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Chylothorax and Recurrent Laryngeal Nerve Injury Associated with Robotic Video-Assisted Mediastinal Lymph Node Dissection

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Summary

Objective—Although the technical aspects of robotic video-assisted thoracic surgery (RVATS) for lung resections may be advantageous, compared with standard thoracoscopy, complications of chylothorax and recurrent laryngeal nerve injury (RLNI) associated with mediastinal lymph node dissection (MLND) may be significant.

Methods—Consecutive patients who underwent RVATS anatomic lung resection for suspected or confirmed cancer and experienced RLNI or chylothorax were identified and reviewed from a prospectively maintained database. Complications were graded according to the Common Terminology Criteria for Adverse Events version 3.0.

Results—From July 28, 2010, to December 20, 2013, 251 patients underwent RVATS segmentectomy, lobectomy, or bilobectomy with mediastinal lymph node dissection (MLND). Eleven patients (4.4%) experienced MLND-related complications and composed the study group; 81.8% were right-sided resections, and median lymph node counts in right station IV and station VII were 9 (range, 1–23) and 5.5 (range, 1–10); 72.7% of cases were performed for early-stage I and II lung cancers. Chylothorax (6/251 [2.4%]) and RLNI (6/251 [2.4%]) were significantly more common in the RVATS group than in the open thoracotomy and standard VATS groups. Complications requiring procedural intervention (Grade 3) are as follows: 4 cases of RLNI in patients undergoing percutaneous vocal cord medialization and 3 cases of chylothorax in patients undergoing image-guided thoracic duct embolization or maceration. No operative interventions were required.

Conclusions—RVATS MLND may be associated with increased rates of chylothorax and RLNI. Attention must be paid to identifying potential technical pitfalls with RVATS lung resections, adjusting surgical techniques accordingly, and minimizing patient morbidity.

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Keywords

Robotic surgery; VATS; lung cancer; mediastinal lymph node dissection; complications

Introduction

Video-assisted thoracic surgery (VATS) lobectomy has become an increasingly accepted approach for resection of early-stage lung cancers, with similar operative mortality and oncologic outcomes and less morbidity and hospital length of stay, compared with open thoracotomy approaches.^{1–4} However, although VATS likely allows for adequate mediastinal lymph node sampling (MLNS), some reports suggest it does not allow for complete mediastinal lymph node dissection (MLND) of N1 and N2 stations, potentially resulting in the understaging of patients.^{5–7}

The proponents of robotic VATS (RVATS) lobectomy have suggested that it possesses technical advantages over standard VATS lobectomy, allowing for superior and complete MLND, similar to that achieved by open lobectomy.⁸ Although the overall morbidity associated with RVATS lobectomy appears to be favorable, MLND-specific morbidity related to this approach has not been well defined.

After the inception of RVATS using a 4-arm portal approach at our institution, we observed an anecdotal increase in MLND-associated complications, which has been suggested by other authors as well.⁹ The purpose of this study was to (1) review the experience at our institution, (2) identify the rates of MLND-associated chylothorax and RLNI in RVATS compared with standard VATS and open thoracotomy, and (3) identify potential correctable technical reasons for these events.

Methods and Patients

Consecutive patients who underwent RVATS anatomic lung resection for suspected or confirmed cancer performed during the study period and who experienced a complication of RLNI or chylothorax were identified and reviewed from a prospectively maintained database. A waiver of review for this study was granted by our institutional review board.

All patients underwent routine staging studies—including PET-CT, brain MRI (when indicated), and mediastinal staging via mediastinoscopy or endobronchial ultrasound (when appropriate)—for clinically suspicious lymphadenopathy by FDG avidity or CT criteria.

Patients underwent RVATS pulmonary resection (segmentectomy, lobectomy, bilobectomy) performed using a 4-arm robotic platform by one of two surgeons (I.S.S. or D.J.F.). Routine MLND was performed in all cases as part of the standard practice on our service.

Complications were graded according to the Common Terminology Criteria for Adverse Events version 3.0. Rates of chylothorax and RLNI in patients who underwent RVATS were compared with those in historical cohorts of patients who underwent open and standard VATS pulmonary resections, by use of a standard, two-tailed Fischer's exact test with significance levels defined at $P \leq 0.05$.

Results

In total, 251 patients underwent RVATS segmentectomy, lobectomy, or bilobectomy with MLND from July 28, 2010, to December 20, 2013. Eleven patients (4.4%) experienced 12 MLND-related complications and were included in the study group. There were 6 cases of RLNI (2.4%) and 6 cases of chylothorax (2.4%). Case-specific data are presented in Table 1.

The majority of cases in the study group were right-sided resections (9/11 [81.8%]). Median lymph node counts in right station IV and station VII were 9 (range, 1–23) and 5.5 (range, 1–10), respectively. Most cases (8/11 [72.7%]) were performed for early-stage I and II lung cancers.

Complications requiring procedural intervention (Grade 3) were as follows: 4 cases of RLNI in patients undergoing percutaneous vocal cord medialization and 3 cases of chylothorax in patients undergoing image-guided thoracic duct embolization or maceration. No operative interventions were required. There was no operative mortality in this small patient cohort.

A cohort of 1389 patients who underwent standard VATS and 3938 who underwent open pulmonary resection (segmentectomy, lobectomy, and bilobectomy) from 2000 to 2013 were retrospectively identified, and rates of chylothorax and RLNI were queried. Data on this cohort are summarized in Table 2. There were no significant differences in rates of RLNI or chylothorax between the open and standard VATS groups ($P=0.65$ and $P=0.38$, respectively). The incidences of RLNI and chylothorax were significantly higher in the RVATS group than in the open ($P=0.003$ and $P=0.03$, respectively) or standard VATS ($P=0.003$ and $P=0.01$, respectively) groups.

Discussion

Routine MLND during pulmonary resection for cancer potentially allows for improved pathologic staging, compared with MLNS.¹⁰ With the increasing use of minimally invasive VATS approaches, there is concern that the efficacy of MLND may be compromised with these procedures, resulting in less thorough clearance of lymph node stations and leading to a greater predilection for MLNS.⁶ Merritt et al. found a significantly lower mean number of lymph nodes resected by VATS than by open thoracotomy (9.9 vs. 14.7; $P=0.003$) at their institution, resulting in a significant increase in the rate of upstaging in the latter group (10% vs. 25%; $P=0.05$).⁷ Scott et al. reported a secondary analysis of the prospective, randomized Z0030 patient cohort who underwent MLND and found that more lymph nodes were retrieved by open lobectomy (median, 19; range, 2–83) than by VATS approaches (median, 15; range, 5–48), although the difference was not statistically significant ($P=0.147$).¹ A national Danish trial reported by Licht et al. identified similar findings, but with significantly higher rates of upstaging in both N1 and N2 stations by thoracotomy than by VATS ($P<0.001$).¹¹ Concerns regarding these findings may be a significant contributing factor to the relatively low use of VATS for cancer resections, despite the purported benefits of VATS over open resections, especially for early-stage disease.¹²

It has been suggested that the use of the robotic platform allows for superior MLND, compared with open procedures, largely owing to the improved imaging and technical

capabilities of the instrumentation.^{13, 14} In a large series of RVATS pulmonary resections for cancer, Park et al. noted a 24% rate of upstaging, with 18% attributable to N1 nodes and 6% to N2 nodes, which are similar to the rates for open surgery.¹⁵ In their initial series of 168 RVATS resections, Cerfolio et al. identified no differences in the median number of lymph nodes removed or the median number of lymph node stations assessed, compared with open resections.⁸

The initial results from the ACOSOG Z0030 multi-institutional, randomized, prospective trial, reported by Allen et al., showed a 1.7% rate of chylothorax and a 1.0% rate of RLNI in patients undergoing MLND.¹⁰ In a propensity-matched follow-up study of this trial by Scott et al. that compared open thoracotomy with standard VATS, the incidence of chylothorax was 1.0% and that of RLNI was 0.4%.¹ These complications were entirely limited to the 686 patients undergoing open procedures, with none seen in the 66 patients undergoing VATS procedures. However, at least one report, by Bryant et al., identified a higher rate of chylothorax with RVATS. In their study, 41 of 2838 patients undergoing pulmonary resection (1.4%) experienced chylothorax; among these patients, RVATS ($P=0.03$), lobectomy ($P=0.01$), and the presence of pathologic N2 disease ($P=0.03$) were significant risk factors for this complication.⁹

The current study supports the findings of Bryant et al., with a significantly higher rate of chylothorax and RLNI in our RVATS group than in our standard VATS or open thoracotomy groups. We surmise that the higher rate associated with RVATS may be due to a few key factors. Our subjective experience supports the belief that RVATS improves the ability to perform complete MLND, compared with standard VATS, owing to the exceptional visualization afforded by the robotic platform and the technical superiority of the instrumentation. These advantages have potentially led to a tendency to perform even more-thorough, or “aggressive,” MLNDs than were previously feasible and may explain the incidence of right-sided recurrent nerve injuries seen in this series. In addition, and perhaps more importantly, technical adjustments made with the robotic platform, including decreased use of clips and more liberal use of cautery during subcarinal and paratracheal dissection, may predispose the procedure to higher rates of these complications. Given these findings, we have proposed adjustments to our current approach, in favor of increased use of surgical clips delivered by either the robotic platform or the bedside assistant. Consideration should also be given to the use of sharp division or bipolar energy sources to limit thermal spread and potential nerve injury.

This study is inherently biased by its retrospective nature. It may also represent the as yet increasing or maturing experience of the surgeons performing these procedures, after modification of the RVATS procedure from a 3-arm approach with access incision (previously described) to a 4-arm portal method.¹⁶

Although our subjective experience suggests that the robotic platform has superior technical capabilities as a minimally invasive tool, especially for advanced segmental lung resection, the true clinical benefit of RVATS versus standard VATS remains undetermined, particularly in early-stage patients. Despite a purported decrease in rates of upstaging in VATS versus open procedures, there remains significant debate whether this bears any clinical

significance or impact on survival, particularly in patients with small, “ground glass” tumors lacking in solid components and with no clinical evidence of metastatic lymphadenopathy.^{10, 17} The potential morbidity of MLND versus its clinical benefit should be carefully considered in these patients.

In summary, while these complications are potentially a marker of thorough MLND, our findings suggest that rates of RLNI and chylothorax are higher with RVATS than with standard VATS or open procedures. Although RVATS may allow for greater adoption of minimally invasive approaches, attention must be paid to technical aspects of MLND with RVATS contributing to these complications. As with the introduction of any new, “disruptive” technology, ongoing identification, critique, and correction of these pitfalls are paramount to maximize patient safety, minimize morbidity, and potentially advance the standard of care.

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Table 1

Summary of data on patients with robotic video-assisted thoracic surgery mediastinal lymph node dissection (MLND)—associated complications

Case	Complication(s)	Procedure laterality	MLND station(s)	LN count(s)	Operation	Clinical stage	Pathologic stage	CTCAE grade(s)
1	L RLNI	Right	IV, VII	NR, 6	RLL/RML Bilobectomy	IIB	IIIA	3
2	L RLNI	Left	V, VII	2, 8	LUL Lobectomy	IB	IA	3
3	Chylothorax	Left	V, VII	2, 5	LUL Lobectomy	IIA	IV ^a	3
4	R RLNI	Right	IV, VII	9, 4	RLL Segmentectomy	IIIA	IA	1
5	Chylothorax	Right	IV, VII	1, 1	RUL Lobectomy	IA	IB	2
6	Chylothorax	Right	VII	9	RLL Lobectomy	IB	Benign ^b	2
7	Chylothorax	Right	VII	NR	RLL Lobectomy	IA	IA	3
8	RLNI	Right	IV, VII	7, NR	RUL Lobectomy	—	IB	1
9	R RLNI	Right	IV, VII	23, 3	RUL/RML Bilobectomy	—	IA	3
10	R RLNI, chylothorax	Right	IV, VII	19, 10	RUL Lobectomy	—	IIA	3, 1
11	Chylothorax	Right	IV, VII	NR, NR	RUL Lobectomy	—	IIA	3

CTCAE, Common Terminology Criteria for Adverse Events version 3.0; LN, lymph node; MLND, mediastinal lymph node dissection; NR, not reported; RLNI, recurrent laryngeal nerve injury; RUL, right upper lobe; RLL, right lower lobe; RML, right middle lobe; LUL, left upper lobe

^aPatient with metastatic melanoma.

^bGranuloma.

Table 2

Incidence of recurrent laryngeal nerve injury (RLNI) and chylothorax in open, video-assisted thoracic surgery (VATS), and robotic VATS (RVATS) pulmonary resections at Memorial Sloan Kettering Cancer Center

Complication	Approach			<i>P</i>
	Open (N=3938)	VATS (N=1389)	RVATS (N=251)	
RLNI	19 (0.5)	5 (0.4)	6 (2.4)	0.7 ^a ; 0.003 ^b ; 0.003 ^c
Chylothorax	34 (0.9)	8 (0.6)	6 (2.4)	0.4 ^a ; 0.03 ^b ; 0.01 ^c

Data are no. (%).

^aOpen vs. VATS.

^bOpen vs. RVATS.

^cVATS vs. RVATS.