and women has been reported as 24 and 9.8, respectively, per 100,000.<sup>[5]</sup> On the other hand, the incidence of primary spontaneous pneumothorax is 7.4 to 18 per 100,000 men and 1.2 to 6 per 100,000 women.<sup>[6,7]</sup> Treatment options for spontaneous pneumothorax include conservative approaches from bed rest, to more invasive procedures such as aspiration and chest tube drainage, chemical pleurodesis, and surgical procedures such as video-assisted thoracoscopic surgery (VATS) or axillary thoracotomy. The recurrence rate following conservative treatment after the first attack of spontaneous pneumothorax is estimated to be between 30% and 50%.<sup>[8]</sup> The most commonly accepted indications for surgical treatment of spontaneous pneumothorax include; prolonged air leak (more than seven days long), recurrent pneumothorax, contralateral pneumothorax and patients in high risk occupational groups (such as pilots and divers) with the first spontaneous pneumothorax.<sup>[2,9,10]</sup> The conventional treatment method of spontaneous pneumothorax is open axillary thoracotomy with bullectomy and pleurectomy. Bullae resection and the use of VATS during partial pleurectomy for the treatment of pneumothorax was first described in 1991.<sup>[11]</sup> In this study, the advantages and disadvantages of axillary thoracotomy and VATS, and their superiority over each other were evaluated.

## PATIENTS AND METHODS

A total of 199 patients with primary spontaneous pneumothorax, who underwent surgery at the Thoracic Surgery Clinic of Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital, and at the Kadıköy and Kozyatağı Acıbadem Hospitals, between January 2009 and December 2015, were retrospectively evaluated. The study protocol was approved by the Ethics Committee of Acıbadem

University. Patients were informed about procedures to be undertaken and their written consents were obtained. The study was carried out in accordance with principles of the Declaration of Helsinki. The patients were divided into two separate groups. Axillary thoracotomy, wedge resection, apical pleurectomy, tissue adhesive procedures were performed in 48 patients of Group 1, while VATS, wedge resection, apical pleurectomy and tissue adhesive procedures were performed in 151 patients of Group 2. Patients taken in for operation were followed up for a period of one year. Preoperative thorax computed tomography (CT) scans were performed on all patients who underwent surgery. Patients who underwent thoracotomy procedures other than axillary thoracotomy and spontaneous pneumothorax patients older than 35 years of age were not included in the study. Furthermore, primary spontaneous pneumothorax patients who were taken into emergency surgery due to hemopneumothorax were not also included in the study. Comparison of the two groups was made in terms of age, gender, rate of long-term analgesic use, duration of procedure, duration of hospitalization, recurrence, complication and mortality rates. All cases were operated-on in the lateral position under general anesthesia and with double lumen tube (Carlens tube) ventilation. In Group 1, an incision was made from the axillary fold region into the thorax through the third intercostal space. Intercostal blockade with bupivacaine hydrochloride (Marcaine, Abbott Laboratories Limited, Canada) was performed on all patients for analgesia during the operation. In Group 2 patients, a midaxillary 2 cm incision was made between the 7<sup>th</sup> and 8<sup>th</sup> ribs, creating a thoracoport of 10 mm and surgery was initiated with 30° thoracoscope (Karl Storz GmbH & Co. KG, Tuttlingen, Baden-Württemberg, Germany). The procedure was performed by opening a second hole through the 5<sup>th</sup> or 6<sup>th</sup> intercostal space on the posterior axillary line, and a third hole through the 4<sup>th</sup> intercostal space on the anterior axillary line front and creating a 5 or 10 mm thoracoport incision. Adjustable 55 mm or 75 mm staplers (Ethicon Endosurgery, Johnson and Johnson Medical, USA) were used for the lung wedge resection of Group 1 patients, whereas the endoscopic 45 mm or 60 mm staplers (Ethicon Endosurgery, Johnson and Johnson Medical, USA) were used for wedge resection of Group 2 patients. The apical pleurectomy, in both groups was performed from the apex to the level of the fourth rib. The synthetic tissue adhesive (Tisseel Iyo, Baxter Healthcare Ltd., England) was applied to the stapler line. After the procedure, one 24- or 28-French thoracic catheter was placed in the thorax in both groups and connected

**Table 1. Distribution of descriptive characteristics**

	n	%	Mean±SD	Min-Max
Age (year)			21.3±7.1	13-35
Gender				
Male	178	89.4		
Female	21	10.5		
Surgery type				
Axillary thoracotomy	48	24.1		
Video-assisted thoracoscopic surgery	151	75.8		
Age at surgery				
Axillary thoracotomy			24.5±6.6	13-35
Video-assisted thoracoscopic surgery			22.0±6.4	15-35
Duration of postoperative hospitalization			5.1±2.6	2-20

SD: Standard deviation; Min: Minimum; Max: Maximum.

to the closed underwater drainage system. Thoracic catheters of patients with less than 150 mL of drainage within 24 hours and no air leak, and whose lungs had expanded were removed. All patients were discharged when they were fully mobile and when their pain could be kept under control with oral analgesics.

The Number Cruncher Statistical System (NCSS) 2007 & Power Analysis and Sample Size (PASS) 2008 Statistical Software (Utah, USA) used for statistical analysis. Descriptive statistical methods (Mean, Standard Deviation, Median, Frequency, Ratio, Minimum, and Maximum) were used for the evaluation of study data, while the Mann-Whitney U test was used for the comparison of quantitative data as well as parameters without normal distribution for the two groups. The Fisher's exact test was used for the comparison of qualitative data. The level of significance was evaluated at  $p < 0.01$  and  $p < 0.05$  values.

## RESULTS

A total of 199 patients, 178 male (89.4%) and 21 female (10.5%), (mean age: 21.3±7.1 years, range 13 to 35 years), who were diagnosed with primary spontaneous pneumothorax and hospitalized with the indication for surgery at all three clinics, within a period of six years between January 2009 and December 2015, were retrospectively evaluated. axillary thoracotomy was performed in 48 (24.1%) of the patients and while VATS was performed in 151 (75.8%) patients, as the first surgical intervention. The mean age of patients with axillary thoracotomy type surgery was 24.5±6.7 years (range, 13-35 years), whereas the mean age of patients with VATS was 22.0±6.4 years (range, 15-35 years) (Table 1).

Wedge resection together with apical pleurectomy and tissue adhesion were performed in both video

**Table 2. Evaluation according to type of surgery**

	Axillary thoracotomy (n=48)				VATS (n=151)				p
	n	%	Mean±SD	Min-Max	n	%	Mean±SD	Min-Max	
Age (year)			24.5±6.7	13-35			23.2±6.5	15-35	0.756*
Duration of postoperative hospitalization			4.6±1.7	2-12			5.5±3.0	2-20	0.142*
Gender									0.331‡
Male	41	85.4			137	90.7			
Female	7	14.9			14	9.2			
Recurrence									0.411‡
Absent	44	91.6			147	97.3			
Present	4	8.3			4	2.6			
Complication									0.100‡
Absent	42	87.5			139	92.1			
Present	6	12.5			12	7.9			

VATS: Video-assisted thoracoscopic surgery; SD: Standard deviation; Min: Minimum; Max: Maximum; \* Mann-Whitney U test; ‡ Fisher's exact test.

assisted thoracoscopic surgery and axillary thoracotomy procedures. Five of the patients underwent bilateral surgery at different times due to contralateral recurrent pneumothorax. Fifty-four of the patients were those who had pneumothorax for the first time, underwent tube thoracostomy + closed underwater drainage, and who were considered to have prolonged air leak (PAL) due to air leakage of more than five days during the follow-up period and subjected to surgery. The remaining surgical procedures were performed on 145 patients (119 with recurrence for the first time, 16 with recurrence for the second time, six with recurrence for the third time, two with fourth recurrence, and two with fifth recurrence), who were previously treated with oxygen therapy or who were subjected to surgery following recurrence after being treated with tube thoracostomy. Our surgical interventions resulted in a total of nine recurrences (four axillary thoracotomy, and five VATS procedures). All of these nine recurrence cases were subjected to reoperation (three with thoracotomy and six with VATS).

The evaluations made according to the type of surgery are shown in the last row of Table 1 and in Table 2. The mean postoperative hospital stay was found to be  $5.1 \pm 2.6$  (range: 2-20) days. The postoperative hospital stay was calculated as  $4.6 \pm 1.7$  days (range 2 to 12) days in the axillary thoracotomy group, and  $5.5 \pm 3.0$  (range, 2 to 20) days in the VATS group, just slightly more than in the axillary thoracotomy group. In the axillary thoracotomy group, there were 41 males (85.4%) and seven females (14.9%), whereas in the VATS group there were 137 males (90.7%) and 14 females (9.3%). The number of cases of recurrences in the axillary thoracotomy group was found to be four (8.3%), and that in the VATS group was found to be four (2.64%). On the other hand, with regards to complications, prolonged air leakage was observed in six patients (12.5%) subjected to axillary thoracotomy, and in 12 patients (7.9%) who underwent the VATS procedure.

There was no statistically significant difference between age distribution, postoperative hospital stay, gender distribution, recurrence rates and rate complication according to surgical type ( $p > 0.05$ ).

The duration of surgery in our study was found to be longer in the VATS group, with the mean duration in the axillary thoracotomy Group reported as  $40 \pm 10$  min and in the VATS Group as  $65 \pm 15$  min. The rate of long-term analgesic use in our study was reported as 4% in VATS patients and 25% in axillary thoracotomy patients. No infection and bleeding requiring revision

was observed in any patient, and no mortality was reported.

## DISCUSSION

Posterolateral thoracotomy, anterior thoracotomy, sternotomy and axillary mini thoracotomy are reported to have been used in the surgical intervention of historically recurrent cases of pneumothorax. Video-assisted thoracoscopic surgery, which is considered as the last approach in the treatment of pneumothorax, is currently the most commonly used procedure.<sup>[12]</sup>

In the study by Kocatürk *et al.*,<sup>[13]</sup> the most common surgical indications for primary spontaneous pneumothorax was reported as ipsilateral recurrent pneumothorax and prolonged air leak (PAL). Similar incidence rates were observed in our study.

Following a wedge resection, pleural adhesion is provided by a combination of pleurectomy, pleural abrasion or chemical irritation procedures. Pleurectomy is suggested to be better in terms of recurrence when compared to pleural abrasion.<sup>[14-17]</sup>

The combination of bullectomy and parietal pleurectomy is an effective method to prevent the recurrence of pneumothorax. However, parietal pleurectomy has its drawbacks; especially in young patients, serious problems may be encountered when the pleura is opened in the future due to any cause like lung transplantation. As a result, alternative partial pleurectomy or parietal abrasion techniques are currently being used for pleurodesis.<sup>[3,18]</sup> Bullae and blebs are mostly found at the apex of the lungs. Horio *et al.*<sup>[19]</sup> demonstrated that recurrence rates were higher in patients treated with VATS than in those who underwent thoracotomy. This was suggested to be due to the fact that there was a higher likelihood of bullae or blebs being missed in the VATS group of patients. Technically, it is more difficult to test air leak during VATS than during open surgery. Many authors recommend wedge resection of the apex of the lung because it is important not only to remove blebs in all cases, but also for the formation of inflammation in the lungs and thoracic walls, even when bullae cannot be observed at the apex.<sup>[20,21]</sup>

The ipsilateral recurrence rate in patients treated with non-surgical methods is reported to range widely from 16% to 52%. On the other hand, the contralateral recurrence rate was reported as 5-15%. The value of CT for the recurrence of pneumothorax has previously been demonstrated by various studies.<sup>[22-26]</sup> In our study, all patients were subjected to CT before treatment. In a meta-analysis involving studies conducted between

1993 and 2006, recurrence rates ranged from 0% to 16% for VATS and from 0% to 6.8% for open surgical procedures.<sup>[27]</sup> The American College of Chest Physicians (ACCP) recommends thoracoscopic surgery for the prevention of recurrence,<sup>[10]</sup> whereas the British Thoracic Society (BTS) recommends open surgery and pleurectomy due to the low recurrence rate.<sup>[28]</sup>

In our study, the recurrence rate following axillary thoracotomy was 8.3% (n=4), while the recurrence rate after VATS was found to be 2.6% (n=4). This rate was higher in cases with axillary thoracotomy, although not statistically significant. Unlike the results of our study, the majority of the studies have demonstrated that the recurrence rate is higher in the VATS group.<sup>[27]</sup>

Literature studies confirm that the duration of hospitalization and postoperative pain are reduced in patients treated with VATS when compared to thoracotomy.<sup>[29-32]</sup> In the study conducted by Tarshihi, the duration of surgery in patients treated with VATS was reported as 78.9±6.2 min, whereas that for axillary thoracotomy was found to be 28.8±4.2 min.<sup>[33]</sup> These results were found to be consistent with the duration of the surgery in our study. We suggest that the longer the duration of video assisted thoracoscopic surgical interventions is as a result of the learning curve. This was observed as the duration of the last VATS attempts were shorter in recent years.

Video assisted thoracoscopic surgical techniques have advantages such as less pain, shorter time of return to normal activities, less chronic pain and better patient satisfaction. Literature studies show that chronic pain requiring analgesic use for longer than one month was at a rate of 3% after VATS and 19% after open surgery.<sup>[34]</sup> In our study, the rate long-term analgesic use was 4% for patients subjected to VATS and 25% for axillary thoracotomy patients.

No postoperative complications were observed in our study except for PAL. The absence of other complications such as pneumonia, arrhythmia, atelectasis, are attributed to the fact that patients were young and had no comorbid diseases; and there was no statistically significant difference between the two groups.

Surgery for primary spontaneous pneumothorax is generally safe and the surgery related mortality rate is not reported in many studies.<sup>[35,36]</sup> No case of mortality was also reported in our study. However, it should be kept in mind that mortality due to surgery for secondary spontaneous pneumothorax is between 2-10%.<sup>[28,37]</sup>

We suggest that VATS is the primary treatment option in the surgical treatment of primary spontaneous

pneumothorax when compared to axillary thoracotomy, due to the decreased need for analgesia, shorter duration of hospitalization and faster mobilization, although there is no statistically significant difference in results between the video-thoracoscopic surgery group and axillary thoracotomy group.

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