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VATS cost is less than thoracotomy in operable NSCLC patients

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Abstract:

BACKGROUND AND AIM: Better management of financial resources provided by the government-based insurance system is one of the important challenges in the administration of hospitals. The aim of this study was to compare videothoracoscopic surgery and open thoracotomy regarding cost and hospital stay.

METHODS: Eighty-eight patients who underwent video-assisted thoracoscopic surgery (VATS) or open thoracotomy for operable (stage IA–IIIA) non-small cell lung cancer were analyzed retrospectively. The general cost of hospital treatment, cost of operation, and cost of hospital stay of these patients were compared.

RESULTS: A total of 48 lobectomies, 33 wedge resections, 2 segmentectomies, and 5 pneumonectomies were analyzed. Fifty-eight patients (65.9%) underwent VATS resection, and 30 patients (34.1%) had resection via open thoracotomy. There was no statistically significant difference in terms of gender, age, and pulmonary function test between the groups. The postoperative hospital stay, intensive care unit stay, was higher in patients who underwent thoracotomy compared with patients who underwent VATS (p=0.006 vs p=0.02). The total hospital cost and the cost of operation for patients operated via VATS were lower compared with the costs for patients operated via thoracotomy (p=0.026 vs p=0.014). When analyzed separately, the cost of VATS lobectomy was lower than that of lobectomy via thoracotomy; however, the difference was not statistically significant (p=0.114).

CONCLUSIONS: The total hospital cost and the cost of operation via VATS are lower than the costs of thoracotomy. VATS also leads to a reduced hospital stay. VATS should be considered the gold standard in resectional surgery in patients who need lobectomy, segmentectomy, or wedge resection.

Keywords:

Cost, lung cancer, thoracotomy, video-assisted thoracoscopic surgery

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Introduction

The most important advancement in thoracic surgery has been the introduction and advent of video-assisted thoracoscopic surgery (VATS).[1,2] Since its introduction, VATS has significantly minimized complications, reduced postoperative pain, shortened the recovery time, and improved the quality of life over the past 20 years.[3,4] Anatomic resections can be performed as either open thoracotomy or VATS. However, the cost of operation via VATS has been accepted to be higher as it involves the usage of videothoracoscopic units and disposable staplers and their reloads.[5] One of the important challenges in the administration of healthcare departments is the rational management of financial resources reserved by the government or insurance system for healthcare. This proposed high cost of videothoracoscopic resections inclines hospital managers and governmental insurance managements to impose restrictions on the use of VATS.[5] The evaluation and analysis of the cost of a service has a key role in the selection of the best cost-effective procedure. The aim of this study was to compare the overall hospitalization cost of lobectomy via thoracotomy and via VATS.

Materials and Methods

Between July 2018 and July 2019, patients who underwent pulmonary resections were analyzed. A total of 107 patients (81 men, 26 women) were studied. The preoperative workup included routine blood tests, posteroanterior chest radiograph, pulmonary function test with diffusion capacity of the lung for carbon monoxide, and blood gas analysis. A computed tomographic scan of the thorax was performed in most patients. Mediastinoscopy or video-assisted mediastinoscopic lymphadenectomy was performed in patients with tumors larger than 3 cm or hilar location. We used a Linder-Dahan mediastinoscope (Richard Wolf, Knittlingen, Germany). Pulmonary resection was performed in patients with non-small cell lung cancer who were evaluated to be cT1-4N0-1M0 or patients with pulmonary metastases from secondary organs. An anatomical resection was performed in lung cancer patients, whereas a wedge resection or anatomical resection was accomplished in patients with pulmonary metastasis.

Patients who were under 18 years of age, who underwent lung volume reduction surgery/bullectomy, and who did not receive pulmonary resections were excluded from the study.

The following information was recorded: Demographic, clinical, functional, and surgical variables including age, gender, forced expiratory volume in 1 second (FEV_1), percentage of FEV_1 according to expected FEV_1, forced vital capacity (FVC), (FEV_1), FEV_1 percentage of the predicted value, forced vital capacity (FVC), FVC percentage of the predicted value, FEV1/FVC ratio, pulmonary risk index, cigarette smoking, alcohol usage, cardiac risk index, histological type of pathology, pathological staging of patients with lung cancer according to the 8th staging system,[6] type of operation, surgical approach (videothoracoscopy, thoracotomy, or hybrid), intensive care unit stay, postoperative stay, postoperative complications, and total cost of hospitalization including preoperative, perioperative, postoperative care and applied services.

Patients who had higher than 2 L or 80% of predicted FEV_1 underwent pneumonectomy. Patients who had lower than 2 L or 60% of predicted postoperative FEV_1 underwent ventilation perfusion lung scintigraphy, and patients who had lower than 0.8 L or 40% of predicted FEV_1 underwent ventilation perfusion lung scintigraphy, and patients who were calculated to have more than 2 L or 60% of predicted postoperative FEV_1 underwent resectional surgery.

An anterolateral thoracotomy through the fifth intercostal space or a videothoracoscopy was performed on patients under general anesthesia in the lateral decubitus position. The type of approach depended on the surgeon's preferences and was slightly influenced by the T factor of the tumor. Patients with tumors larger than 5 cm or hilar invasion were operated by videothoracoscopic access if the surgeon was more comfortable in this access. Analgesia was provided with subcutaneous narcotic analgesics and nonsteroid anti-inflammatory drugs. When necessary, endoscopic or linear staplers (Covidien, USA) were used for parenchymal resection, vessel ligation, and bronchial division. A bipolar energy device (LigaSure, Medtronic, USA) was used in most patients.

After surgery, most patients were taken care of in a thoracic surgery unit. The peripheral oxygen saturation

was monitored for the first postoperative day. Many patients were taken care of in a general intensive care unit. Electrocardiogram, pulse, peripheral oxygen saturation, arterial tension, and urine output were monitored continuously in these patients. Both VATS and thoracotomy patients were taken care of based on the same postoperative criteria of management.

Emphasis was placed on aggressive pulmonary care, mobilization, pain management, incentive spirometry, early oral alimentation in all patients. Postoperative complications were written retrospectively based on hospital records. The data were used only in collective summaries with total anonymity of patients. For this reason and because the study was retrospective, the approval of the institutional review board was waived. The total cost of hospitalization was documented based on financial records retrieved from the income department of our hospital (i.e., the final hospital bill). For every patient, the hospital bill included the following: The cost of medication given to the patient in the ward, the cost of the operation (remuneration of operators, scrub nurses, anesthesiologist, equipment used for surgery, equipment used for anesthesia, drugs administered in the operating room), cost of intensive care unit (if any), and cost of postoperative ward service (cost of medication, hospitalization, cost of nurse and physicians' service). The postdischarge cost was not considered in this study.

All patients were staged according to the 8th TNM lung cancer staging system.

To perform a homogenous comparison between videothoracoscopy and thoracotomy groups, patients with severe complications requiring ICU stay, prolonged ventilation, or longer hospitalization were excluded from the study. Informed consent of the patient and approval of the institutional review board (i.e., ethics committee) were obtained.

Statistical evaluation

Continuous preoperative parameters (after variance) were evaluated using Student's -t-test. Non-parametric values were analyzed using the Mann–Whitney U test or Chi-squared test. The test was deemed statistically significant when the p-value was <0.05.

Results

Of the 88 patients evaluated, 58 were operated via VATS. There was one postoperative death (1.1%). A summary of the demographics of the patients is shown in Table 1. One patient died postoperatively (1.1%) It was found that the choice of the approach was not dependent on gender, type of operation, age, or pulmonary function test (Table 1). The postoperative hospital stay and the need for intensive care unit hospitalization were higher in patients who underwent thoracotomy compared with patients who went through the VATS procedure (p=0.006 vs p=0.02). The average total cost of patients operated via VATS was lower compared with patients operated via thoracotomy (p=0.026 vs 0.014) [Table 1 and Fig. 1a, b]. When we analyzed patients who had a lobectomy, it was found that the total cost of VATS lobectomy (15 741±6818 TL) was lower than that of lobectomy via thoracotomy (19 398±9649 TL), but the difference was not statistically significant (p=0.114) [Fig. 2]. At least one complication was found in 8 patients (13.8%) in VATS and 6 patients (30.0%) in the thoracotomy group. When we excluded patients who had complications and reanalyzed the remaining patients (50 patients via VATS and 24 patients via thoracotomy), we found that the mean total cost of VATS lobectomy (13 408±7003 TL) was statistically significantly lower than that of lobectomy via thoracotomy (18 220±9991 TL) (p=0.02).

Discussion

VATS lobectomy has been successfully done worldwide for more than 20 years and has been accepted as a better option for the management of early-stage non-small cell lung cancer.[2–5,7] However, the instrumentation and necessity to use disposable material raise a question regarding the cost of the procedure.[5] We have shown that the cost of anatomic resection via VATS was lower than that of thoracotomy. The major reason for this cost difference is a shorter hospital stay and lower morbidity. In our series, the patients who had undergone VATS resection had a shorter hospital stay and lesser need for ICU stay. Burfeind and colleagues[6] reported that the cost of quality-adjusted life year for each year for each patient was lower for thoracoscopy (US$10 084) compared with thoracotomy (US$12 119). This difference suggests that videothoracoscopic resection should be performed not because it results in better outcomes, less postoperative pain, less complication, shorter hospital stay, and faster return to normal life[2,4,5]

Table 1: Clinicopathologic characteristics of patients and comparisons

	Video-assisted thoracoscopic surgery, n (%)	Thoracotomy, n (%)	p
Gender			0.146 (Chi-squared test)
Male	18 (31.0)	25 (83.3)	
Female	40 (69.0)	5 (16.7)	
Mean age (years)	60.6	61.3	0.786 (Mann-Whitney U Test)
Type of resection			
Lobectomy	24	24	0.001 (Chi-squared test)
Wedge resection	32	1	
Segmentectomy	2	0	
Pneumonectomy	0	5	
Pulmonary function test			(Mann Whitney U test)
FVC (L) (SD)	3.34±0.95	3.28±1.18	0.895
FVC%	96.25±22.33	91.60±24.65	0.900
FEV_1 (L)	2.43±0.91	2.41±0.75	0.881
FEV_1%	86.38±21.57	82.47±25.41	0.350
FEV_1/FVC	69.60±16.45	69.32±16.00	0.425
FEV_1/FVC (%)	90.25±20.70	91.39±21.11	0.418
Stage of the tumors			
T0N0M0	9	6	0.004 (Chi-squared test)
Tis	0	1	
IA1	4	0	
IA2	11	1	
IA3	5	1	
IB	3	3	
IIA	3	1	
IIB	6	6	
IIIA	3	5	
Hospital stay	4.73±2.83	6.94±4.14	0.006 (Mann-Whitney U test)
Intensive care unit admission	6	9	0.020 (Chi-squared test)
Mean total cost (Turkish lira)	14 059±7874	18 597±9716	0.019 (Mann-Whitney U test)
Cost of operation	3996±1660	4675±1023	0.014 (Mann-Whitney U test)

FVC: Forced vital capacity, FEV: forced expiratory volume

but because it costs less compared with thoracotomy. This result is important not only for developed countries such as the United States[8] but also for countries whose healthcare resources are very limited.

Although we observed a lower cost for videothoracoscopic anatomic resections, the cost of VATS lobectomy was shown to be possibly further reduced through the prudent use of costly instruments and technologies.[9] Bendixen and colleagues performed a randomized study and reported that VATS is a cost-effective alternative to thoracotomy in stage 1 non-small cell lung cancer patients.[10] We were able to show that VATS is cost-effective in patients with stage IA–IIIA non-small cell lung cancer. In our analysis, the cost of operation was found to be lower in the VATS group. This finding might be due to the fact that linear open-surgery staplers were used during open operations. The use of these products has become standard during the last decade. We were also able to show that VATS lobectomy is less expensive than lobectomy performed via thoracotomy although the difference was not statistically significant.

There are some limitations of our study that should be addressed. This study was a retrospective analysis of patients from one institution. The number of used stapler reloads was not standardized. In our series, the stages in the open thoracotomy group were statistically significantly higher. It was expected since most T3 and T4 tumors could be operated via thoracotomy rather than via videothoracoscopy.

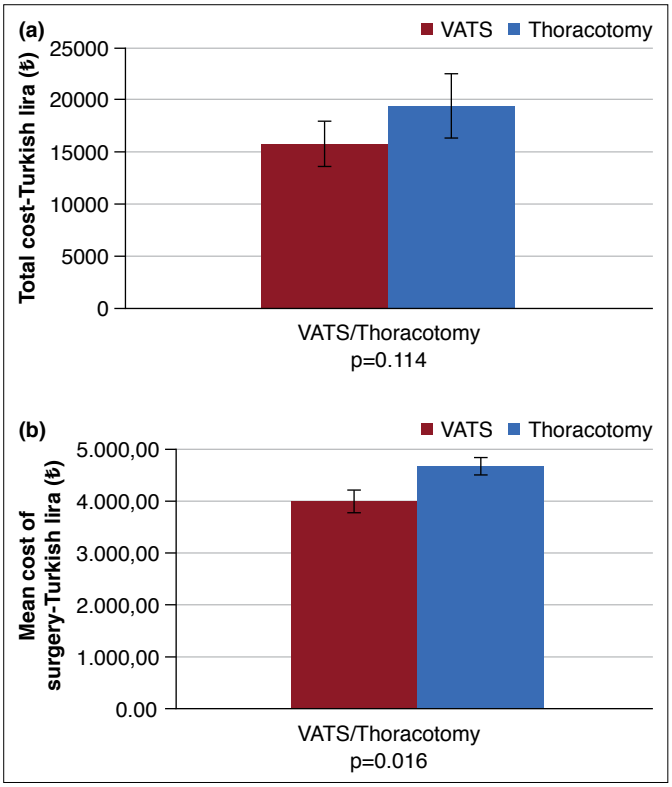

Figure 1: (a) Total hospital cost; (b) cost of operation. Bars represent standard deviation

VATS: Video-assisted thoracoscopic surgery

We did not consider the cost of the videothoracoscopic system and the cost of other reusable instruments. In our series, 32 wedge resections were performed. In 24 cases the purpose was diagnosis of a suspected lesion and in 8 cases it was treatment of malignancy on patients whose lung function was poor (i.e., postoperative predicted FEV_1 <40%). We analyzed the patients who had resectional surgery for 1 year to limit the variability in terms of the amount of reimbursement and offsetting factors of possible selection bias and learning curve.

To define the best treatment available for the operable lung cancer patients, effectiveness, beneficial effect (survival), side effects, time to postoperative recovery, quality of life, and cost should be considered in a concept of "value-based medicine."[11] Videothoracoscopic resections provide the best possible treatment with the lowest possible adverse events, and they provide the fastest possible recovery.[2,4,7,8] We have shown that this approach also leads to the least economic impact on the healthcare system. To maximize the whole healthcare system's efficiency and sustainability in a dominantly public-funded

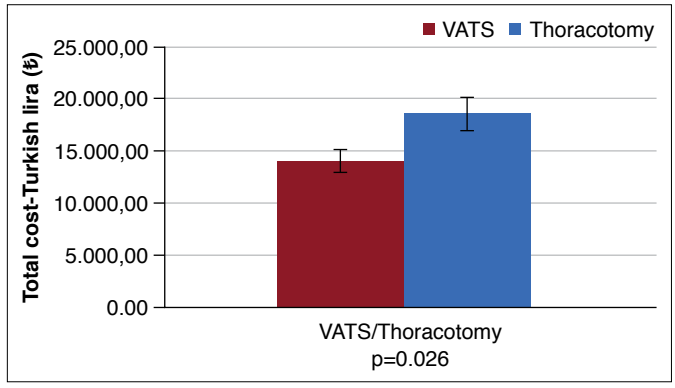

Figure 2: Total hospital cost in patients undergoing lobectomy. Bars represent standard deviation

VATS: Video-assisted thoracoscopic surgery

insurance system, the most effective mode of surgery such as videothoracoscopy should be chosen.

In our study, the total hospital cost of the operation and the cost of operation were calculated to be US$2343 and US$666, respectively, which were much lower than those of Poland and the United States.[4,9] It is probably due to the low cost of hospital services and workforce. It is another reason that videothoracoscopic resections should be preferred to open resections. The performed videothoracoscopic resections were predominantly uniportal videothoracoscopic resections performed through only one utility incision. In our study, we did not analyze the impact of the number of ports on cost, although we were able to disclose any statistically significant different impact on clinical parameters.[12]

Conclusion

The cost of VATS anatomic resections is lower compared with thoracotomy in surgical resections of lung cancer. It should be preferred in terms of health economics. VATS has been proven better in terms of pain, postoperative mortality, morbidity, and quality of life after the operation. It should be the gold standard and must be performed where available.

Conflicts of interest

There are no conflicts of interest.

Ethics Committee Approval

The study was approved by the Cerrahpasa Faculty of Medicine Clinical Research Ethics Committee (No: E-83045809-604.01.02-134291, Date: 09/07/2021).

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