EARLY RESULTS OF ROBOTIC LOBECTOMY TREATMENT NON-SMALL CELL LUNG CANCER: EXPERIENCE AT CHO RAY HOSPITAL

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Summary

Objectives*:** Nowadays, there are numerous ways to configure trocar placements for lobectomy using the Da Vinci Xi system. Cho Ray Hospital conducted robotic video-assisted thoracic surgery (rVATS) lobectomy in July 2018 and obtained satisfactory results. Currently, there is no research on rVATS lobectomy in Vietnam, so we decided to report our initial experiences using rVATS lobectomy in non-small cell lung cancer at our institute. ***Subjects and methods: rVATS for lobectomy was performed on 79 patients with lung cancer who were treated at Cho Ray Hospital from July 2018 to June 2022. All patients were performed the rVATS lobectomy with triangular port placement. The cardiere, harmonic arms were used as robotic arms in the present study which was further coordinated with thoracic surgical instruments through working support. The early outcomes were: The rate of conversion to open procedure, post-operative complications, and day of post-operation. ***Results:*** Out of 79 enrolled patients, the majority of study participants were males and belonged to the 60 - 69 years age group. Most of them had tumor lesions in the left upper lobe, followed by the right upper lobe and right lower lobe, respectively. The mean tumor size was noted to be 3.8 cm. The mean time of operation was 262.2 minutes. The average blood loss was 200 mL. The rate of conversion to open procedure accounted for 8.9%. In intraoperative lymphadenectomy for the mediastinal lymph node, the resection rate was 74.7%. Amongst postoperative complications, prolonged air leak > 7 days was the most common. In the hospital, mortality was found to be 1.3%. Changes in clinical and pathological lymph node assessment via intraoperative lymph node dissection accounted for 32.9%.

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The good results account for 87.3%. Central lung tumors had a higher rate of conversion to open procedures than statistically significant peripheral ones ($p < 0.001$). Conversion to open procedure was not statistically significantly associated with lung tumor size ($p = 0.26$). There is a statistically significant correlation between N1/N2 lymph nodes on thoracic CT scan and converted to open case. ***Conclusion:*** Robotic lobectomy for lung cancer is a safe and practical technique despite the associated primary challenges.

* *Keywords:* Lung cancer; Robotic video assisted thoracic surgery; Lobectomy.

INTRODUCTION

Robotic thoracoscopy using the Da Vinci system was invented to solve the existing difficulties in conventional thoracoscopy. rVATS has a 3D screen that senses the depth of the surgery. The robotic arm is flexible, rotates 360 degrees, and accurately simulates the surgeon's movements for better and more efficient surgery in narrow spaces. A number of studies have demonstrated that rVATS reduces the rate of conversion to open surgery, reduces the rate of post-operative complications, and decreases the length of hospital stays [1]. rVATS is increasingly developed and popular. According to Da Vinci's annual report, in 2017, there was a growth in the number of VATS to 16% compared to 13% in 2016. There is a strong development of robotic systems for surgery in countries such as Europe, Japan, Korea, and China.

Nowadays, there are numerous ways to configure trocar placements for lobectomy using the Da Vinci Xi system: Totally portal robotic lobectomy and 3- or 4-port robot-assisted thoracic surgery (RATS) are both options [2]. With four arms and one port-assisted at the ninth intercostal, Cefolio advised port placement in "a straight line" through the eighth intercostal [3].

In Vietnam, the rVATS lobectomy was first applied at Binh Dan Hospital in 2016, but the number is still limited. Cho Ray Hospital conducted rVATS lobectomy in July 2018 and obtained satisfactory results. Currently, there is no research on rVATS lobectomy in Vietnam, so we decided: *To report our initial experiences using rVATS lobectomy in non-small cell lung cancer at our hospital.*

SUBJECTS AND METHODS

1. Study design and participants

Between July 2018 to June 2022, rVATS for lobectomy were performed on 79 patients with non-small cell lung

cancer who were treated at Cho Ray Hospital, Vietnam. We collected the patient who had clinical stages I, II, and IIIA following the 8th edition of TNM classification of the International Association of the study of Lung cancer based on contrast chest CT scan, brain MRI, and PET scan. They all were suspected or diagnosed with clinical stages I and IIIA lung cancer and were candidates for radical surgical resection (ASA 1-3). Exclusion criteria were severe heart disease, renal impairment, any other serious comorbidities according to the investigator, recent oncologic history (another malignant tumor within the last 2 years), and previous chest surgery. In stage cIIIA, we chose T3N1 and T4N0, excluded T4, which invaded the diaphragm, heart, and main bronchus.

Pre-operative staging included contrast-enhanced total body CT and FDG-PET. The standard functional evaluation included ECG, cardiological evaluation, pulmonary function tests, and pre-anesthesia evaluation.

In the case of suspicious mediastinal nodes, EBUS or mediastinoscopy was performed before resection. A pre-operative diagnosis was obtained by CT-driven needle biopsy or through endotracheoscopy. In the absence of a pre-operative diagnosis, intraoperative lung cancer confirmation was obtained through the frozen section.

2. Operative approaches

All procedures were performed under general anesthesia, with patients in the lateral decubitus position. DaVinci Robotic System Xi was used with a 30◦ camera and standard endoscopic staplers. The rVATS technique was utilized under the direction of the American Chest Surgery Association, which was further customized to fit the circumstances in Vietnam. The patient was anesthetized with a double-lumen endotracheal tube and the lung on the side with the tumor cancer was deflated. In rVATS, the robot arms were set up as follows [4]:

In case of right lung cancer: Trocar camera: Intercostal space 8 on the back 1 cm form axillary line. Arm 1: Intercostal space 5 in the middle between the anterior axillary line and midclavicular line. Arm 2: Intercostal space 7 on the back 3 cm from the posterior axillary line. Working support: (1,5 cm): Intercostal space 7 at anterior axillary line.

In case of left lung cancer: Trocar camera: Intercostal space 7 in the middle between the anterior axillary line and mid anterior axillary. Arm 1: Intercostal space 8 on the back 3 cm from the

posterior axillary line. Arm 2: Intercostal space 4 in the middle between the anterior axillary line and midclavicular line. Working support: (1,5 cm): Intercostal space 9 at anterior axillary line

In all cases, we used only the cardiere and harmonic arms, which were further coordinated with thoracic surgical instruments through working support: Suction, Kelly, stapler. No need for CO_2 infiltration. After lobectomy, the N1 lymph node was routinely dissected. For N2, we performed lymphadenectomy to N2 which had > 1 cm in the CT scan or seen on screen.

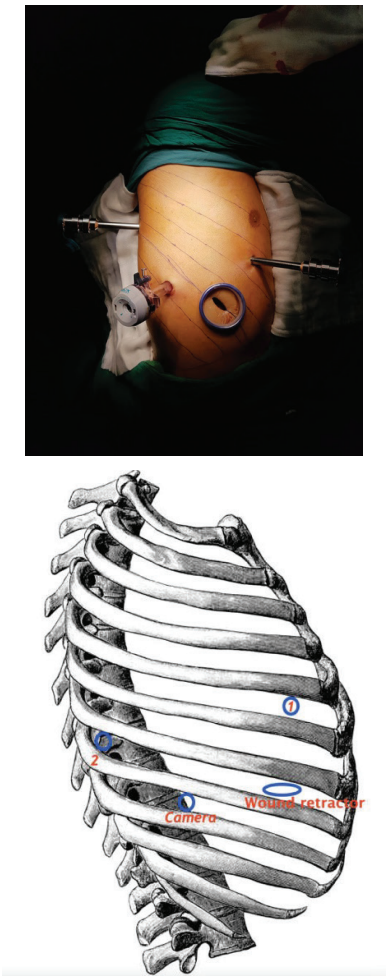

Figure 1: Trocar placement on the right side.

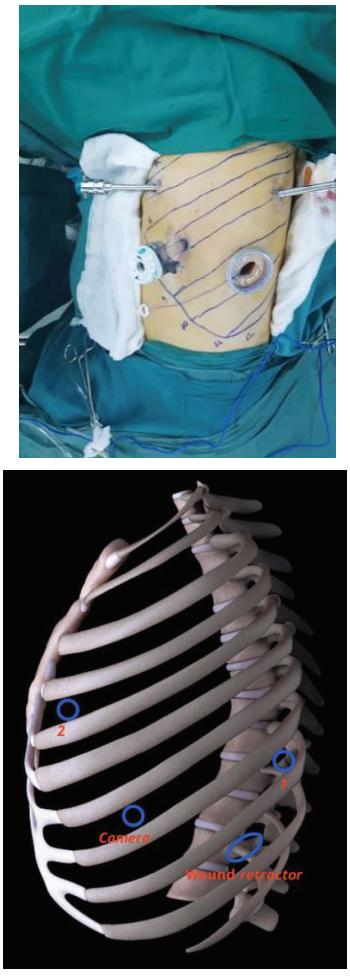

Figure 2: Trocar placement on the left side.

Figure 3: VAST instruments were used through working support.

3. Early outcome

The early outcome was investigated by: Time of operation was defined as the time skin to skin; the rate of conversion to open procedure in the case had a damaged artery or any problem; the lymph node dissected by using robotic arms; the post-operative complication rate; mortality. We classified the early outcome following Clavien and Anthony Yim.

In this study, we focused on the safety and efficacy of modified triagular port placement for lobectomy. The advantages and disadvantages of this approach will be discussed. Besides, the factors affecting this access and outcome will be analysed.

4. Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel, 2010) and then exported to the data editor page of IBM SPSS version 22.0 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics and frequency distribution were calculated. The Chi-square test was used for bivariate associations. For all tests, the confidence interval and p-value were set at 95% and ≤ 0.05, respectively.

RESULTS

The study included 79 patients with non-small cell lung cancer who were treated at Cho Ray Hospital, from July 2018 to June 2022.

Table 1: Distribution of study subjects and descriptive statistics.

Independent variables	Number of patients (%)
Gender	
Male	54 (68.4)
Female	25 (31.6)
Age (years)	
30 - 39	1 (1.3)
40 - 49	8 (10.1)
50 - 59	22 (27.8)
60 - 69	33 (41.8)
> 70	15 (19)
Tumor lesion	
Right upper lobe	19 (24.1)
Right middle lobe	2 (2.5)
Right lower lobe	21 (26.6)
Left upper lobe	28 (35.4)
Left lower lobe	9 (11.4)
Tumor location	
Peripheral	69 (87.3)
Central	10 (12.7)
Clinical stage/ Pathological stage	
Stage I	37 (46.8) / 31(39.2)
Stage IIA	9 (11.4) / 9 (11.4)
Stage IIB	13 (16.5) / 18 (22.8)
Stage IIIA	20 (25.3) / 13 (16.5)
Stage IIIB	0 (0) / 8 (10.1)
Tumor size (cm) (mean $\pm$ SD)	3.8 ± 1.6
Histology	
Adenomacarcinoma	71 (89.9)
Squamous	8 (10.1)
ASA	
Grade 1	2 (2.5)
Grade 2	43 (54.4)
Grade 3	34 (43.1)

Out of 79 enrolled patients, the majority of study participants were males and belonged to the 60 - 69 years age group *(Table 1)*. The majority of them had tumor lesions on the left upper lobe followed by the right upper lobe and right lower lobe, respectively. The mean tumor size was noted to be 3.8 cm. Maximum cases had a clinical stage of Grade 1, and none of them had Grade 3B. The majority of the lesions were noted to be adenocarcinoma.

Table 2: Perioperative outcomes and early outcomes.

Variables (n = 79)	**Number of patients (%)**
Time of operation (min) (mean ± SD)	262.2 ± 76.4 (min: 95; max: 450)
Blood loss (mL) (mean ± SD)	200 [50; 2000]
Conversions total/ conversion emergent for bleeding	7 (8.9) / 1 (1.3)
Lymph node N2 dissection	59 (74.7)
Number station N2 dissection (n = 59)	
1	31 (52.5)
2	17 (28.8)
3	10 (16.7)
4	1 (1.7)
Chest tube duration (days) (mean ± SD)	3.5 ± 2.3
Hospital length of stay (days) (mean ± SD)	5.5 ± 3.6
Post-operative complications	
Pneumonia	1 (1.3)
Prolonged air leak > 7 days	8 (10.1)
Subcutaneous emphysema	1 (1.3)
Re-operation	
Hemothorax	1 (1.3)
Bronchial fistular	1 (1.3)
In-hospital mortality	1 (1.3)

The mean time of operation was 262.2 minutes. The average blood loss was 200 mL. The rate of converting open accounted for 8.9%. In that, only 01 case (1.3%) had been converted emergent for bleeding due to artery damage. In operative lymphadenectomy for the mediastinal lymph node, the resection rate was 74.7%. Resecting one position accounted for mainly 52.5%, 2 positions for 28.8%. The average number of resected N2 lymph nodes for 1.7. Amongst postoperative complications, prolonged air leak > 7 days was the most common. In the hospital, mortality was found to be 1.3% *(Table 2).* The rate of re-operation is 2 cases (2.6%), of which 01 case died after re-operation.

Table 3: Changement of TNM.

Variables (n = 79)	**Number of patients (%)**
Changes in staging following lymph node dissection	
No changes	48 (60.8)
Upstaged	21 (26.6)
Downstaged	10 (12.7)
Change of lymph node	
Down stage N	9 (11.3)
cN0 → pN1	6 (7.6)
cN0 → pN2	8 (10.1)
cN1 → pN2	3 (3.8)

c: clinical; p: pathological

There were 48/79 cases accounting for 60.8% in accordance with the clinical and pathological stages. Changes in clinical and pathological lymph node assessment via intraoperative lymph node dissection accounted for 32.9% *(Table 3).* The good results accounted for 87.3%.

Table 4: Comparative assessment of conversion to open procedure according to characteristics of tumor and lymph node in contrast to CT-scan.

		Convert open		p
		No (n = 72) (%)	**Yes (n = 7)** (%)	
Tumor lesion	Left upper lobe	24 (33.3)	4 (57.4)	0.536
	Left lower lobe	8 (11.1)	1 (14.3)	
	Right upper lobe	19 (26.4)	2 (28.6)	
	Righr midle lobe	2 (2.8)	0 (0.0)	
	Right lower lobe	19 (26.4)	0 (0.0)	
Tumor location	Peripheral	67 (93.1)	2 (28.6)	< 0.001
	Central	5 (6.9)	5 (71.4)	
Tumor size	< 3 cm	30 (41.7)	1 (14.3)	0.26
	3 - 5 cm	28 (38.9)	3 (42.9)	
	5 - 7 cm	12 (16.7)	2 (28.6)	
	> 7	2 (2.8)	1 (14.3)	
Lymph node N1	No	41 (56.9)	1 (14.3)	0.012
	< 1 cm	21 (29.2)	2 (28.6)	
	> 1 cm	10 (13.9)	4 (57.1)	
Lymph node N2	No	34 (47.2)	0 (0.0)	0.038
	< 1 cm	28 (38.9)	6 (85.7)	
	> 1 cm	10 (13.9)	1 (14.3)	

In the case converted to the open procedure, the number of the conversion to open procedure in the upper left lobe accounted for mainly 4/7 cases (57.1%).

However, there was no statistically significant correlation between lung tumor site and conversion rate (p = 0.68). Central lung tumors had a higher rate of conversion than statistically significant peripheral ones (p < 0.001). Conversion to open procedure was not statistically significantly associated with lung tumor size (p = 0.26). There is a statistically significant correlation between N1/N2 lymph nodes on thoracic CT-scan and converted cases.

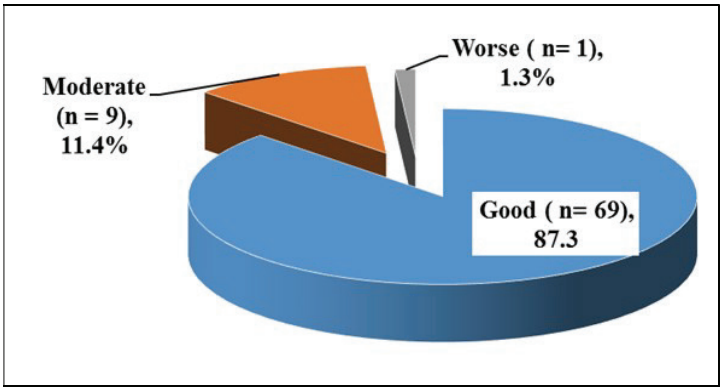

Figure 4: Early outcome of rVAST lobectomy.

DISCUSSION

- Modified triangular port placement of rVAST lobectomy

Currently, there are 2 methods of approach in rVATS: Total or partial approach with robotic arms. At our facility, with the condition equipment and the actual situation, we chose to approach partial rVAST with one working support port which was 1.5 cm, and used the normal thoracoscopic instrument during surgery. With this modification, we save 01 robotic arm, helping to reduce the cost of rVAST (about 12 - 14 million VND). Surgeons have the familiarity of switching from VATS to rVATS and still take advantage of the flexible robotic arms in dissection and lobectomy. When reviewing the medical literature, we found that there are also many authors who change the port placement of the robotic arm with a different approach, such as Veronesi G. [5]. Author Parini [2] also synthesized that there are many approaches and positions of robotic arms depending on the actual conditions at the centers, the generation of robots used, and the habits and experiences of the surgeons

- Lymphadenectomy during rVATS lobectomy

Lymph node resection helps to more accurately assess the pathologic staging. With rVATS, some reports show that there is an advantage in lymph node resected in lung cancer over VATS and can reach the level of open surgery. During the operation, the mediastinal lymph node resected was 74.7%. Resecting one position accounted for mainly 52.5%, 2 positions for 28.8%. The average number of resected N2 lymph nodes was 1.7.

Author Tang A. concluded that with stage I lung cancer, rVATS had results comparable to open surgery in terms of lymph node resection, negative margin rate, and overall survival [6]. In the same, author Novellis P. showed that in the hilar lymph node, rVATS could dredge lymph node better than VATS (p = 0.01) and are equivalent to open surgery (p = 0.33) [7]. In clinical practice, we have found that rVATS lymphadenectomy depends on the skill and experience of the surgeon. When using rVATS, we still perform routine lymph node resection according to lymph node mapping and take all nodes and tissue around like VATS.

- Conversion to open procedure using rVAST.

In the study, we recorded the conversion to open surgery were 7 cases (accounting for 8.9%). In particular, proactive conversion to open surgery was 6/7 cases due to tumor or lymph node invasion artery or large tumors with no operating space. During the operation, we noticed that there were 03 large tumors wrapped around blood vessels, difficult dissection, and heavy bleeding or tumors taking up all the manipulation space. In these cases, we actively switch open surgery. In 3 cases of lymph nodes sticking to the artery, we tried to dissect but found that the lymph node had invaded the outer layer of the artery, which would likely puncture the artery if the dissection was stronger, so we actively switched open surgery to ensure the safety of the patient.

Velez-Cubian et al. (2016) reported that the experience of robotic lung lobectomy for 159 patients showed a 7.6% incidence of intraoperative accidents, of which bleeding accounted for 5.7%, and bronchial damage was 1.3%. The authors also noted the rate of conversion to open surgery was 8.8%, and an emergency conversion to open surgery due to bleeding was 4.4% [8]. Author Zang J. et al. (2022) report a comparing rVATS and VATS in terms of conversion to open surgery. When analyzing large data from large studies, the authors showed that rVATS reduces bleeding rates (p = 0.003) and reduces the rate of conversion to open

surgery (p = 0.004) [9]. In the same view, Ma J. et al. synthesized 18 studies with 11,247 patients, including 5114 rVATS and 6133 VATS. It is often shown that rVATS reduces blood loss (p = 0.01) and reduces the rate of conversion to open surgery (OR = 0.5, p < 0.001) [10].

CONCLUSION

rVATS had good early results. The modified triangular port placement was suitable for the conditions at Cho Ray Hospital. The rate of conversion to open surgery and post-operative complications were acceptable for the initial period of performing rVATS lobectomy to treat lung cancer.

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