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Research Article

Shoud we Perform Robotic Video-Assisted Thoracic Lobectomy for Lung Cancer which had Large Tumor

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Abstract

Background: It was reported that 27% of lung cancer patients were diagnosed with advanced stage by the time of detection. In Vietnam, RATS has only been recently developed. At Cho Ray Hospital, since our first case in July 2018, RATS lobectomy was developed rapidly with an increasing number of patients. We conducted this study to evaluate the efficacy of RATS lobectomy in patients with locally advanced non-small cell lung cancer.

Method: From July 2018 to June 2022, RATS lobectomy was performed in 79 patients with non-small cell lung cancer at Cho Ray Hospital, Vietnam. We included the patients diagnosed with clinical stage I, II and IIIA. We devided 79 patient in two groups: Group 1: 50 patitens who had tumor <5 cm of diameter; Group 2: 29 patitents who had tumor 5 cm of diameter (cT3 and cT4). Early outcome was investigated by: operative time; rate of intra-operative bleeding, the rate of conversion to open procedure ; the number of lymph nodes collected; the rate of post-operative complications; and mortality rate.

Result: There were no statistically significant differences in gender, age, tumor location and preoperative respiratory function between 2 groups. In group 2, the clinical stage was mainly IIIA, accounting for 65.5%. The mean operative time of the tumor 5 cm group was longer than that of the other group (273.7 minutes vs. 255.5 minutes), but the difference was not statistically significant. The rate of lymph node dissection implemented in the 2 groups was similar (group 1: 72% vs group 2 79.3%, p=0.33). The rate of conversion to open surgery in group 2 was significantly higher than in group 1 (17.2% vs 4.0%) (p = 0.046). There was no statistically significant difference in postoperative complications in the 2 groups. In group 1, the survival rates were 91.3% and 80.4% respectively after 1 and 2 years. In group 2, survival rate were 88% and 62.2% respectively. There was no significant difference in the survival rate between the 2 groups (p=0.272).

Conclusion: RATS is effective in lobectomy for non-small cell lung cancer 5 cm in size (cT3 and cT4). Tumor size 5 cm did not increase the surgical time, the rate of postoperative complications, or change the postoperative recurrence rate but increase the convertion to open surgery rate.

Keywords: RATS; Mini-invased surgery; Lobectomy; Non-small cell lung cancer.

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Introduction

It was reported that 27% of lung cancer patients were diagnosed with advanced stage by the time of detection with tumor enlargement and necrosis, mediastinal lymphadenopathy, pleural, vascular or bronchial invasion, which challenges surgeons and compromises surgical oncological outcome [1,2]. Video-Assisted Thoracic Surgery (VATS) in these cases is often very difficult and is occasionally converted to open surgery to ensure R0 resection and adequate lymph node dissection.

Robot-Assisted Thoracic Surgery (RATS) has witnessed tremendous growth in the last two decades. For the treatment of non-small cell lung cancer, compared with VATS, RATS lobectomy has been reported to decrease the rate of conversion to open surgery, postoperative complications, and length of hospital stay [3-5]. RATS lobectomy benefits surgeons with flexibility of robotic arms and intraoperative 3D imaging for better vascular and lymph node dissection, and therefore, has been shown to be highly effective in advanced patients. Conversion rate to open surgery range from 8.6% to 17.3%. postoperative complications are encountered in 27.6 - 44.2% of the cases, and the 30-day mortality rate is approximately 1.9% [6-8].

In Vietnam, RATS has only been recently developed. Currently, there are 5 operating Da Vinci Xi robotic surgery systems nationwide. In thoracic surgery, Binh Dan Hospital was the first to perform RATS lobectomy in July 2017, but the number of operations is still limited. At Cho Ray Hospital, since our first case in July 2018, RATS lobectomy was developed rapidly with an increasing number of patients. During the implementation of RATS, we changed the position of the robotic arms approaching in a triangular shape to suit the local conditions with the same approach criteria as VATS and reduced 01 robot arm. From 7/2018 to 7/2022, we performed RATS lobectomy for 79 patients with stage I-IIIA disease. We conducted this study to evaluate the efficacy of RATS lobectomy in patients with locally advanced non-small cell lung cancer.

Method

Study design

From July 2018 to June 2022, RATS lobectomy was performed in 79 patients with non-small cell lung cancer at Cho Ray Hospital, Vietnam. We included the patients diagnosed with clinical stage I, II and IIIA (8th edition of TNM classification of the Internatonal Association of the study of Lung cancer) via contrast chest CT scan, brain MRI and PET scan. These patients 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, and excluded T4 which invaded diaphragm, heart and main bronchus.

We divided 79 patient in two groups:

- Group 1: 50 patients who had tumor <5 cm of diameter.

- Group 2: 29 patients who had tumor 5 cm of diameter (cT3 and cT4).

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

In case of suspected mediastinal nodes, EBUS or mediastinoscopy was performed before resection. A preoperative diagnosis was obtained by CT-driven needle biopsy or endobronchial biopsy. In the absence of a preoperative diagnosis, intraoperative lung cancer was confirmed with frozen section.

Operative approaches

All procedures were performed under general anesthesia with a double-lumen endotracheal tube to deflate the diseased lung, with patients in the lateraldecubitus position. DaVinci Robotic System Xi was used with a 30◦ camera and standard endoscopic staplers. Our RATS technique was modified from the protocol posted by American Chest Surgery Association to fit the circumstances in Vietnam. Robotic arms were set up as followed [4]:

- In case of right lung cancer: Camera trocar: 8th intercostal space on the back 1 cm from posterior axillary line. Arm 1: 5th intercostal space at the midpoint between anterior axillary line and midclavicular line. Arm 2: 7th intercostal space on the back 3 cm from posterior axillary line. Assistant trocar (1.5 cm): 7th intercostal space at anterior axillary line.

- In case of left lung cancer: Camera trocar: 7th intercostal space at the midpoint between anterior axillary and midaxillary line. Arm 1: 8th intercostal space on the back 3 cm from posterior axillary line. Arm 2: 4th intercostal space at the midpoint between anterior axillary line and midclavicular line. Assistant trocar: (1.5 cm): 9th intercostal space at anterior axillary line.

In all cases, we used only the cadiere forcep and harmonic scalpel robotic arms which were further supported with thoracoscopic instruments through assistant trocar: suction, Kelly forcep, stapler, etc. No CO_2 insufflation was needed. After lobectomy, N1 lymph nodes were routinely dissected. For N2, we performed lymphadenectomy to lymph nodes >1 cm on CT scan or on intraoperative screen.

Early outcome was investigated by: operative time; rate of intra-operative bleeding defined as blood loss >500 ml due to vessel damage, the rate of conversion to open procedure ; the number of lymph nodes collected; the rate of post-operative complications; and mortality rate.

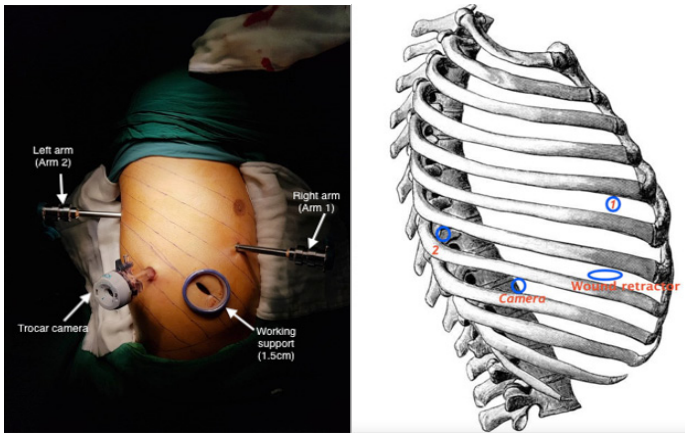

Figure 1: Trocar placement on right side.

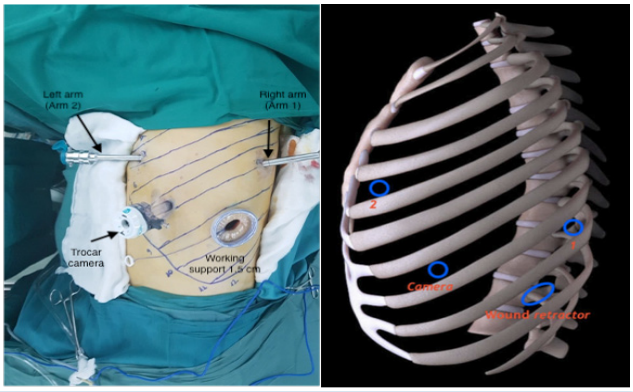

Figure 2: Trocar placement on lelf side.

Statistical analysis

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

Results

From 7/2018 to 7/2022, we performed RATS lobectomy on 79 non-small cell lung cancer patients and divided them into 2 groups:

- Group 1: 50 patents withtumor size < 5 cm

- Group 2: 29 patients with tumor size 5 cm.

Figure 3: VATS instruments used via assistant trocar.

Table 1: Characteristic of patients.

		Group 1 (n=50) N(%)	Group 2 (n=29) N(%)	p value
Gender				
	Male	33 (66.0)	21 (72.4)	0.55*
	Female	17 (34.0)	8 (27.6)	
Age (years)		61.2 ± 8.4	61.1 ± 9.6	0.92**
Tumor size (cm)		2.7 ± 0.9	6.1 ± 1.2	0.001**
Lymphadenopathy detected on CT scan				
	N1	18 (36.0)	19 (65.5)	0.03*
	N2	26 (52.0)	19 (65.5)	0.01*
Lobular lesion distribution				
	LUL	16 (32.0)	12 (41.4)	0.46*
	LLL	5 (10.0)	4 (13.8)	
	RUL	16 (32.0)	5 (17.2)	
	RML	2 (4.0)	0 (0)	
	RLL	11 (22.0)	8 (27.6)	
Location of tumor				
	Peripheral	44 (88.0)	25 (86.2)	0.81
	Central	6 (12.0)	4 (13.8)	
FEV1/FVC (%)		77.2 ± 11.4	73.7 ± 9.2	0.19**
TNM staging (cTNM/pTNM)				
	Stage I	34 (68.0)/ 31 (62.0)	0 (0) / 0 (0)	0.001*
	Stage IIA	2 (4.0) / 0 (0)	0 (0) / (0)	
	Stage IIB	4 (8.0) / 10 (20.0)	10 (34.5) / 17 (58.7)	
	Stage IIIA	10 (20.0) / 8 (16.0)	19 (65.5) / 5 (17.2)	
	Stage IIIB	0 (0) / 1 (2.0)	0 (0) / 7 (24.1)	

*: chi-quare test; **: t-test,
LUL: left upper lobe ; LLL: left lower lobe; RUL: right upper lobe; RML: right middle lobe; RLL: right lower lobe.
cTNM: clinical TNM; pTNM: pathologic TNM

Table 2: Results of operation.

		Group 1 (n=50) N(%)	Group 2 (n=29) N(%)	p value
Operative time		255.5 ± 68.4	273.7 ± 88.5	0.31**
N2 lymphadenectomy		36 (72.0)	23 (79.3)	0.33*
Number of N2lymph nodes collected				
	Station 1	22 (61.1)	9 (39.1)	0.11*
	Station 2	10 (27.8)	7 (30.4)	
	Station 3	3 (8.3)	7 (30.4)	
	Station 4	1 (2.8)	0 (0)	
Intra-operative bleeding		1 (2.0)	1 (3.4)	0.6*
Conversion to open surgery		2 (4.0)	5 (17.2)	0.046*
Post-operative complications				
	Pneumonia	1 (2.0)	0 (0)	0.07*
	Stroke	1 (2.0)	0 (0)	
	Prolonged air leak (>7 days)	2 (4.0)	6 (20.7)	
	Emphysema	0 (0)	1 (3.4)	
	Bronchial fistula	1 (2.0)	0 (0)	

*: chi-quare test; **: t-test

Table 3: Results of operation.

		Group 1 (n=50) N(%)	Group 2 (n=29) N(%)	p value
Pathological results				
	Adenocarcinoma	46 (92.0)	25 (86.2)	0.411*
	Squamous carcinoma	4 (8.0)	4 (13.8)	
Metastatic lymph node level N1		12 (24.0)	5 (17.2)	0.481*
Metastatic lymph node level N2		9 (18.0)	7 (23.1)	0.513*
Time of follow up (month)		26.2 ± 10.9	22.1 ± 9.4	0.323**
Recurrent lymph node		14 (31.8)	6 (27.3)	0.705*
Distant metastasis		17 (39.5)	10 (45.5)	0.674*

*: chi-quare test; **: T-test

Table 4:

Time of suvival	Group 1 (n=50) N(%)	Group 2 (n=29) N(%)	p value
1 year	91.3	80.4	0.272*
2 year	88.0	62.2	

*: log rank (Mantel-Cox)

There were no statistically significant differences in gender, age, tumor location and preoperative respiratory function between 2 groups. In group 2, the clinical stage was mainly IIIA, accounting for 65.5%. On CT scan images, group 2 had a significantly higher percentage of enlarged N1 and N2 lymph nodes than group 1.

The mean operative time of the tumor 5 cm group was longer than that of the other group (273.7 minutes vs. 255.5 minutes), but the difference was not statistically significant. The rate of lymph node dissection implemented in the 2 groups was similar (group 1: 72% vs group 2 79.3%, p=0.33). In group 2, the number of N2 lymphadenectomy performed at 2 or more stations accounted for 60.8%. The rate of intraoperative bleeding was similar in the 2 groups. The rate of conversion to surgery in group 2 was significantly higher than in group 1 (17.2% vs 4.0%) (p = 0.046). In group 1, there were 2 cases of conversion to open surgery, one of which was due to arterial damage during dissection. In group 2, all the 5 cases converted to elective open surgery was due to lack of space for manipulation or invasion to the bronchi/blood vessels. The most common postoperative complication was pneumothorax lasting >7 days, group 2 had a complication rate of prolonged pneumothorax of 20.7%. There was no statistically significant difference in postoperative complications in the 2 groups.

Most pathology findings in the two groups were adenocarcinoma. The rate of lymph node metastasis to N1 and N2 in the 2 groups was insignificantly different. During postoperative follow-up, we found that the rate of lymph node recurrence and distant metastasis in the 2 groups had no statistically significant difference. In group 1, the survival rates were 91.3% and 80.4% respectively after 1 and 2 years. In group 2, survival rate were 88% and 62.2% respectively. There was no significant difference in the survival rate between the 2 groups (p=0.272).

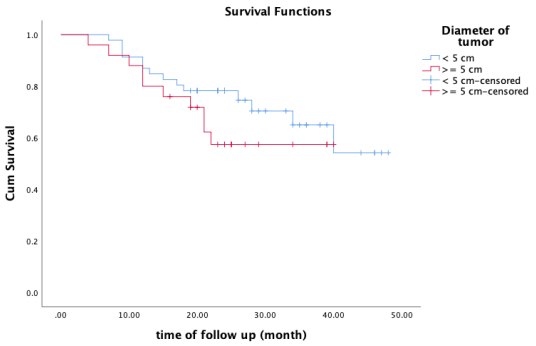

Figure 4: Kaplan-Meier of survival.

Discussion

First, we would like to discuss about the modified triangular port placement in RATS lobectomy. Currently, there are 2 approaches in RATS: total and partial approach with robotic arms. Parini et al also reviewed that there were many approaches and positions of robotic arms to consider depending on the actual conditions at the centers, the generation of robots used, and surgeons' habits and experience [9]. To the best of our knowledge, many authors changed the trocar placement of the robotic arm with different approaches, as mentioned in a study by Veronesi G [10]. At our center, we choose partial-approach RATS with one 1.5 cm assistant trocar for conventional thoracoscopic instrument during surgery. With this modification, we saved 01 robotic arm, helping to reduce the cost of RATS (about 12-14 million VND per case). Surgeons are familarized with switching from VATS to RATS and take advantage of the flexible robotic arms in dissection and lobectomy.

There was no significant difference between the 2 groups in terms of operative time. The mean operative time in the group with tumors ≥5 cm was 273.7 minutes. Kneuertz P.J. recorded a mean operative time of 283.6 minutes with RATS lobectomy in 296 patients [12]. Nelson B.D. et al reported their mean operative time on 106 patients was 226 minutes, significantly longer than conventional thoracoscopy with 173 minutes ($p<0.001$) [13]. The issue of prolonged operative time with RATS has also been reported in many other multicenter studies

A study by Mao J. et al in 2019 showed that RATS significantly took longer than conventional laparoscopic surgery ($p<0.001$). However, reports in the last 5 years showed no statistically significant difference between the 2 surgical groups in terms of surgery time [14]. A meta-analysis by Ma J reviewing 13 reports from 2015 to 2020 comparing operative time between RATS and conventional laparoscopic surgery implied that there was no statistically significant difference ($p=0.92$) [15].

In our study, the rate of conversion to open surgery in the group of tumors >5 cm was 17.2%, all were due to large tumor and vascular invasion, which minimized manipulation space and made laparoscopic dissection difficult and therefore, compromised oncological outcome of the surgery. In the group of tumors < 5 cm, the rate of conversion to open surgery was 2/50 cases, one of which were due to pulmonary artery injury during dissection. The rate of conversion to surgery in group 2 was higher than in group 1 (17.2% vs 4%) with statistical significance with $p = 0.046$. Author Yang H-X et al (2016) reported the rate of conversion to open surgery was 9.2% (16 cases) in RATS for 172 patients, with 3 cases due to bleeding (1.7%), 5 cases due to adhesions in pleural space, 3 cases of inadequate ventilation with single lun, 2 cases due to incompetent assistant, 1 case with limited intra-thoracic view, 01 case with anesthesia machine error and 01 case of bulky hilar lymph nodes [11]. Veronesi showed a conversion rate to open surgery of 15.2% of 223 patients with stage pIIIA non-small cell lung cancer [7]. Huang et al. reported a conversion rate in 58 patients with stage cIIIA of 8.6% [8]. Except for the conversion to open surgery due to vascular injury, plan for anticipated conversion due to large tumor or lymph node invasion should depend on the surgeons' level of experience. Planned open surgery will help reduce blood loss and ensure safety for the patients.

In our study, during postoperative follow-up, we found that the rate of lymph node recurrence and distant metastasis in the 2 groups had no statistically significant difference. The survival rates for group 1 were 91.3% and 80.4%, respectively after 1 and 2 years. In group 2, survival rates were respectively 88% and 62.2%. There was no significant difference in survival between the 2 groups ($p=0.272$). Author Cerfolio conducted a study on 1339 patients undergoing RATS lobectomy and recorded the 5-year survival rates by stage as follows: IA 83%, IB 77%, IIA 68%, IIB 70 %, IIIA 62% (N2 metastasis 73%), IIIB 31% (without N3 metastasis). The author also emphasizes that the excellent survival rate of RATS is due to its ability to radically remove lymph nodes, improving the pathologic staging and thereby, more appropriate and early decision for adjuvant chemotherapy at the correct stage [16]. A report on robotic non-small cell lung cancer surgery on 249 patients by Toosi et al showed a mean follow-up time of 18 months. The lung cancer stage survival rates assessed after surgery at 1 year and 3 years were: Stage-I, 92% (87–97%) and 75% (63–87%); Stage-II, 83% (70–96%) and 73% (49–97%); Stage-III, 75% (63–87%) and 44% (26–62%); and Stage-IV, 67% (37–97%) and 0% [17] . The survival rate in our study is similar to that of other authors in the world.

Conclusion

RATS is effective in lobectomy for non-small cell lung cancer 5 cm in size. Tumor size 5 cm did not increase the surgical time, the rate of postoperative complications, or change the postoperative recurrence rate. The rate of conversion to open surgery increased when the tumor is 5cm and the decision of conversion was within the plan.

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