A comparative cost analysis study of lobectomy performed via video-assisted thoracic surgery versus thoracotomy in Turkey

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Abstract

Introduction: Cost analysis studies performed in western countries report that the overall cost of lobectomies performed via video-assisted thoracic surgery is similar to or less than those performed via thoracotomy. The situation may be different in a developing country.
Aim: We evaluated the cost differences of these two surgical methods.
Material and methods: We retrospectively reviewed the hospital records of 81 patients who underwent lobectomy either via video-assisted thoracic surgery (n = 32) or via thoracotomy (n = 49). Patient characteristics, pathology, perioperative complications, additional surgical procedures, length of hospital and intensive care unit stay, and outcomes of both groups were recorded. Detailed cost data for medications, anesthesia, laboratory, surgical instruments, disposable instruments and surgery cost itself were also documented. Statistical analyses were performed to compare the groups.
Results: The two groups were homogeneous in regard to age, sex, pathology and perioperative morbidity. The mean duration of hospitalization in the video-assisted thoracic surgery group was significantly shorter than that of the thoracotomy group (7.78 ±5.11 days vs. 10.65 ±6.57 days, p < 0.05). Overall final mean cost in the video-assisted thoracic surgery group was significantly higher than that of the thoracotomy group ($3970 ±1873 vs. $3083 ±1013, p = 0.002). This significant difference relies mostly on the cost of disposable surgical instruments, which were used much more in the video-assisted thoracic surgery group than the thoracotomy group ($2252 ±1856 vs. $427 ±47, p < 0.05).
Conclusions: In contrast to western countries, a video-assisted thoracic surgical lobectomy may cost more than a lobectomy via thoracotomy in a developing country. More expensive disposable surgical instruments and cheaper hospital stay charges lead to higher overall costs in video-assisted thoracic surgical lobectomy patients.

Key words: lobectomy, video-assisted thoracic surgery, thoracotomy.

Introduction

With the development of thoracic surgery, nowadays thoracic surgeons are seeking minimally invasive procedures both to increase patient comfort and to reduce the costs of interventional procedures. Thoracoscopic procedures which have come into use since 1991 are becoming more common and preferred as they are more cosmetic with a small incision, less pain and blood loss, and shorter intensive

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care unit and hospital stay [1]. While thoracoscopy was used most commonly for diagnostic purposes in parenchymal and pleural lesions and for management of pleural effusions, in recent years, the proportion of thoracoscopic resections in lung cancer surgery has increased with the developments in endoscopic equipment [2–4]. However, beside the advantages, video-assisted thoracic surgery (VATS) also brings disadvantages such as increased need for disposable equipment, limited digital palpation and obscure long-term results [5].

The most effective treatment in resectable lung cancer is still lobectomy [6]. It is obvious that VATS lobectomy gives a better postoperative life quality compared to open thoracotomy. Many comparative studies report that the costs of VATS lobectomy and thoracotomy are equal or less in VATS.

Aim

We evaluated cost differences of these two surgical methods in our country.

Material and methods

We retrospectively investigated the records of 81 stage I non-small cell lung carcinoma (NSCLC) patients who underwent lobectomy in our institution between September 2007 and March 2009. Forty-nine of those patients had resection via thoracotomy and 32 via VATS. Patient characteristics, perioperative complications, additional surgical procedures, their pathologies and length of hospital and intensive care unit stays were investigated. The costs for anesthesia, laboratory, medications, surgical equipment and surgery were calculated. All costs were converted to US dollar currency at the time of the study.

All patients were preoperatively assessed with history, physical examination, serum biochemistry and complete blood count, respiratory function tests, electrocardiography, chest radiography and computed tomography. None of the lung cancer patients performed with VATS or open thoracotomy had mediastinal, chest wall or major artery involvement. All lung cancer patients had preoperative histologic diagnosis. Preoperative management included positron emission tomography (PET-CT) and brain magnetic resonance imaging (MRI) to investigate distant metastasis. Mediastinoscopy for preoperative lymph node staging was performed in only 2 patients who had VATS due to negative mediastinal status on

PET-CT. In the thoracotomy group, 32 patients had mediastinoscopy to rule out suspected lymph node positivity on preoperative radiological examinations.

In the thoracotomy group, the serratus anterior muscle was spared and thoracotomy was performed via the posterolateral fifth intercostal space. The vascular structures were tied using silk sutures. The bronchus was hand-sewn using vicryl or prolene sutures. In the VATS lobectomy group, a 30-degree thoracoscope was inserted via a 10 mm thoracoport from the anterior axillary line in the seventh intercostal space. Two or three port incisions were used. A 4 cm utility incision was made through the fifth intercostal space along the anterior axillary line. Endoscopic vascular staplers were used to divide the pulmonary artery, vein and bronchus. Patients in both groups underwent systemic lymph node dissection. Patients who were converted to thoracotomy were excluded from the study.

Detailed cost data were calculated for drugs, anesthesia, laboratory tests, surgical equipment, disposable devices and surgery. Findings were reported as the group average ± standard deviation. Cost analysis was based on invoices paid to the hospital by the Republic of Turkey Social Security Administration. The Kolmogorov-Smirnov test was applied for both techniques to test for a normal distribution.

Statistical analysis

Based on Kolmogorov-Smirnov test statistics, the thoracotomy group was compatible with a normal distribution. However, since the VATS group did not exhibit a normal distribution, the Mann-Whitney U test was performed to determine whether there was a significant difference between the costs of the two techniques.

Results

Thirty-two patients among 81 who were included in the study underwent VATS lobectomy and 49 underwent lobectomy with standard posterolateral thoracotomy. Patients in each group were homogeneous in terms of sex, age, diagnosis and comorbid factors (Table I). Of the patients who underwent VATS lobectomy ($n = 32$), 10 were women and 22 were men. Of those who underwent lobectomy with standard thoracotomy ($n = 49$), 6 were women and 43 were men. Mean age was 66 ±3.8 in the VATS group and 58 ±4.4 in the thoracotomy group. Among

the patients who underwent VATS lobectomy, 7 had benign pathology, while 25 had malignant pathologies. Among those who underwent lobectomy with standard thoracotomy, 8 patients had benign pathology whereas 41 had malignancy (Table I).

The most common comorbidities in each group were chronic obstructive pulmonary disease (COPD) and hypertension. In the VATS lobectomy group, hypertension and COPD were present as comorbid factors in 25% and 28%, and in the lobectomy group with thoracotomy, 31% and 27%, respectively.

Among 32 patients who underwent VATS lobectomy, 10 had left upper, 8 right upper, 7 left lower, 5 right lower and 2 middle lobectomies (Table II). Stages of all lung cancer patients in both groups were T1 or T2, N0, M0. All patients were admitted to a postoperative intensive care unit overnight following the surgery. Thirteen patients who underwent lobectomy with thoractomy stayed in the postoperative intensive care unit for 2 days, 1 patient for 3 days and 1 for 5 days. Thirty-four other patients were admitted to the ward following postoperative stay in the intensive care unit overnight. Among them, 1 patient with right lower bilobectomy needed 4 days of intensive care unit treatment for mechanical ventilation due to respiratory failure. Another patient stayed in the intensive care unit for 2 days following completion of pneumonectomy for bronchopleural fistula that developed following right upper lobectomy. The remaining 13 patients were followed in the intensive care unit for 1 day due to postoperative bleeding, pneumonia, atelectasia and for primary repair of trachea laceration due to endotracheal tube malposition. Among 32 patients who underwent VATS lobectomy, 30 were admitted to the ward following surgery. Only 2 patients needed intensive care unit stay for 1 day (1 patient for high output, 1 following revision for massive air leak). The most common complications in each group were prolonged air leak and atelectasis (7%).

Mean hospital stay for those patients was 10.65 ±6.57 days. For patients who underwent VATS lobectomy, mean hospital stay was 7.78 ±5.11 days. The longer hospital stay in VATS lobectomy patients in our group when compared to similar studies in the literature can be attributed to our learning curve period with VATS lobectomy. The patients who underwent lobectomy via thoracotomy had significantly longer hospital stay compared to those who underwent VATS lobectomy ($p < 0.05$). In our country

Table I. General characteristics of patients who underwent lobectomy

Variables	VATS ($n = 32$)	Thoracotomy ($n = 49$)
Patient's gender (male/female)	22/10	43/6
Age	66 ±3.8	58 ±4.4
Diagnosis:		
Bronchiectasis	6 (19%)	8 (16%)
Aspergilloma	1 (3%)	–
Carcinoid tumor	1 (3%)	3 (6%)
Adenocarcinoma	11 (34%)	15 (31%)
Squamous cell carcinoma	13 (41%)	23 (47%)
Hypertension	8 (25%)	15 (31%)
Diabetes mellitus	6 (19%)	5 (10%)
Coronary artery disease	1 (3%)	2 (4%)
COPD	9 (28%)	13 (27%)
Smoking	26 (81%)	29 (60%)
FEV$_1$ (%)	62 ±20	70 ±19

COPD – chronic obstructive pulmonary disease, FEV$_1$ – forced expiratory volume in the 1st s

Table II. Distribution of anatomic pulmonary resections and TNM stages

Variables	VATS ($n = 32$)	Thoracotomy ($n = 49$)
LUL	10	13
RUL	8	16
LLL	7	7
RLL	5	8
RML	2	3
BLB	–	2
Stage:		
T1N0M0	10	6
T2N0M0	14	32

BLB – bilobectomy, LLL – left lower lobectomy, LUL – left upper lobectomy, RLL – right lower lobectomy, RML – right middle lobectomy, RUL – right upper lobectomy

hospital the bed cost for 1 day is between $10 and $15, which is one of the main factors why the cost for thoracotomy patients is less than that in the published literature.

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Table III. Operational costs (US dollars)

Variables	VATS (n = 32)		Thoracotomy (n = 49)	
	Mean	Standard deviation	Mean	Standard deviation
Postoperative drugs	355.82	556.43	186.05	251.69
Anesthesia drugs	101.04	65.5	94.92	88.76
Laboratory tests	223.36	249.76	158.23	185.51
Pathology	287.36	104.52	154.48	95.09
Anesthesia	223.48	62.22	165.32	59.11
Surgery cost	888.99	619.22	586.48	82.48
Anesthesia instruments	62.98	30.90	66.49	29.9
Surgical instruments	142.31	85.88	86.74	82.8
Disposable surgical				
Instruments	427	470.35	2251.78	1855.65
Ward instruments	17.52	20.95	17.14	15.92
Ward or ICU procedures	241.76	235.97	156.3	121.1
Total average cost*	3083		3970	

ICU – intensive care unit, VATS – video-assisted thoracoscopic surgery; *p = 0.002

There was no statistically significance between the two groups in terms of costs of administered drugs, laboratory tests, anesthesia or surgery. Mean total cost in the videothoracoscopic lobectomy group ($3970 ±1873) was significantly higher than that for open lobectomy ($3083 ±1013) ($p$ = 0.002). This significant difference was related to the additional cost of disposable surgical equipment ($p < 0.05$) (Table III).

Discussion

Thoracic surgeons, without compromising patient care, prefer surgical methods which reduce mortality, morbidity and the cost. Publications report that reducing hospital stay and preoperative tests significantly reduces costs. In recent literature, it is mentioned that the cost of VATS lobectomy is lower, especially in developed countries [7].

In developing countries, the main reasons for the high cost of VATS lobectomy are endostaplers and other disposable devices [7]. In the last decade, VATS lobectomy has increasingly been recommended and successfully performed in patients with early stage NSCLC [8–10], with advantages such as less postoperative pain, fewer complications and shortened hospital stay [10–14]. In cancer surgery, long-term survival of patients who underwent lobectomy via VATS or thoracotomy showed similarities in various comparative studies and meta-analyses [15–17].

Hazelrigg et al. reported that thoracoscopic procedures have higher costs [18]. In that study, similar to ours, it was found that high costs were related to disposable devices being more expensive. In another study it is reported that significantly higher costs of the VATS procedure can limit widespread introduction of VATS lobectomy [19]. On the other hand, Burfeind et al. reported that VATS lobectomy is a cheaper procedure compared to posterolateral thoracotomy [20]. Swanson et al. also obtained similar findings in a multicentric study [21].

In a study by Casali and Walker who compared thoracoscopic and open resections, the cost of the thoracoscopic group was significantly lower. The highest outflow was caused by disposable devices. However, since hospital stay was shorter, the total cost of thoracoscopic resections was lower [22]. Sugi et al. compared 10 VATS lobectomies with 20 thoracotomies. The cost of disposables was found to be significantly higher in the VATS group. The length of hospital stay was the same and as a result the general cost of VATS lobectomies was found to be higher [23]. Park et al. compared the costs of open, thoracoscopic and robotic resections. The cost of robotic re-

sections was higher compared to thoracoscopic and open resections. Nevertheless, they found that costs of thoracoscopic resections were lower compared to open resections [24].

According to these studies, the general cost of VATS or thoracotomy for lung resection is variable and the issue is controversial. It is clear that, with high disposable instrument costs where hospital stay between the groups is the same or it does not make any significant difference due to low bed fees, the total cost of VATS lobectomy would be higher. In a study reviewing the cost analysis reports, it is stated that the general cost of VATS procedures is higher. However, in studies between different countries where hospital stay duration, bed fees and disposable instrument costs vary, it is reported that no definitive conclusions could be drawn. Further prospective randomized studies are necessary to clarify the cost issue more precisely, and strategies of cost reduction should be developed [25].

In this study, we compared the costs and hospital stay durations of patients who underwent VATS or lobectomy with standard thoracotomy. The costs of main devices such as video and endoscopic equipment were excluded. Disposable devices and hospital service costs (intensive care, anesthesia, surgery, bed fees, etc.) were included. While hospital stay was significantly shorter in the VATS group than the thoracotomy group, the total cost was still higher. This is because of low bed costs and high costs of the disposable instruments that are used in VATS lobectomy.

The patient distribution was based on the surgeon's choice. Therefore, being a non-randomized retrospective study with a low number of patients was the biggest limitation of our study.

Conclusions

The most important factors that affect the total cost in thoracic surgery are the costs of hospital stay and the components required for patient care. In our country, bed costs are lower than those in other countries. Our study shows that low bed costs and high costs of disposable instruments in VATS lobectomy are the main factors responsible for the higher cost of VATS lobectomy. As a result, unlike western countries, in developing countries like ours, VATS resections cost more than thoracotomy. Time to return to work as one of the determinants of the economic outcome cannot be assessed accurately in Turkey as lung cancer pa-

tients are accepted as retired (for at least 2 years) as soon as they apply to the social security system.

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