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Original Research

Comparison of the Video-assisted Thoracoscopic Lobectomy versus Open Thoracotomy for Primary Non-Small Cell Lung Cancer: Single Cohort Study with 269 Cases

Volkan Erdogu, Hasan Akin, Yasar Sonmezoglu, Ali Cevat Kutluk, Celal Bugra Sezen, Mustafa Vedat Dogru, Ozkan Saydam, Muzaffer Metin

Department of Chest Surgery, Yedikule Chest Diseases and Surgery Training and Research Hospital, Istanbul, Turkey

Abstract

Objectives: This study aims to compare the outcomes of video-assisted thoracoscopic surgery (VATS) lobectomy with open thoracotomy lobectomy in patients with non-small cell lung cancer (NSCLC).

Methods: There were 269 cases with NSCLC who underwent lobectomy between 2017-2019; these cases were retrospectively studied. VATS lobectomy (VATS Group) and open thoracotomy lobectomy (Thoracotomy Group) patients' results were compared according to the length of hospitalizations, early postoperative complications and tumor size and stages.

Results: VATS lobectomy was performed in 89 (33%) of these patients, whereas 180 (67%) patients underwent lobectomy using open thoracotomy for NSCLC. The findings showed that the average length of hospitalization was shorter in the VATS Group compared to the Thoracotomy Group (4 vs. 5.5 days) ($p<0.05$). It was found that the mean size of the tumour was smaller in the VATS Group when compared to the Thoracotomy Group (2.66 cm vs 3.97 cm) ($p<0.001$). Early postoperative complications were lower in the VATS Group (n=15, 16.8% vs n=58, 32.2%; $p<0.021$).

Conclusion: In VATS lobectomy cases, postoperative complications are less, and the length of hospitalization is shorter. VATS lobectomy is mostly preferred smaller than 3 cm tumor size.

Keywords: Lobectomy; thoracotomy; non-small cell lung cancer; video-assisted thoracoscopic surgery (VATS).

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Many centers worldwide perform lobectomy by video-assisted thoracoscopic surgery (VATS) as an alternative to open thoracotomy in suitable cases, especially in early stage non-small cell lung cancer (NSCLC) cases.[1] According to many studies, the advantages of VATS lobectomy compared to conventional open thoracotomy include shorter length of hospitalization, less postoperative complications, shorter duration of the chest tube, a more cosmetic incision, less postoperative pain, therefore better postoperative life quality and importantly similar overall survival rates compared to open thoracotomy.[2-4] VATS resections have become increasingly popular worldwide following the improvements in training programmes, drawing young surgeons' interest in VATS lobectomy, leading to increased experience.[5]

In our Thoracic Surgery Clinic, VATS lobectomy is being performed since the beginning of the 2010s. VATS experience of

Address for correspondence: Volkan Erdogu, MD. Yedikule Gogus Hastaliklari ve Cerrahisi Egitim ve Arastirma Hastanesi Gogus Cerrahisi Klinigi, Istanbul, Turkey
Phone: +90 505 241 44 36 **E-mail:** verdogu@gmail.com

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surgeons who study in our clinic is increasing by the years. In the present study, we compared the outcomes of patients with VATS lobectomy with patients with open thoracotomy in NSCLC regarding the length of hospitalization, early postoperative complications and tumor size and stages.

Methods

We retrospectively reviewed the data of the patients who underwent anatomical lung resection due to NSCLC, between 2017-2019, in our center, using the prospectively collected data of the lung cancer database of our institution. The data of 468 patients were evaluated. In the present study, 98 patients who underwent pneumonectomy via open thoracotomy or VATS were excluded from this study. Also, 26 patients with chest wall resection additional to thoracotomy, 43 patients with sleeve resection with open thoracotomy and 32 patients who received neoadjuvant chemotherapy (CT) +/- radiotherapy (RT), a total of 199 patients were excluded from this study. After the excluded patients, the remaining 180 patients who underwent lobectomy via open thoracotomy and 89 patients with VATS lobectomy, total 269 patients were included in this study. Preoperative invasive and non-invasive diagnoses and/or staging methods were performed in all these 269 patients. Positron Emission Computerized Tomography (PET-CT) was performed in all cases. Fiber optic bronchoscopy (FOB) was performed routinely in central masses and suspicious peripheral nodules. Mediastinoscopy was performed in all cases except cT1N0M0 squamous cell carcinomas and patients who were not diagnosed with lung cancer. There were 30 patients in the VATS Group and 41 patients in the Thoracotomy Group that could not be diagnosed before the surgery decision with minimal invasive techniques (Transthoracic fine-needle biopsy, FOB). In these cases, before resection, suspicious nodules were sampled by wedge resection by staplers or by fine-needle biopsy in case the nodule localization central. VATS lobectomy or thoracotomy lobectomy was performed after malign pathology results confirmed by frozen section.

All patients in both groups were operated by four surgeons who worked in the same thoracic surgery clinic. All open thoracotomies were performed by a posterolateral incision. In the VATS Group, only 10 of the cases had an uniportal approach; other cases were via biportal approach. In an uniportal approach, 4-5 cm utility incision was made in the mid-axillary line through the fourth or fifth intercostal space. In biportal approach, surgeons used an additional port incision for the 30-degree rigid thoracoscope from 7th intercostal space in the anterior or mid-axillary line. The surgeon and the assistant are positioned on the same side of the patient, while the nurse is positioned on the opposite side.

The patients' files were retrospectively studied for the length of hospitalization, early postoperative complications, tumour sizes as reported in pathology reports, histological types and tumour stages.

This study was approved by the Institutional Review Board and was conducted in accordance with the principles of the declaration of Helsinki. Confirmed number/date 2272/08.05.2020.

Statistical Analysis

The continuous variables were expressed as mean and standard deviation and categorical variables as frequencies and percentages. Student t-test was used for the comparison of the means of the groups and the chi-square test for the categorical data and the percentages. IBM SPSS Statistics, version 23 for Windows (IBM Corporation, Armonk, NY, USA), was used to execute the calculations.

Results

In this study, 269 patients were included. There were 89 patients (33%) in the VATS Group, whereas 180 patients (67%) in the Thoracotomy Group. The mean age was 63±8.2 (range 33-82 years). The majority of patients were men (79.8%, n=212). Adenocarcinoma was the predominant histological type in both groups 64% (n=57) in VATS Group; 52.7% (n=95) in Thoracotomy Group) (Table 1). Mean size of the tumor was 3.31±1.36 (0.2-12 cm). In the VATS Group, the mean size of the tumor was 2.66±1.33 cm (range 0.2-6 cm), whereas it was 3.97±1.4 (range 0.6-12 cm) in the Thoracotomy Group ($p<0.05$). The difference in tumor size between groups was found statistically significant (Table 1). When the surgical techniques, preferred according to tumor size were evaluated, there were 127 (47.2%) cases with tumors between 0-3 cm according to pathology reports and VATS lobectomy was the preferred technique in 58 (45.6%) of them, whereas in 69 (54.4%) cases thoracotomy approach prefered ($p=0.329$). The number of 3-5 cm tumor cases was 91 (33.8%) in all patient groups and preference of the VATS lobectomy was in 26 (28.5%) cases, whereas for 65 (71.5%) cases prefered surgery approach was thoracotomy lobectomy ($p<0.05$). Tumors greater than 5 cm was 51 (18.9%) cases in all cases and only in five (9.8%) cases VATS lobectomy, in 46 (90.2%) cases, thoracotomy lobectomy was the preferred technique (($p<0.001$).). The preference of the thoracotomy approach appears to be significantly higher when the tumor size greater than 3 cm (Table 1) When the mean length of hospitalization was evaluated, it was found to be five days for all patients and in the VATS Group the mean length was four days, whereas it was 5.5

Table 1. Characteristic of the patients-size of the tumor-length of hospitalization

Variable	Total	VATS Group	Thoracotomy Group	p
n (%)	269	89 (33)	180 (67)	
Age, Years, Mean (SD)	63 (8.2)	63.6 (8.6)	62.5 (8.3)	0.567
Gender, n (%)				
Male	212 (79.8)	68 (76.4)	144 (80)	
Female	57 (21.2)	21 (23.6)	36 (20)	
Histological Type, n (%)				
Adenocarcinoma	152 (56.5)	57 (64)	95 (52.7)	0.187
Squamous cell	117 (43.5)	32 (36)	85 (47.3)	
Tumor size, cm (SD)	3.31 (1.36)	2.66 (1.33)	3,97±1.4	<0.05
Preferred surgical technique in 0-3 cm tumors, n (%)	127 (47.2)	58 (45.6)	69 (54.4)	0.329
Preferred surgical technique in 3-5 cm tumors, n (%)	91 (33.8)	26 (28.5)	65 (71.5)	<0.05
Preferred surgical technique in > 5 cm tumors, n (%)	51 (18.9)	5 (9.8)	46 (90.2)	<0.001
Mean length of hospitalization day	5 days	4 days	5.5 days	<0.05

VATS: Video-assisted thoracoscopic surgery; Cm: centimeter; Tm: Tumour; SD: Standard deviation.

Table 2. Stage of tumors in VATS Groups and Thoracotomy group

Groups	Stage I n (%)	Stage II n (%)	Stage III n (%)	Total
VATS Group	69 (77.5)	16 (17.9)	4 (4.6)	89
Thoracotomy Group	70 (38.8)	68 (37.7)	42 (23.5)	180
p	0.932	<0.001	<0.001	0.001
Total	139	84	46	269

n: Number; VATS: Video-assisted thoracoscopic surgery.

days in the Thoracotomy Group. This difference was found to be statistically significant (p<0.05) (Table 1). According to pathology reports, most of the patients were stage I in the total 269 patient population (n=139; 51.6%). There were 84 (31.2%) patients with stage II and 46 (17.1%) patients with stage III. In the VATS Group, 69 (77.5%) patients were stage I according to pathology reports, 16 (17.9%) patients were stage II and only four (4.6%) patients were stage III, whereas stage I, 70 (38.8%), stage II, 68 (37.7%) and 42 (23.5%) patients were stage III in the Thoracotomy Group (Table 2). In the Thoracotomy Group, a more homogeneous distribution was remarkable. In stage II and stage III, thoracotomy preference was found to be significantly higher than VATS preference (p <0.001, 0 <0.001, respectively).

There were 74 (27.5%) patients who had early postoperative complications. In the Thoracotomy Group, 58 (32.2%) patients, in VATS Group, 16 (17.9%) patients had postoperative complication. The difference between the two groups regarding early postoperative complications was found to be statistically significant (p=0.014). There were no 30-days mortalities in both groups (Table 3).

Early postoperative complications are listed in Table 3. In both groups, the predominant complication was a prolonged air leak (more than seven days). Due to prolonged air leak, the mean length of hospitalization was 12 days in

Table 3. Early postoperative complication in VATS Group and in Thoracotomy Group

Early Postoperative Complications	VATS n (%)	Thoracotomy n (%)	p
Number of all early postoperative complications	16 (17.9)	58 (32.2)	0.014
Prolonged air leak (>7 days)	7 (7.8)	24 (13.3)	
Surgical site infection	0	5 (2.7)	
Bronchopleural fistula	1 (1.1)	2 (1.1)	
Atelectasis	2 (2.2)	7 (3.8)	
Pneumonia	1 (1.1)	4 (2.2)	
Arrhythmia	4 (4.5)	12 (6.6)	
Pulmonary embolism	0	2 (1.1)	
Haemorrhage	1 (1.1)	2 (1.1)	

n: Number; VATS: Video-assisted thoracoscopic surgery; BPF: bronchopleural fistula.

the VATS Group and 13.4 days in the Thoracotomy Group. Due to prolonged air leak, one patient in the VATS Group underwent re-VATS on the 7th day of air leak. In the Thoracotomy Group, prolonged air leaks showed regression on follow-ups without the need for surgical revision. There were three patients with bronchopleural fistula (BPF) (Thoracotomy Group n=2, VATS Group n=1). In the Thoracotomy Group, one BPF patient underwent re-thoracotomy rest-pneumonectomy with omentoplasty. The other two patients were kept under observation and medically treated. In the thoracotomy group, five patients presented with surgical site infection. In these patients, the infected surgical area was fully opened, surgically debrided, vacuum-assisted closure (VAC) was applied and when the infection was regressed, patients were taken for revision surgery in time. In the Thoracotomy Group, fiber optic bronchoscopy (FOB) was conducted in early-onset postoperative atelectasis and expansion of the lungs was achieved by clearing the secretions in 7 patients. No FOB was required in the VATS Group. In the Thoracotomy Group, two patients with >1500cc hemorrhagic drainage on a postoperative first day were taken to the operating theatre for revision surgery, whereas in the VATS Group, one patient with 1000 cc early-onset hemorrhagic drainage was kept in for observation, and the drainage resolved on follow-ups without the need for surgery.

Gender, age, histopathological type of tumor and tumor size showed no significant impact on early postoperative complications.

In nine patients, the VATS lobectomy procedure was converted to thoracotomy during the operation (10.1%). In five of these patients, the switch was due to bleeding from the pulmonary artery branches; in two patients, it was due to a challenging dissection owing to fibrotic hilar lymph nodes and in another two patients, it was due to excessive pleural adhesion.

Discussion

VATS lobectomy is increasingly performed with success worldwide. When compared to thoracotomy, it leads to a shorter length of hospitalization, less hemorrhagic during surgery, shorter duration of the chest tube, and lower rates of postoperative morbidity.[6] Some studies have found that the 5-year survival rates of VATS lobectomy are significantly higher when compared to thoracotomy; however, current studies with larger patient groups have found no statistical difference in survival rates.[7]

In a large cohort study, the length of hospitalization in VATS lobectomy patients is significantly shorter than thoracotomy lobectomy patients (five days vs. six days).[8] In the present study, our patients' median length of stay in hospital is similar to the literature, but discharge is a little bit earlier (4 days vs. 5.5). That is probably because our clinic is a high volume clinic. Therefore, patients' discharges may be a little bit earlier than the stated day in the literature.

VATS lobectomy is most often preferred for tumors smaller than 3 cm and in early-stage NSCLC.[9] Experienced centers perform VATS resections in tumors greater than 3 cm and locally advanced NSCLC with success.[10] Pischik et al.[11] determined a cut point of greater than 5 cm of tumor size to define a locally extensive for VATS cases in 2014.

Tomoyuki and et al.[12] compared the outcomes of VATS lobectomy versus open thoracotomy in >5 cm tumors and noted that there was less bleeding and shorter hospitalization in the VATS group. The important thing that should be cared for is that large tumors must be carefully maneuvered during VATS to prevent cancer cell spillage.

In the present study, VATS lobectomy was performed mostly in early-stage tumors. In less than 3 cm tumors, VATS lobectomy preference rate was 45.6%, whereas it was 28.5% in tumors between 3-5 cm and only 9.8% in >5 cm tumors. It seems that the preference for VATS decreased in our study as the tumor size increased.

By increased experience, more complex cases are dared to be performed by thoracic surgeons, such as sleeve resections, operations in patients who have received neoadjuvant treatment, chest wall invasions and pneumonectomies.[13-16]

According to Li et al.,[15] a thoracic surgeon should perform between 100 and 200 VATS resections to achieve efficiency. Over time, we aim to enhance our experience with cases and attempt VATS resections in larger and more complicated cases.

Many studies have shown that VATS lobectomy is superior to thoracotomy regarding early-onset morbidity.[16,17] Nestor et al.[18] noted that one of the most common early complications is a prolonged air leak. They found that the rate of prolonged air leak is 11% in VATS lobectomy patients, whereas 19% in thoracotomy lobectomy patients. The results are similar in our study as both groups' predominant postoperative complication was a prolonged air leak.

In the present study, there were nine patients (10.1%) who required conversion due to perioperative problems. In the literature, conversion rates have been reported between 2.5%-9.3% of total VATS resections.[19, 20] The most common reason is similar to our findings, perioperative hemorrhage. Other reasons are hilar fibrotic or calcific lymph nodes, adhesions, to achieve the optimal resection of the tumors, invasions of the mediastinum or chest wall, or a requirement

for sleeve resections.

Our study has several limitations. First, this is a retrospective study. In the present study, we discuss the preference of surgical procedure according to the pathological size and tumor stage since we do not have clinic stages. Only tumor diameter was considered in the choice of surgical approach. Other parameters affect surgical approach choice, such as central or peripheral localization or invasions, which has not been compared in the present study. Also, in this study, we did not mention the number of VATS resections according to years. Therefore, we cannot show the rate of experience over the years. Another limitation is the lack of information regarding lymph node sampling. The provision of conversion rates is one of the strengths of this study. We believe that we have demonstrated the advantages of VATS lobectomy, such as short length of hospitalization and lower rates of early-onset complications, quite comprehensively. We think that by discussing preferences of surgical procedures according to tumor size, we have provided a different perspective concerning VATS as a choice of surgical approach.

VATS resections are preferred mostly in the early-stage and less than 3 cm tumors. VATS lobectomy is superior to thoracotomy with lower rates of early postoperative complications, and shorter length of hospitalization; thus, it can be safely preferred. For tumors larger than 3 cm, a preference for VATS decreases. As we gain experience in our clinic over time, we aim to use VATS safely in more advanced stage cancers.

Disclosures

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