New Approach to Complete Video-assisted Thoracoscopic Lobectomy in T2 and T3 Non-Small Cell Lung Cancer

MASATO KATO[1*], HIDEYA ONISHI[2*], KOUICHI FURUGAKI[1], SEIJI YUNOTANI[1], KOTARO MATSUMOTO[3], NOBUKO TSURUTA[4], KATSUYA NAKAMURA[5] and MITSUO KATANO[2]

[1]Department of Surgery, Karatsu Red Cross Hospital, Karatsu, Saga, Japan;
Departments of [2]Cancer Therapy and Research and [5]Surgery and Oncology,
Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan;
Departments of [3]Surgery and [4]Respiratory Medicine, Hamanomachi Hospital, Fukuoka, Japan

Abstract. *Complete video-assisted thoracoscopic surgery (c-VATS) for lung cancer is minimally invasive because of the small incision required. c-VATS has recently become a standard procedure for treatment of stage IA/IB lung cancer. However, a long thoracic incision or extensive costal rib resection is required in patients with large lung tumors. We herein introduce an improved VATS lobectomy procedure for patients with T2 and T3 lung cancer. In this technique, resected tissue is removed through a small upper abdominal midline incision below the xiphoid through the retrosternal-extraperitoneal pathway. Five patients who underwent this new procedure were compared against 10 control patients who underwent hybrid VATS lobectomy. Significantly fewer patients who underwent c-VATS lobectomy complained of severe postoperative pain; however, there was no significant difference in the postoperative hospital stay between the two groups. The present study demonstrates that c-VATS lobectomy can be performed with minimal operative pain and without need for a long thoracic incision or extensive rib resection, even in patients with large lung tumors (T2 and T3). These results suggest that the indications for c-VATS lobectomy in patients with T2 and T3 non-small cell lung cancer can be expanded by implementation of our approach, which involves removal of the freed lobe through an abdominal incision.*

*These Authors contributed equally to this study.

Correspondence to: Hideya Onishi, Department of Cancer Therapy and Research, Graduate School of Medical Sciences, Kyushu University, Fukuoka 812-8502, Japan. Tel: +81 926426220, Fax: +81 926426221, e-mail: ohnishi@surg1.med.kyushu-u.ac.jp

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Video-assisted thoracoscopic surgery (VATS) was first reported in 1992 (1, 2). The generally accepted standard indication for VATS is stage I non-small cell lung cancer (NSCLC) without lymph node metastasis. VATS is divided into two categories. One is hybrid VATS (h-VATS), which is performed mainly by direct visualization using video assistance. Rib resection is required to establish an adequate field of view, and the surgical wound is larger than the port size. The other category is complete VATS (c-VATS), which is performed using only the view provided by the monitor. Thus, the advantages of c-VATS over h-VATS include less postoperative pain and an early cosmetic benefit because of the small incision required. In addition, regarding the utility of VATS, recent studies have found no significant differences in outcomes, curability, or complications between VATS and conventional open surgery (3, 4). Moreover, the progress in the development of surgical techniques, including lymph node dissection, and surgical instrumentation has expanded the indications for VATS to include high-stage NSCLC (5, 6). Therefore, if large tumors can be successfully removed without need for a long thoracic incision or extensive costal rib resection, c-VATS may be performed in patients with stage II or III NSCLC.

Rib resection is necessary to remove large lung tissue specimens or tumors from the intrathoracic region, and several methods of dividing the ribs through a thoracic route have been described (7). However, severe postoperative pain is associated with rib resection and costal nerve injury, and some authors have described the performance of multiple nerve blocks to reduce this pain (8). Postoperative pain may delay the patient's recovery from surgery. Moreover, later recovery may lead to later initiation of chemotherapy. Therefore, the performance of c-VATS has extremely high clinical significance. We herein describe our experience with a novel c-VATS technique that involves removal of resected lung tissue from an abdominal incision in patients with T2 and T3 NSCLC.

Table I. *Characteristics of patients with T2 and T3 non-small cell lung cancer who underwent complete video-assisted thoracoscopic surgery.*

Case no.	Age (years)	Gender	Side	Performed surgery	Tumor size (mm)	p-Stage	Histology
1	71	M	Rt	Rt upper + node 2a	60×50	IIA (pT2aN0M0)	Pleomorphic
2	70	M	Rt	Rt upper + node 2a	80×40	IIB (pT3N0M0)	Adenocarcinoma
3	79	M	Rt	Rt lower + node 2a	90×55	IIB (pT3N0M0)	Adenocarcinoma
4	85	M	Rt	Rt upper	60×55	IV (pT2bNxMla)	Adenocarcinoma
5	63	F	Lt	Lt tower + node 2	140×90	IIB (pT3N0M0)	Adenocarcinoma

F, Female; M, male; Rt, right; Lt, left.

Table II. *Characteristics of patients with T2 and T3 non-small cell lung cancer who underwent hybrid video-assisted thoracoscopic surgery (control group).*

Case no.	Age (years)	Gender	Side	Performed surgery	Tumor size (mm)	p-Stage	Histology
1	60	F	Lt	Lt lower + node 2	58×36	IIA (pT2bN0M0)	Adenocarcinoma
2	78	F	Lt	Lt lower + node 2	60×38	IIA (pT2bN0M0)	SCC
3	64	M	Rt	Rt middle-lower + node 2a	62x32	IIA (pT2bN0M0)	SCC
4	79	M	Lt	Lt tower + node 2	54×45	IIA (pT2bN2M0)	SCC
5	71	M	Rt	Rt upper + node 2	52×40	IIA (pT2bN0M0)	Adenocarcinoma
6	60	M	Lt	Lt lower + node 2	78×80	IIIA (pT3N2M0)	Pleomorphic
7	79	F	Rt	Rt middle-lower + node 2a	75×60	IIIA (ϱT3N1M0)	Adenocarcinoma
8	75	M	Lt	Lt lower + node 2a	82×55	IIB (pT3N0M0)	SCC
9	73	M	Lt	Lt bwer + node 2	60×38	IIA (pT2bN0M0)	Pleomorphic
10	69	M	Rt	Rt lower + node 2a	57×54	IIB (pT2bNlM0)	SCC

F, Female; M, male; Rt, right; Lt, left; SCC, squamous cell carcinoma.

Patients and Methods

Fifteen patients with T2 and T3 NSCLC who underwent surgical treatment at the Hamanomachi Hospital, Fukuoka, Japan, from December 2009 to December 2013 were included in the study. Five patients underwent c-VATS lobectomy, and 10 control patients underwent h-VATS lobectomy involving rib resection. The characteristics of the patients who underwent c-VATS and h-VATS are shown in Tables I and II, respectively. There were no significant differences in age, sex, or operation side between the two groups (data not shown). The tumour large perpendicular was 60 to 140 mm in the c-VATS group and 52 to 82 mm in the h-VATS group. The TNM stage was classified using the Seventh Edition of the General Rule for Clinical and Pathological Record of Lung Cancer (9). All patients were given full explanations and provided their written informed consent before treatment.

Results

Surgical procedure. The patient was placed in the lateral decubitus position under general anaesthesia. For upper lobectomy, the ports were placed in the third, fifth, and seventh intercostal spaces on the anterior axillary line for the operator and camera pole and in the sixth and eighth intercostal spaces on the infrascapular line for the assistant (Figure 1). For lower lobectomy, the port locations were shifted down by one intercostal space. Upon completion of lobectomy, the freed lobes were placed in an endocatch bag. An abdominal skin incision of <5 cm was then created just below the xiphoid. A forceps was inserted through this incision into the intrapleural cavity through the preperitoneal cavity to remove the resected lung tissue by grabbing the endocatch bag (Figure 2A). Although the abdominal incision was not visible from the intrapleural space, the resected lung tissue was removed with the forceps through this route (Figure 2B and C). The postoperative scar is shown in Figure 2D.

Comparison between c-VATS and h-VATS groups. The number of patients who complained of severe pain and required analgesics was compared between the c-VATS and h-VATS groups. As shown in Table III, significantly fewer patients in the c-VATS than h-VATS group developed severe pain. Notably, many patients in the h-VATS group required analgesics for a long duration after operation. We also evaluated whether this extenuated pain affected the duration of the postoperative hospital stay. However, no significant difference in the postoperative hospital stay was noted between the two groups (Figure 3).

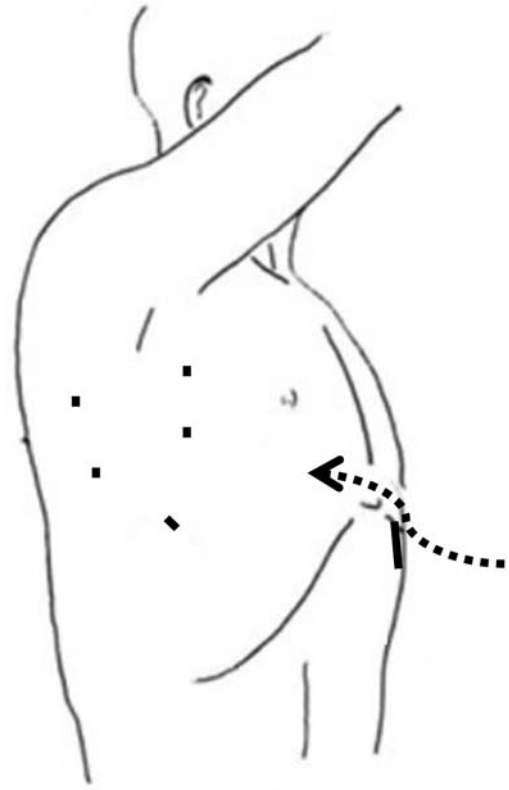

Figure 1. *Schema of the locations of the ports. For upper lobectomy, the ports were placed in the third, fifth, and seventh intercostal spaces on the anterior axillary line for the operator and camera pole and in the sixth and eighth intercostal spaces on the infrascapular line for the assistant. A forceps was inserted through this incision into the intrapleural cavity through the pre-peritoneal cavity to remove the resected lung tissue (dotted line).*

Table III. *Comparison of number of patients requiring for pain control in new procedure (complete video-assisted thoracoscopic surgery) versus previous method (hybrid video-assisted thoracoscopic surgery).*

	Pain control		
	Yes	No	Total
New procedure	1	4	5
Previous procedure	8	2	10
Total	9	6	15
p-Value	0.025*		

*Calculated by the Chi-squared test.

Discussion

VATS lobectomy is associated with a smaller surgical wound, a lower amount of resected costal cartilage (by about half), and more rapid patient recovery than by conventional thoracotomy. Additionally, if the surgical technique is stable, VATS is very useful and safe because the field of view can be shared between the surgeon and assistants. Therefore, the indications for VATS have been extended to elderly patients, as shown in the present study (Tables I and II). We began performing h-VATS in 2001 and gradually switched to c-VATS lobectomy after having acquired experience with many c-VATS procedures. As in previous studies (10, 11), all operations were performed by the same skilled surgeon; therefore, the analyses in the present study are well-comparable.

The most novel finding in this study is that the indications for c-VATS lobectomy in patients with T2/T3 NSCLC can be expanded by the herein-described approach. Generally, the wound size in c-VATS is less than 4 to 6 cm. If the resected lobe in patients with T2/T3 cancer is removed through a thoracic wound, the wound size should be larger than 5 cm because rib resection must be performed. However, if the resected lobe in patients with T2/T3 cancer is removed through an abdominal incision, the skin incision might be less than 5 cm, and c-VATS may be possible.

Another important point is that postoperative pain is attenuated in our new procedure. Many patients who undergo rib resection experience severe pain and require analgesics for long periods of time. This increases healthcare costs and may reduce the patient's postoperative quality of life. Reduced postoperative pain may allow for early recovery and discharge. Indeed, three out of the five patients who underwent c-VATS in the present study were discharged on postoperative day 11. However, there was no significant difference in the duration of the postoperative hospital stay. The length of stay is often determined by what is convenient for the patient. Based on our experience, we believe that hospital discharge following c-VATS using our new technique is possible after about seven days. Further comparisons of more patients undergoing the new *versus* the control procedure may reveal a difference in the length of hospital stay.

Among the five patients who underwent c-VATS in the present study, three developed postoperative recurrence and two died (data not shown). Therefore, our newly introduced technique did not improve these factors. These results suggest the great aggressiveness of stage II and stage III lung cancer in these patients. However, we believe that our new procedure is clinically useful because patients may undergo chemotherapy sooner. Lung cancer has an extremely poor prognosis, and we therefore should remember that we must not pursue only a smaller surgical wound technique.

In conclusion, our proposed procedure is superior to the conventional technique with respect to less invasiveness, decreased postoperative pain, a lower requirement for analgesics, and earlier recovery and rehabilitation. To our knowledge, this is the first report of the removal of lung cancer specimens from an abdominal incision below the xiphoid. We expect that this new procedure will be helpful for patients with large, resectable lung tumors.

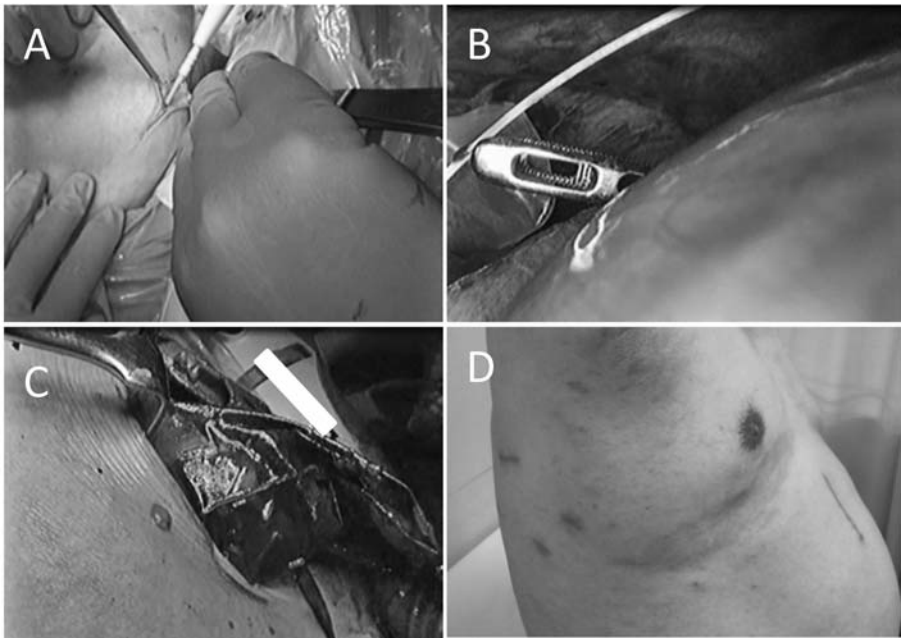

Figure 2. *Representative photographs of lobectomy by video-assisted thoracoscopic surgery. Abdominal skin incision below the xiphoid (A), forceps inserted through the abdominal incision (B), removal of the resected lung tissue from the abdominal skin incision (C), and postoperative skin scar (D).*

Conflicts of Interest

The Authors declare no conflict of interest in regard to this work.

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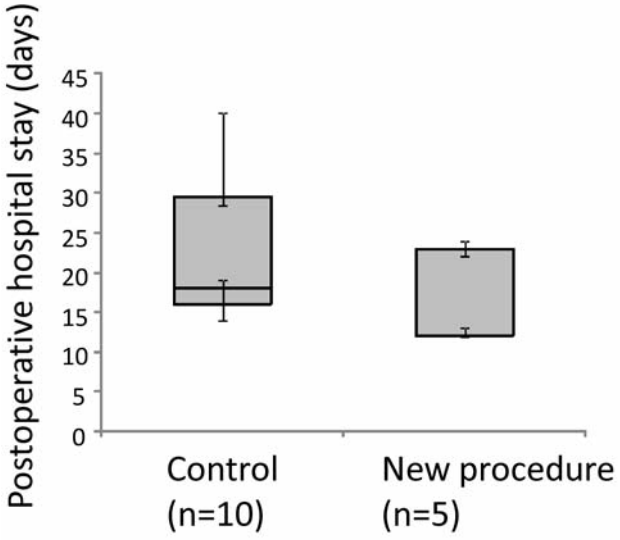

Figure 3. *Duration of postoperative hospital stay in days between patients who underwent our new procedure and patients in the control group.*

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