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Original Article

Importance of simulation devices in thoracic surgery education: a prospective comparative study

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ABSTRACT

Background: This manuscript aims to evaluate VATS lobectomy simulation training and the success of surgeons who have just started on simulation.

Materials and Methods: In the study, which was designed prospectively, we used a VATS simulation device to evaluate two expert surgeons and three residents' VATS right upper lobectomy outcomes. Forty-five resections were performed by residents (Group-A), while 43 resections were performed by expert surgeons (Group-B).

Results: 45 (51.1%) were in Group-A, and 43 were in Group-B 78 (88.6%) successful resections were completed in simulation. The division and stapling time of the bronchus, superior pulmonary vein, and superior pulmonary artery was shorter for Group-B than for Group-A ($p < 0.05$). Eight resections (17.8%) could not be completed in Group-A due to complications, while in Group-B, two resections (4.7%) were incomplete due to complications ($p = 0.090$).

Conclusions: Based on this study, we believe that the experience of novice surgeons can be increased, especially with simulation training. Completion of similar operations also showed good content validity, especially when compared with experienced surgeons.

Keywords: VATS, stimulation, thoracic surgery, lobectomy, lung resection

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Introduction

Video-Assisted Thoracic Surgery (VATS) approaches have been performed in lung resections since the 1990s [1]. Nowadays, minimally invasive surgery is preferred over open surgery in lung cancer operations, and new developing technologies change surgeons' vision into minimally invasive surgery. VATS and robotic-assisted thoracic surgery (RATS) have become the most popular approaches in lung cancers surgery. Compared to open surgery, its earlier discharge, less pain, and complication rates, faster return to daily activities, reduced cytokine release, and economic advantages are more prominent, particularly, in minimally invasive approaches [1-3].

Despite all the innovations in minimally invasive surgery, surgical resections performed with VATS take longer compared to open surgery. The most remarkable reason for this is the challenges encountered in learning the use of thoracoscopic instruments and camera and hand orientation in narrow spaces. Moreover, the training of constantly developing technological instruments and their adaptation for surgery make up one of the primary problems for surgeons. Thus, it is considered that training such as dry lab, wet lab, training box, simulation, and live surgery enhance the adaptation of surgeons to technology. Although there are publications on the importance of these trainings in the literature, comparative publications are quite limited.

Our aim in this manuscript is to evaluate VATS lobectomy simulation training and the success of surgeons who have just started on simulation.

Materials and Methods

The study, which was designed prospectively, was conducted between October and November 2021. We used the Simbionix VATS simulation device (USA Corporation, Cleveland, OH) in this study. Two expert surgeons and three residents performed VATS right upper lobectomy resections in this study. In this study, 88 right upper lobectomies were performed in the simulation environment. Forty-five resections were performed by residents (Group-A) while 43 resections were performed by expert surgeons (Group-B).

Group A consists of surgeons in their first year of physician residency and who have not previously performed any lung resections on their own. Before the resection simulation, residents finished the training programs in the simulation, and expert surgeons guided them. Besides, upper lobectomy resection training was provided by expert surgeons in a simulation environment. Expert surgeons have performed more than 100 lung cancer resections in the last two years and have been routinely performing lung resections with VATS for seven years.

The ethics committee approval of the study was obtained from the local ethics committee of our hospital. (Ethics Committee Decision No: 2021-157)

Surgical Technique

In the Simbionix VATS simulation device, the surgeon can see the surgery in VATS surgeries from the standard viewing angle. Simulation allows operation with 3 ports. Surgeons evaluate the thoracic cavity with a camera at the level of the anterior axillary line. There was no variation or tumoral structures in the training module. Standard anatomical tissues are included in the simulation, and all vascular, parenchymal, and bronchial structures can be dissected and resected in the simulation device.

All procedures were conducted in the same way in the simulation. Operations were performed using the 3-port technique (Figure 1A). Surgical field exposure was adjusted benefiting from the 30-degree optical usage feature. First, the upper lobe pulmonary vein was dissected and excised with an endoscopic vascular stapler (Figure 1B). Subsequently, after the pulmonary arteries leading to the upper lobe were dissected and cut, the bronchus was turned, and the endoscopic parenchyma was cut with a stapler. Following the fissure was completed with the stapler, the program automatically puts the material into the endobag and removes it.

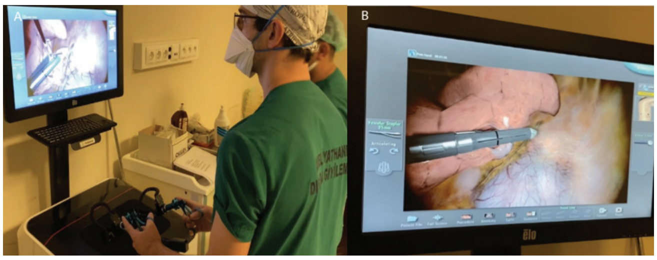

Figure 1. The simulation device **(A),** image of dividing the vascular structures with a stapler during the simulation **(B)**.

Statistical Analysis

Statistical analyzes were performed using IBM SPSS for Windows version 22.0. Numerical variables were evaluated as mean and standard deviation or median, minimum, and maximum values; categorical variables were summarized using numbers and percentages. Parametric test assumptions (normality and homogeneity of variances) were checked before comparing numerical variables between the groups. Differences between groups were analyzed using the independent-samples t-test. Categorical values were analyzed using Fisher's exact test. Mann-Whitney U test was used to compare continuous variables. The level of significance was accepted as $p < 0.05$ for all analyzes.

Results

Of the 88 resections included in the study, 45 (51.1%) were in Group-A, and 43 were in Group B. 78 (88.6%) successful resections were completed in simulation training. The total duration of operation was determined to be 15.3 ± 6 min. The mean duration of the superior pulmonary vein (SPV) rotation and stapling was 4.5 ± 2.2 minutes. Besides, the mean duration of SPV ligation and stapling was 5.3 minutes (IQR: 4.1-7.3) in Group-A, while it was 3.1 minutes (IQR: 2.6-3.5) in Group-B ($p < 0.001$). The mean duration of the superior pulmonary artery (SPA) ligation and cutting with a stapler was 4.6 ± 2.8 min. While it was 7 minutes (IQR: 5-8) for SPA ligation and cutting with staples in Group A, it was 2.5 minutes (IQR: 2-3.5) in Group-B ($p < 0.001$). The mean time to ligate the upper lobe bronchus and cut it with a stapler was 4.4 ± 2.1 minutes. It was 6 (IQR: 5-7.4) in Group A, whereas it was observed to be 3 minutes (IQR: 2.4-3.5) in Group-B. A significant difference was found between the groups ($p < 0.001$). In Table 1, the operational characteristics of the groups are compared.

Table 1. Operational characteristics between groups.

Variables		Resident	Expert	p
Right Superior Pulmonary Vein Dissection (Min)	Median (IQR)	5.3 (3.3)	3.1 (0.9)	<0.001
Right Superior Pulmonary Artery Dissection (Min)	Median (IQR)	7 (3)	2.5 (1.5)	<0.001
Right Upper Lobe Bronchus (Min)	Median (IQR)	6 (2.5)	3 (1.1)	<0.001
Total Operation Time (Min)	Median (IQR)	19.8 (6.2)	8.7 (3)	<0.001

Abbrev.; Min: Minute, IQR: Interquartile Range

Eight resections (17.8%) could not be completed in Group-A due to complications, while in Group B, two resections (4.7%) were incomplete due to complications ($p = 0.090$). Complications occurred in a total of 15 (17%) resections. 12 (26.7%) complications occurred in Group-A. In Figure 2, the relationship between complication rates and case order in Group-A. Resection was successfully completed by intervening in 5 of these complications. While major vascular injury occurred in 9 (20%) patients in Group-A, major vascular injury developed in 3 (7%) patients in Group-B ($p = 0.098$). In both groups, one major vascular injury was successfully managed, and the resection was completed. The pericardial injury also occurred in 1 patient in Group-A who developed a major vascular injury. Table 2 shows the comparison of complications and groups. In Group-A, as the number of operations increased, the time of the operation decreased so they were mildly negatively correlated ($r = -0.499$) (Figure 3).

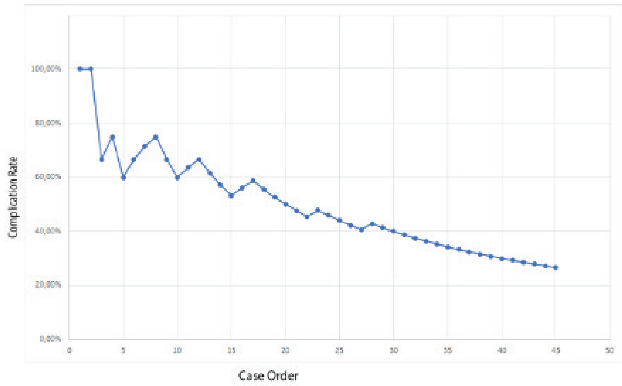

Figure 2. Relationship between complication rates and case order in Group-A.

Figure 3. Relationship between operation times and case order in successful resections in Group-A.

Table 2. Comparison of complications and groups.

Variables	Resident n (%)	Expert n (%)	p
Intraoperative complication	12 (26.7)	3 (7)	0.014
Major vasculer injury	9 (20)	3 (7)	0.075
Phrenic nerve injury	3	0	1
Pericardium injury	1	0	1
Completing the resection	37 (82.2)	41 (95.3)	0.090

Discussion

Since uniportal surgical operations have become popular in recent years and resections with thoracotomy can be performed with uniportal surgery, many young surgeons have started performing VATS operations. Yet, the most remarkable problem is that VATS training is different from open surgery training and is relatively challenging. Although VATS has many advantages, major and mortal complications have been reported in the literature [4]. Young surgeons are discouraged, especially due to possible bleeding, and with the same concern, the willingness of specialist surgeons to have assistants perform these surgeries decreases. Hence, video thoracoscopic resections are performed in a limited number of centers in many countries as well as in our country [5]. We think that the most important reason for this problem in our country is the lack of VATS training programs.

There are different training programs regarding VATS and robotic surgery training in the literature [4,6-9]. In literature, there are publications suggesting that short-term observer programs are effective in education in centers with a high surgical patient volume, there are also authors who advocate step training models. Shioe et al stated that observers can be trained in a short time in training held in high-volume and experienced centers. Torre et al suggested that training on animal models is a good option for uniportal VATS lobectomy practice [10]. Rocco et al argue that if the opportunity for major resections is given, there will be more tendency toward minimally invasive surgery. We also consider that simulation training is crucial for residents who are new to VATS. We are of the opinion that the training is especially beneficial for residents to gain experience in VATS before the surgery and increase instrument coordination and 3D thinking.

Larsen et al revealed that virtual reality simulator training can reduce morbidity rates and shorten the operation duration [9]. Štupnik stated that surgical environments are not the best training areas since they are stressful places, and simulation training is important for the new generation of surgeons in this respect [11]. Solomon et al, on the other hand, developed an anatomy training model with a cognitive simulator made by surgical instruments on a haptic feedback device. They stated that thanks to this cognitive training model, the deficiencies in the existing training models can be corrected. Jensen et al. assessed the results of novice, intermediate and experienced surgeons in their LapSim virtual reality simulation training [12]. No difference was found between the groups in terms of the amount of bleeding, the duration of the operation, and the selection of the right instrument. As a result of the study in which 103 surgeons were included, they suggested that this simulation training is crucial to gaining experience in VATS. Furthermore, they stated that by improving the software, the differences between surgeons could be assessed more clearly. On the other hand, in the Haidar simulation study, a significant difference was found between the amount of bleeding, the duration of the operation, and the path length of the instruments between the experienced surgeon and the novice and intermediate surgeon [13]. In the study, they stated that novices passed the simulation test by practicing. Similarly, in the study of Tanaka et al on the wet-lung model, the procedures were performed successfully in both groups, though there were differences between the groups in terms of procedure times [14]. As a result of our study, we determined that novice surgeons successfully performed lobectomy after completing the simulation training. When compared with experienced surgeons, we did not find any significant difference between the groups. We observed that the most notable difference was the duration of the operation and the number of complications.

Likewise, Wan et al [15] have shown that trainees can safely perform VATS lobectomy under the supervision of experienced surgeons. Later, Peterson et al [4] stated in their study that TCs have a similar rate of morbidity to ECs. Training consultants also stated that more prolonged air leaks were observed, and the operation time was longer. When complications in our simulation study were analyzed, it was noticed that major vascular injuries and mortality rates were higher in the resident arm. Whereas these rates were observed to be higher at the onset of the simulation training, we found that the complication and mortality rates decreased as we gained experience towards the end of the training. Moreover, we found that the operation durations and vein ligation times became shorter towards the end of the training. Based on this, we think that at the end of the training, especially VATS practice is more encouraging and contributes positively to motivation.

Limitation of the Study

The main limitations of the study include the inability to measure the amount of bleeding and the fact that it was performed by more than one surgeon, it was performed in a single center, and the instrument movements could not be calculated.

Based on the result of this study, we have come to a conclusion that the experience of novice surgeons can be increased, particularly through simulation training. Completion of similar operations also showed good content validity, especially when compared with experienced surgeons. We consider that VATS simulation training in thoracic surgery is an important cornerstone and should be applied in VATS training all over the world.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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Ethics approval

Approval was obtained from the Local Ethics of Yedikule Chest Diseases and Thoracic Surgery Education and Research Hospital (Rec Number: 2021-157).

Authors' contribution

CBS,OS,MM; conceptualized and drafted the article, CO-wrote the paper GT,MVD,SE; drafted the article, collected and analyzed data, YE,VENY; collected data.

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