Original Article

# Uniportal thoracoscopic mediastinal lymphadenectomy using appropriate surgical steps

**Kazuhito Nii, Hitoshi Igai, Kazuki Numajiri, Fumi Ohsawa, Mitsuhiro Kamiyoshihara**

Department of General Thoracic Surgery, Japanese Red Cross Maebashi Hospital, Maebashi, Gunma, Japan

*Contributions:* (I) Conception and design: K Nii, H Igai; (II) Administrative support: H Igai, M Kamiyoshihara; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: K Nii, H Igai; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Kazuhito Nii, MD, PhD. Department of General Thoracic Surgery, Japanese Red Cross Maebashi Hospital, 389-1 Asakura-cho, Maebashi, Gunma 371-0811, Japan. Email: knii2121@gmail.com.

**Background:** Although lymphadenectomies play an important role in the surgical treatment of patients with non-small cell lung cancer (NSCLC), the quality of lymphadenectomies via a uniportal approach has only been evaluated in a few studies. We describe the surgical steps for a mediastinal lymphadenectomy via uniportal video-assisted thoracoscopic surgery (uVATS) and compare the quality of mediastinal lymphadenectomies using uVATS versus multiportal video-assisted thoracoscopic surgery (mVATS).

**Methods:** Between April 2017 and January 2023, we analyzed data from 304 patients with NSCLC who underwent (bi-)lobectomy with nodal dissection (ND)2a-1 or greater lymphadenectomy via uVATS or mVATS. We compared patient characteristics and perioperative results, including the number of harvested lymph nodes (LNs), between the two approaches. In addition, the factors associated with N-upstage were identified.

**Results:** No significant differences in the total number of harvested LNs were detected between the two approaches. Significantly more LN#2R/4R zone LNs were harvested in the uVATS group compared with the number harvested in the mVATS group [uVATS group: 8.5, interquartile range (IQR), 5–12.3; mVATS group: 7, IQR, 5–9, P=0.0177], while no significant differences in total nodes or nodes harvested in other zones were detected. Multivariable analysis revealed that pathologic invasion size [odds ratio: 1.0200, 95% confidence interval (CI): 1.0100–1.0400, P=0.0050], but not approach (uVATS, odds ratio: 0.6240, 95% CI: 0.3160–1.2300, P=0.1750), significantly contributed to N factor upstages.

**Conclusions:** The use of appropriate surgical steps enabled us to achieve similar quality lymphadenectomies via mVATS or uVATS.

**Keywords:** Lymphadenectomy; non-small cell lung cancer (NSCLC); uniportal video-assisted thoracoscopic surgery (uVATS)

Submitted Sep 01, 2023. Accepted for publication Nov 24, 2023. Published online Jan 15, 2024.
doi: 10.21037/jtd-23-1350
**View this article at:** https://dx.doi.org/10.21037/jtd-23-1350

## Introduction

Uniportal video-assisted thoracoscopic surgery (uVATS) is an emerging minimally invasive surgical approach. Rocco *et al.* first reported wedge resection using a uniportal approach in 2004 (1). Gonzalez *et al.* first described a uniportal thoracoscopic major pulmonary resection in 2011 (2). Recent reports describe the advantages of uVATS over VATS, including less postoperative pain, less blood loss, shorter operative times, and shorter hospital stays. However, uVATS is more technically challenging than conventional multiportal video-assisted thoracoscopic surgery (mVATS) due to the limited number of inserted forceps and the limited angulation (3-5).

© Journal of Thoracic Disease. All rights reserved.

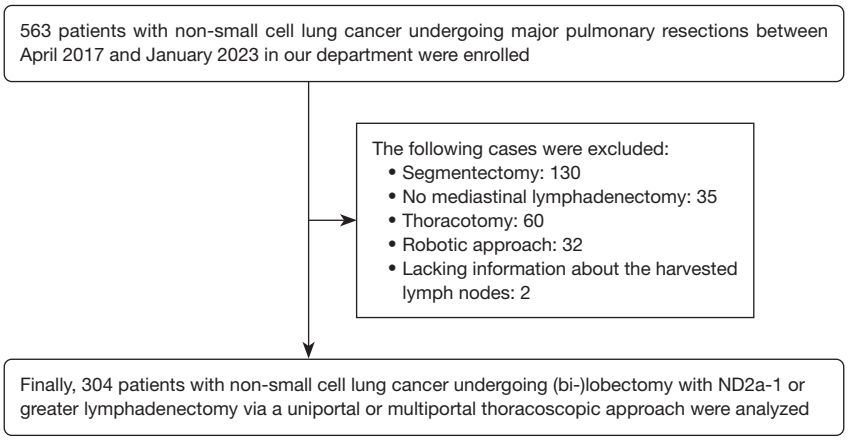



**Figure 1** Patient enrollment process. ND, nodal dissection.

Although surgical treatment is important for patients with non-small cell lung cancer (NSCLC), only a few studies evaluated lymphadenectomy quality via the uniportal approach (6,7). The appropriate surgical steps for the uniportal approach should be performed to ensure the quality of lymphadenectomy because this approach is technically difficult. In this study, we described the surgical steps for mediastinal lymphadenectomy via the uVATS approach and compared the quality of uVATS mediastinal lymphadenectomy to the mVATS approach. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1350/rc).

### Highlight box

**Key findings**

- No significant differences in the numbers of mediastinal lymphadenectomies or N factor upstages were detected during uniportal video-assisted thoracoscopic surgery (uVATS) compared to multiportal video-assisted thoracoscopic surgery (mVATS).

**What is known and what is new?**

- Only a few studies evaluated lymphadenectomy quality via the uniportal approach.
- We described the surgical steps for mediastinal lymphadenectomy via the uVATS approach and compared the quality of uVATS mediastinal lymphadenectomy to the mVATS approach. Performing a mediastinal lymphadenectomy equivalent to mVATS using uVATS is feasible.

**What is the implication and what should change now?**

- By using appropriate surgical steps for uVATS, mediastinal lymphadenectomy quality similar to mVATS is feasible.

## Methods

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Ethics Board of the Japanese Red Cross Maebashi Hospital (approval No. 2023-2, date: April 26, 2023) and individual consent for this retrospective analysis was waived.

### *Patient selection*

Patients with NSCLC who underwent a major pulmonary resection between April 2017 and January 2023 in Department of General Thoracic Surgery, Japanese Red Cross Maebashi Hospital were enrolled in the study. The exclusion criteria were as follows: undergoing segmentectomy, no mediastinal lymph node (LN) dissection, thoracotomy or robot-assisted approach, and missing information about the harvested LNs. After excluding patients, data from patients with NSCLC who underwent (bi-)lobectomy with nodal dissection (ND)2a-1 or greater lymphadenectomy via the uVATS or mVATS approach were analyzed (*Figure 1*). The following data were collected from the clinical records: age, sex, treated lobe, American Society of Anesthesiologists scores, smoking history (pack-years), forced expiratory volume in one second (FEV1.0), %FEV1.0, histology, radiographic solid part, clinical stage, pathological invasive part, pathological stage, surgical procedure, lymphadenectomy extension, operative time, intraoperative blood loss, postoperative drainage time, postoperative hospitalization time, morbidity (Clavien-Dindo grade ≥ III), rate of readmission within 30 days

© Journal of Thoracic Disease. All rights reserved.

after the operation, rate of conversion to thoracotomy, 30-day postoperative mortality rates, and the number of harvested LNs. All enrolled patients were staged according to the tumor-node-metastasis (TNM) staging system of the American Joint Committee on Cancer eighth edition (8). The N factor upstage was also examined. The N factor upstage for NSCLC was defined as the presence of unsuspected pathologic hilar (pN1) or mediastinal (pN2) disease in patients who were preoperatively presumed to have clinical N0 or N1 during the final pathologic examination of the surgical specimens. Both chest computed tomography (CT) and positron emission tomography (PET)/CT findings were used to define clinical N0 lung cancer. Postoperative complications were evaluated with the Clavien-Dindo classification system. The major complications were defined as requiring additional treatment.

### *Surgical technique*

Surgical procedure for mVATS or uVATS was decided by surgeon. All surgeries were proctored by a single senior surgeon (H.I.). Details of the surgical procedure have been described previously (9). Four ports were created on the laterality of the thorax in mVATS. A 3.5–4.0 cm skin incision was made in the fourth or fifth intercostal space on the anterior axillary line in uVATS. Intraoperative surgical procedures were the same in both approaches. Dominant vessels, including the pulmonary artery and vein, were sufficiently exposed and divided, using mainly endovascular staplers. Small vessel branches were dissected using an energy device after proximal ligation with silk sutures. The dominant bronchus was also dissected using a stapler. Interlobar fissures were divided using staplers or an energy device after ligation with silk sutures. The specimen was placed in a plastic bag and removed from the thorax. ND2a-1 or greater lymphadenectomy was then performed; the ND2a-1 lymphadenectomy was performed with a selective mediastinal dissection, while the ND2a-2 lymphadenectomy was performed with a radical mediastinal dissection (10,11). A selective mediastinal LN dissection is described below. When a tumor was located in the upper lobe, we did not dissect the inferior mediastinal LNs. When a tumor was located in the right middle lobe, we dissected the superior and inferior mediastinal LNs. When a tumor was located in the lower lobe, we did not dissect the superior mediastinal and/or aortic LNs. All hilar, lobar and interlobar LNs were dissected as a part of lung resection. At the end of the operation, a chest drainage tube was placed in the thorax.

### *Appropriate surgical steps for LN#2R and 4R via uVATS*

The LN#2R and 4R via uVATS procedure is shown in Video S1. We started harvesting LN#2R and 4R before division of the superior trunk of the pulmonary artery, even in right upper lobectomies, to maintain appropriate tension for the dissection. First, the LNs and adipose tissue were detached from the superior trunk and the main trunk of the pulmonary artery on the caudal side of the azygos vein. The superior vena cava (SVC) and trachea were also detached from the surrounding tissue. To obtain a good surgical view, the azygos vein was retracted toward the head using a long, curved suction device. Next, the mediastinal pleura was incised above the azygos vein to expose the SVC and the azygos vein. To firmly exfoliate the adipose tissue on the back side of the SVC, the SVC was retracted ventrally and an angled thoracoscope was used to secure the field of view. The incised pleura was maneuvered dorsally, and the LNs and adipose tissue were detached from the trachea while carefully avoiding the vagus nerve. The tissue detached on the caudal side of the azygos vein was passed underneath the azygos vein to the head side. Finally, the brachiocephalic artery was detached while retracting the fat tissue, and the LNs were removed *en bloc*.

### *Appropriate surgical steps for LN#7 (right and left side)*

Surgical steps for the removal of LN#7 (left side) are shown in Video S2. First, the lower pulmonary parenchyma was retracted ventrally with a gauze stick. After incising the mediastinal pleura, the LNs and adipose tissue were removed from the main bronchus, pericardium, and esophagus. To obtain a good surgical view in this deep area, the main bronchus was sufficiently exposed and retracted with a cotton stick toward the head instead of retracting the lung. Subsequently, the LNs and adipose tissue were detached from the carina and contralateral main bronchus. Finally, the residual tissue between the LNs and esophagus was divided. The LNs should be pushed with a long-curved suction instead of grasping with forceps to avoid damaging the structural integrity of the LNs and to obtain a good surgical view.

### *Appropriate surgical steps for LN#4L*

Dissection of LN#4L was usually performed concurrently

© Journal of Thoracic Disease. All rights reserved.

with LN#5. To visualize the vagus nerve, an incision was made in the mediastinal pleura below the aortic arch. While carefully avoiding thermal injury of the vagus and recurrent laryngeal nerves, the LNs were initially detached from the left main pulmonary artery. Subsequently, the left wall of the trachea was exposed. The left main pulmonary artery was compressed to obtain a good surgical view by the operative surgeon because this was difficult to perform by the assistant manipulating the thoracoscopy. Finally, the LNs were detached from the trachea and the left main bronchus.

### *Appropriate surgical steps for LN#5 and 6*

An incision was made in the mediastinal pleura along the phrenic nerve in front of the hilum. The mediastinal pleura and phrenic nerve were moved dorsally using suction or a cotton stick. The LN#6 and adipose tissue were exfoliated *en bloc*. Detachment on the head side was performed to expose the aortic arch, and running of the vagus nerve was confirmed. LN#5 and adipose tissue were exfoliated to expose Botallo's ligament from the left wall of the aortic arch. Detachment should be performed while being aware of the running of the left recurrent laryngeal nerve.

### *Statistical analysis*

Categorical variables were compared using Fisher's exact tests, and continuous variables were compared using Mann-Whitney *U* tests. The contribution of factors to N-upstage was assessed using multivariable logistic models. P<0.05 was considered statistically significant. All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria).

## Results

### *Patient characteristics and perioperative outcomes*

A total of 563 patients were enrolled in the study. Based on the excluded criteria, 304 patients were included in the analysis. Patient characteristics are shown in *Table 1*. One hundred and seventy-one patients underwent uVATS and 133 patients underwent mVATS. Patients in the uVATS group were older than patients in the mVATS group but other patient characteristics were similar. More patients underwent ND2a-2 lymphadenectomies in the mVATS group compared with the uVATS. Operative time (uVATS: 144 min, IQR, 121.5–170 min; mVATS: 170 min, IQR, 145–200 min, P<0.0001), postoperative drainage time (uVATS: 1 day, IQR, 1–1 day; mVATS: 2 days, IQR, 2–2 days, P<0.0001), and postoperative hospital stays (uVATS: 3 days, IQR, 2–4 days; mVATS: 3.5 days, IQR, 3–5 days, P<0.0001) were significantly better in the uVATS group compared with the mVATS group. No significant differences in other perioperative outcomes were detected between the two groups.

### *LNs assessment*

The total number of harvested LNs and the number of harvested LNs in each zone, including LN#2R/4R, 7, 4L, and 5/6, were compared between the uVATS and mVATS groups (*Figure 2*). Significantly more LNs were harvested in the LN#2R/4R zone in the uVATS group compared with the nodes harvested in the mVATS group (uVATS group: 8.5, IQR, 5–12.3; mVATS group: 7, IQR, 5–9, P=0.0177). No significant differences in total LNs or LNs in other zones were detected between the two groups.

*Table 2* shows N factor upstaging in the uVATS and mVATS groups. No differences in N factor upstaging were detected between the two groups (uVATS group: 12.3%; mVATS group: 15.8%, P=0.4050). Upstages from N0 to N1 were observed in 13 patients (7.6%) in the uVATS group and 9 patients (6.8%) in the mVATS group. Fifteen patients were upstaged from N0 or N1 to N2 upstage in each group (uVATS, 8.8%; mVATS, 11.3%).

Backgrounds and perioperative outcomes were compared between patients with (n=42) and without (n=262) nodal upstages (*Table 3*). Radiographic solid and pathological invasive parts were significantly different (P=0.0031 and P<0.0001, respectively) while other variables were not significantly different. The total number of harvested LNs and the number of harvested LNs in each zone were also compared between patients with and without nodal upstages as before (*Figure 3*). No significant differences in total LNs or LNs in other zones were detected between the two groups.

Multivariable analysis revealed that sex, histologic type (non-adenocarcinoma), pathologic invasion size, and approach (uVATS *vs.* mVATS) were confounding factors. Pathologic invasion size, but not approach, significantly contributed to N factor upstaging (invasion size: odds ratio, 1.0200, 95% confidence interval: 1.0100–1.0400, P=0.0050; uVATS: odds ratio, 0.6240, 95% CI: 0.3160–1.2300, P=0.1750) (*Table 4*).

© Journal of Thoracic Disease. All rights reserved.

**Table 1** Comparison of patient backgrounds and perioperative outcomes between uVATS and mVATS

| Variables | uVATS (n=171) | mVATS (n=133) | P value |
|---|---|---|---|
| Age (years) | 73 [67–79] | 71 [67–75] | 0.0122 |
| Sex (female/male) | 82 (48.0)/89 (52.0) | 57 (42.9)/76 (57.1) | 0.4170 |
| Height (cm) | 160.5 [153.3–166.6] | 160.1 [153.4–167.1] | 0.7490 |
| Weight (kg) | 58.6 [52.4–67.6] | 57.0 [50.6–65.7] | 0.1490 |
| Body mass index (kg/m$^2$) | 23.0 [20.9–25.5] | 22.3 [20.4–24.5] | 0.0397 |
| Treated lobe | | | 0.9160 |
| LUL | 24 (14.0) | 21 (15.8) | |
| LLL | 29 (17.0) | 26 (19.5) | |
| RUL | 59 (34.5) | 44 (33.1) | |
| RML | 11 (6.4) | 6 (4.5) | |
| RLL | 48 (28.1) | 36 (27.1) | |
| ASA score | 2 [2–2] | 2 [2–2] | 0.6210 |
| Smoking history (pack-years) | 16 [0–42] | 22.5 [0–49.5] | 0.2940 |
| Preoperative FEV1.0 (mL) | 2,080 [1,755–2,510] | 2,240 [1,890–2,660] | 0.0565 |
| Preoperative %FEV1.0 (%) | 93.8 [81.1–109] | 96.6 [81.9–109.7] | 0.5000 |
| Histology | | | 0.2670 |
| Adenocarcinoma | 128 (74.9) | 107 (80.5) | |
| Squamous cell carcinoma | 31 (18.1) | 22 (16.5) | |
| Other types | 12 (7.0) | 4 (3.0) | |
| Radiographic solid part (mm) | 21 [15–31] | 21 [14–29] | 0.2790 |
| cStage | | | 0.51 |
| 0 | 1 (0.6) | 0 | |
| 1A1 | 10 (5.8) | 15 (11.3) | |
| 1A2 | 65 (38.0) | 44 (33.1) | |
| 1A3 | 40 (23.4) | 34 (25.6) | |
| 1B | 23 (13.5) | 17 (12.8) | |
| 2A | 7 (4.1) | 4 (3.0) | |
| 2B | 16 (9.4) | 10 (7.5) | |
| 3A | 7 (4.1) | 9 (6.8) | |
| 3B | 2 (1.2) | 0 | |
| Pathological invasive part (mm) | 22 [15–32] | 22 [11–31] | 0.1760 |
| pStage | | | 0.0327 |
| 0 | 3 (1.8) | 4 (3.0) | |
| 1A1 | 13 (7.6) | 28 (21.1) | |
| 1A2 | 44 (25.7) | 20 (15.0) | |
| 1A3 | 28 (16.4) | 14 (10.5) | |
| 1B | 32 (18.7) | 27 (20.3) | |
| 2A | 8 (4.7) | 4 (3.0) | |
| 2B | 13 (7.6) | 12 (9.0) | |
| 3A | 22 (12.9) | 20 (15.0) | |
| 3B | 5 (2.9) | 3 (2.3) | |
| 4A | 3 (1.8) | 1 (0.8) | |

**Table 1** (*continued*)

© Journal of Thoracic Disease. All rights reserved.

**Table 1** (*continued*)

| Variables | uVATS (n=171) | mVATS (n=133) | P value |
|---|---|---|---|
| Surgical procedure | | | 0.191 |
| Bilobectomy | 0 | 2 (1.5) | |
| Lobectomy | 171 (100.0) | 131 (98.5) | |
| Extension of the lymphadenectomy | | | <0.0001 |
| ND2a-1 | 168 (98.2) | 115 (86.5) | |
| ND2a-2 | 3 (1.8) | 18 (13.5) | |
| Operative time (minutes) | 144 [121.5–170] | 170 [145–210] | <0.0001 |
| Blood loss (grams) | 0 [0–50] | 10 [0–50] | 0.4660 |
| Postoperative drainage time (days) | 1 [1–1] | 2 [2–2] | <0.0001 |
| Postoperative hospitalization time (days) | 3 [2–4] | 3.5 [3–5] | <0.0001 |
| Morbidity | 21 (12.3) | 25 (18.8) | 0.1460 |
| Readmission within 30 days after discharge | 9 (5.3) | 9 (6.8) | 0.6300 |
| Conversion to thoracotomy | 8 (4.7) | 12 (9.0) | 0.1630 |
| 30-day mortality | 1 (0.6) | 1 (0.8) | >0.99 |

Data are presented as median [IQR] or n (%). uVATS, uniportal video-assisted thoracoscopic surgery; mVATS, multiportal video-assisted thoracoscopic surgery; LUL, left upper lobe; LLL, left lower lobe; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; ASA, American Society of Anesthesiologists; FEV1.0, forced expiratory volume in one second; cStage, clinical stage; pStage, pathological stage; ND, nodal dissection; IQR, interquartile range.

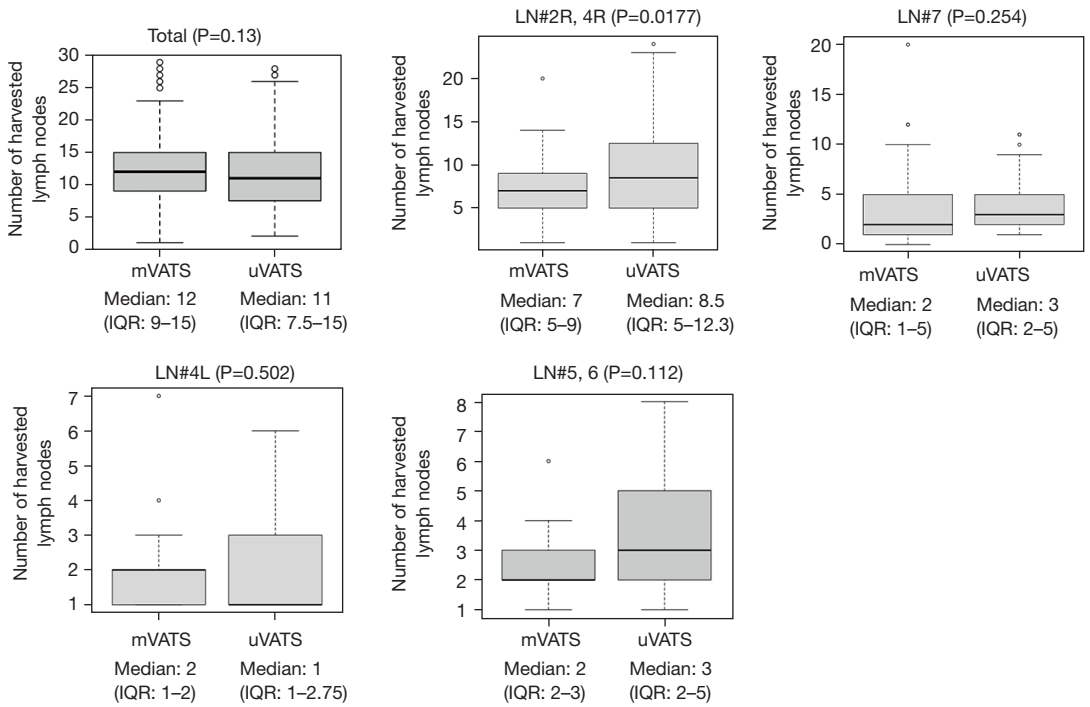



**Figure 2** Comparison of the number of harvested lymph nodes in total and each area between uVATS and mVATS. mVATS, multiportal video-assisted thoracoscopic surgery; uVATS, uniportal video-assisted thoracoscopic surgery; IQR, interquartile range; LN, lymph node.

© Journal of Thoracic Disease. All rights reserved.

**Table 2** Comparison of the rate of N factor upstages between uVATS and mVATS

| Variables | uVATS (n=171) | mVATS (n=133) | P value |
|---|---|---|---|
| N upstage, n (%) | 21 (12.3) | 21 (15.8) | 0.4050 |
| N0 to N1 | 13 (7.6) | 9 (6.8) | |
| N0 or N1 to N2 | 15 (8.8) | 15 (11.3) | |

uVATS, uniportal video-assisted thoracoscopic surgery; mVATS, multiportal video-assisted thoracoscopic surgery.

**Table 3** Comparison of backgrounds and perioperative outcomes between patients with and without nodal upstages

| Variables | With nodal upstages (n=42) | Without nodal upstage (n=262) | P value |
|---|---|---|---|
| Age (years) | 73 [68–78] | 72 [67–76] | 0.1460 |
| Sex (female/male) | 20 (47.6)/22 (52.4) | 119 (45.4)/143 (54.6) | 0.8680 |
| Height (cm) | 162.4 [153.3–166.3] | 160.0 [153.3–167.0] | 0.8400 |
| Weight (kg) | 56.7 [52.8–65.5] | 58.3 [51.3–66.3] | 0.2520 |
| Body mass index (kg/m$^2$) | 22.4 [20.2–24.3] | 22.7 [20.7–25.2] | 0.1270 |
| Treated lobe | | | 0.6850 |
| LUL | 9 (21.4) | 36 (13.7) | |
| LLL | 8 (19.0) | 47 (17.9) | |
| RUL | 13 (31.0) | 90 (34.4) | |
| RML | 1 (2.4) | 16 (6.1) | |
| RLL | 11 (26.2) | 73 (27.9) | |
| ASA score | 2 [2–2] | 2 [2–2] | 0.1820 |
| Smoking history (pack-years) | 30 [0–45] | 20 [0–46] | 0.3310 |
| Preoperative FEV1.0 (mL) | 2,175 [1,650–2,562.5] | 2,170 [1,832.5–2,577.5] | 0.5270 |
| Preoperative % FEV1.0 (%) | 92.9 [90–105.4] | 95.7 [81.9–109.8] | 0.3860 |
| Histology | | | 0.1260 |
| Adenocarcinoma | 31 (73.8) | 204 (77.9) | |
| Squamous cell carcinoma | 6 (14.3) | 47 (17.9) | |
| Other types | 5 (11.9) | 11 (4.2) | |
| Radiographic solid part (mm) | 25 [19–35] | 20.5 [14–128] | 0.0031 |
| cStage | | | 0.0003 |
| 0 | 0 | 1 (0.4) | |
| 1A1 | 1 (2.4) | 24 (9.2) | |
| 1A2 | 8 (19.0) | 101 (38.5) | |
| 1A3 | 10 (23.8) | 64 (24.4) | |
| 1B | 10 (23.8) | 30 (11.5) | |
| 2A | 1 (2.4) | 10 (3.8) | |
| 2B | 11 (26.2) | 15 (5.7) | |
| 3A | 1 (2.4) | 15 (5.7) | |
| 3B | 0 | 2 (0.8) | |

**Table 3** (*continued*)

© Journal of Thoracic Disease. All rights reserved.

**Table 3** (*continued*)

| Variables | With nodal upstages (n=42) | Without nodal upstage (n=262) | P value |
|---|---|---|---|
| Pathological invasive part (mm) | 31 [23.3–37] | 20.5 [13–31] | <0.0001 |
| pStage | | | <0.0001 |
| 0 | 0 | 7 (2.7) | |
| 1A1 | 0 | 41 (15.6) | |
| 1A2 | 0 | 64 (24.4) | |
| 1A3 | 0 | 42 (16.0) | |
| 1B | 0 | 59 (22.5) | |
| 2A | 0 | 12 (4.6) | |
| 2B | 10 (23.8) | 15 (5.7) | |
| 3A | 24 (57.1) | 18 (6.9) | |
| 3B | 6 (14.3) | 2 (0.8) | |
| 4A | 2 (4.8) | 2 (0.8) | |
| Surgical procedure | | | >0.99 |
| Bilobectomy | 0 | 2 (0.8) | |
| Lobectomy | 42 (100.0) | 260 (99.2) | |
| Extension of the lymphadenectomy | | | 0.0529 |
| ND2a-1 | 36 (85.7) | 247 (94.3) | |
| ND2a-2 | 6 (14.3) | 15 (5.7) | |
| Operative time (minutes) | 152.5 [131.3–188.8] | 153.5 [130.5–184.5] | 0.7010 |
| Blood loss (grams) | 25 [0–67.5] | 0 [0–50] | 0.1070 |
| Postoperative drainage time (days) | 1 [1–2] | 1 [1–2] | 0.8360 |
| Postoperative hospitalization time (days) | 3 [2–4.8] | 3 [2–4] | 0.8020 |
| Morbidity | 9 (21.4) | 37 (14.1) | 0.2450 |
| Readmission within 30 days after discharge | 4 (9.8) | 14 (5.3) | 0.2840 |
| Conversion to thoracotomy | 5 (11.9) | 15 (5.7) | 0.1710 |
| 30-day mortality | 0 | 2 (0.8) | >0.99 |
| Surgical approach, uniport/multiport | 21 (50.0)/21 (50.0) | 150 (57.3)/112 (42.7) | 0.4050 |

Data are presented as median [IQR] or n (%). LUL, left upper lobe; LLL, left lower lobe; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; ASA, American Society of Anesthesiologists; FEV1.0, forced expiratory volume in one second; cStage, clinical stage; pStage, pathological stage; ND, nodal dissection; IQR, interquartile range.

## Discussion

We compared lymphadenectomy quality, especially mediastinal lymphadenectomies, using the uVATS approach versus the mVATS approach. Despite the technical difficulties due to the limited manipulation of surgical instruments via a single small skin incision, the number of harvested LNs was similar between the uVATS and mVATS approaches. Moreover, the surgical approach did not significantly affect the number of N-upstages, indicating that lymphadenectomy quality was similar between the two approaches. Many previous reports described the efficacy of uVATS compared to mVATS (12-14). However, most previous reports did not emphasize lymphadenectomy quality. This is the first report focusing on lymphadenectomy quality using the uVATS approach. Our results show that lymphadenectomy quality

© Journal of Thoracic Disease. All rights reserved.

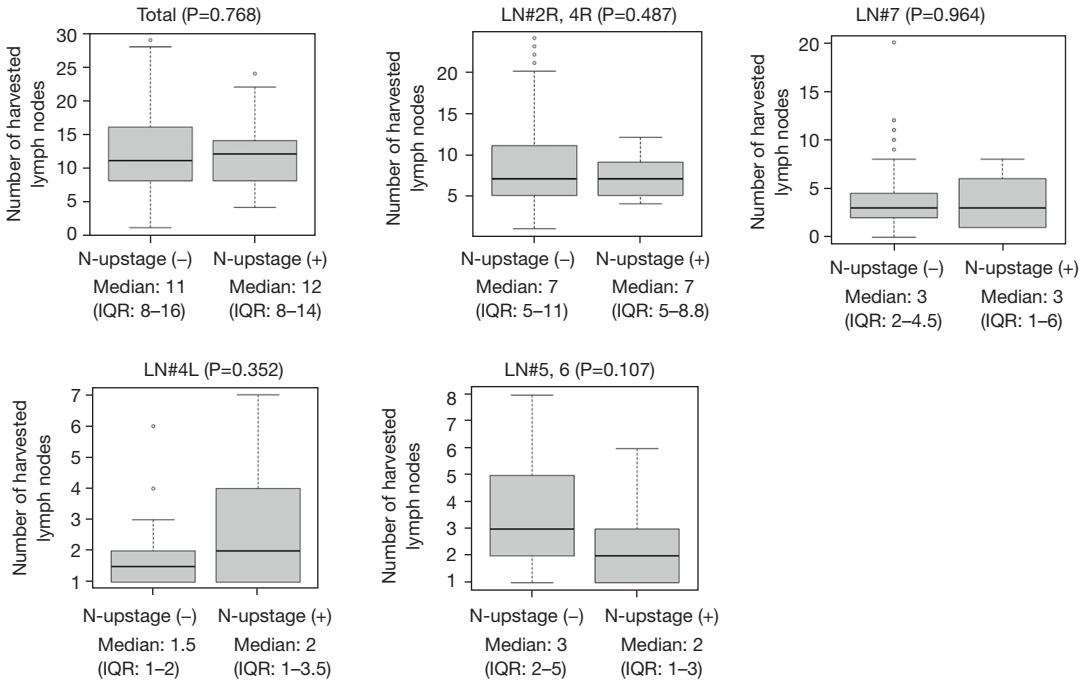



**Figure 3** Comparison of the number of harvested lymph nodes in total and each area between patients with and without N-upstages. IQR, interquartile range; LN, lymph node.

**Table 4** Multivariable analysis to identify contributions to N-upstages

| Cofounding factors | Odds ratio | 95% confidence interval | P value |
|---|---|---|---|
| Sex (males) | 0.7290 | 0.3600–1.4800 | 0.3820 |
| Histology (non-adenocarcinoma) | 1.2800 | 0.5790–2.8400 | 0.5400 |
| Pathological invasive part (continuous variables) | 1.0200 | 1.0100–1.0400 | 0.0050 |
| Approach (uniport) | 0.6240 | 0.3160–1.2300 | 0.1750 |

is similar between the uVATS and mVATS approaches.

Herein, we describe the surgical steps suitable for the uVATS approach to mediastinal lymphadenectomy. Equal numbers of LNs were harvested, and the N-upstage rates were similar for the uVATS and mVATS approaches, indicating that the surgical steps are appropriate. In particular, the methods for obtaining good surgical views with two or three surgical instruments via a small single skin incision with limited angulation are important. For instance, in a LN#7 lymphadenectomy, a gauze stick was initially employed to retract the lung, which gave a good surgical view while using only one instrument. Moreover, the method of applying tension in the dissected area is important. For instance, in LN#2R and 4R lymphadenectomies, we start harvesting the LNs before dividing the superior trunk of the pulmonary artery to apply appropriate tension, even in a right upper lobectomy. If the first branch of the pulmonary artery was transected first, detaching the LNs from the pulmonary artery would be difficult.

The appropriate surgical steps for removing hilar LNs and LN#8/9 were not described in this study because hilar LNs are naturally dissected during detachment of the pulmonary artery and bronchi and LN#8/9 can be dissected in the process of pulmonary ligament and inferior pulmonary vein detachment. Thus, another mediastinal lymphadenectomy was not specifically described for these procedures. These LNs were included in the total number

© Journal of Thoracic Disease. All rights reserved.

of harvested LNs.

The appropriate methods for evaluating lymphadenectomy quality are controversial. In this study, the number of harvested LNs and N-upstages were measured. These measurements were based on previous articles (15-17). The optimal indicators for assessing the accuracy of lymphadenectomies are also controversial. Ludwig *et al.* showed that survival after surgery for node-negative lung cancer was associated with the number of LNs evaluated (18). As the number of harvested LNs increased, the likelihood of missing positive LNs decreased, which may reduce staging errors. Medbery *et al.* examined nodal upstaging between open thoracotomy and VATS using the National Cancer database of patients undergoing lobectomies (19). The high number of harvested LNs in the VATS group may be due to more fragmentation of LNs during VATS. Toker *et al.* noted that preventing air leaks with the fissureless technique after VATS surgery may affect nodal upstaging (20). As the fissure is not dissected, LNs may be undissected. If LN metastases were not identified by imaging, nodal upstaging may depend on the effectiveness of surgical LN evaluation. Therefore, the prevalence of nodal upstaging may be an optimal indicator of complete LN assessment (21).

Unsuspected N2 disease was diagnosed in 4.9–6.5% of clinical stage I NSCLC (19,22). Although CT and PET/CT improved detection sensitivity and specificity, these procedures may fail to identify nodal metastases in approximately 20% of patients with primary lung cancer with normal-sized LNs (23). Lee *et al.* reported that risk factors for N2 upstaging in stage I NSCLC are the presence of a central tumor, a tumor size larger than 2 cm, the maximum standardized uptake value ($SUV_{max}$) value of PET, and adenocarcinoma (22). The nodal upstaging rate may also increase with increasing clinical T stage (15,21). In our study, multivariable analysis demonstrated that pathologic invasion size significantly contributed to nodal upstaging.

### *Limitations*

Our study had several limitations. First, this was a single institutional retrospective study. Therefore, the sample size and statistical power may be insufficient. Second, various operative surgeons, including junior and senior surgeons, were involved in the study, which may introduce bias. It is up to the surgeon to perform mVATS or uVATS, which is also a source of bias. However, all operations were proctored by a single senior surgeon (H.I.), which may reduce this bias. Third, long-term results were unclear, although short-term results, including the number of harvested LNs and N-upstages were evaluated. Long-term results, such as local recurrence, may be the most important results for patients.

## Conclusions

The numbers of harvested LNs during lymphadenectomy were similar for the uVATS and mVATS approaches, despite the uVATS approach being limited to two or three surgical instruments, a small single skin incision, and limited angulation. Moreover, the surgical approach (uVATS or mVATS) was not associated with N-upstaging. These results indicate that equivalent lymphadenectomy quality can be achieved, even in uVATS, when the appropriate surgical steps are employed.

## Acknowledgments

The authors thank all involved surgeons, their coworkers, and the editors and reviewers for their assistance with the manuscript.
*Funding:* None.

## Footnote

*Reporting Checklist:* The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1350/rc

*Data Sharing Statement:* Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1350/dss

*Peer Review File:* Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1350/prf

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1350/coif). H.I. serves as an unpaid editorial board member of *Journal of Thoracic Disease* from August 2022 to July 2024. The other authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised

© Journal of Thoracic Disease. All rights reserved.

in 2013). The study was approved by the Institutional Ethics Board of the Japanese Red Cross Maebashi Hospital (approval No. 2023-2, Date: April 26, 2023) and individual consent for this retrospective analysis was waived.

*Open Access Statement:* This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: https://creativecommons.org/licenses/by-nc-nd/4.0/.

## References

1. Rocco G, Martin-Ucar A, Passera E. Uniportal VATS wedge pulmonary resections. Ann Thorac Surg 2004;77:726-8.
2. Gonzalez D, Paradela M, Garcia J, et al. Single-port video-assisted thoracoscopic lobectomy. Interact Cardiovasc Thorac Surg 2011;12:514-5.
3. Nachira D, Congedo MT, Tabacco D, et al. Surgical Effectiveness of Uniportal-VATS Lobectomy Compared to Open Surgery in Early-Stage Lung Cancer. Front Surg 2022;9:840070.
4. Magouliotis DE, Fergadi MP, Spiliopoulos K, et al. Uniportal Versus Multiportal Video-Assisted Thoracoscopic Lobectomy for Lung Cancer: An Updated Meta-analysis. Lung 2021;199:43-53.
5. Xu GW, Xie MR, Wu HR, et al. A prospective study examining the impact of uniportal video-assisted thoracic surgery on the short-term quality of life in patients with lung cancer. Thorac Cancer 2020;11:612-8.
6. Wang BY, Liu CY, Hsu PK, et al. Single-incision versus multiple-incision thoracoscopic lobectomy and segmentectomy: a propensity-matched analysis. Ann Surg 2015;261:793-9.
7. Liu CC, Shih CS, Pennarun N, et al. Transition from a multiport technique to a single-port technique for lung cancer surgery: is lymph node dissection inferior using the single-port technique?†. Eur J Cardiothorac Surg 2016;49 Suppl 1:i64-72.
8. Goldstraw P, Chansky K, Crowley J, et al. The IASLC Lung Cancer Staging Project: Proposals for Revision of the TNM Stage Groupings in the Forthcoming (Eighth) Edition of the TNM Classification for Lung Cancer. J Thorac Oncol 2016;11:39-51.
9. Matsuura N, Igai H, Ohsawa F, et al. Safety and feasibility of uniportal video-assisted thoracoscopic uncommon segmentectomy. J Thorac Dis 2021;13:3001-9.
10. Okada M, Sakamoto T, Yuki T, et al. Selective mediastinal lymphadenectomy for clinico-surgical stage I non-small cell lung cancer. Ann Thorac Surg 2006;81:1028-32.
11. Matsuura Y, Ichinose J, Nakao M, et al. Outcomes of nodal upstaging comparing video-assisted thoracoscopic surgery versus open thoracotomy for lung cancer. Lung Cancer 2021;152:78-85.
12. Shen Y, Wang H, Feng M, et al. Single- versus multiple-port thoracoscopic lobectomy for lung cancer: a propensity-matched study†. Eur J Cardiothorac Surg 2016;49 Suppl 1:i48-53.
13. Harris CG, James RS, Tian DH, et al. Systematic review and meta-analysis of uniportal versus multiportal video-assisted thoracoscopic lobectomy for lung cancer. Ann Cardiothorac Surg 2016;5:76-84.
14. Wang L, Liu D, Lu J, et al. The feasibility and advantage of uniportal video-assisted thoracoscopic surgery (VATS) in pulmonary lobectomy. BMC Cancer 2017;17:75.
15. Martin JT, Durbin EB, Chen L, et al. Nodal Upstaging During Lung Cancer Resection Is Associated With Surgical Approach. Ann Thorac Surg 2016;101:238-44; discussion 44-5.
16. Ismail M, Nachira D, Swierzy M, et al. Lymph node upstaging for non-small cell lung cancer after uniportal video-assisted thoracoscopy. J Thorac Dis 2018;10:S3648-54.
17. Wang W, Rao S, Ma M, et al. The concept of broad exposure facilitates uniportal video-assisted thoracoscopic mediastinal lymph nodes dissection. J Cardiothorac Surg 2021;16:138.
18. Ludwig MS, Goodman M, Miller DL, et al. Postoperative survival and the number of lymph nodes sampled during resection of node-negative non-small cell lung cancer. Chest 2005;128:1545-50.
19. Medbery RL, Gillespie TW, Liu Y, et al. Nodal Upstaging Is More Common with Thoracotomy than with VATS During Lobectomy for Early-Stage Lung Cancer: An Analysis from the National Cancer Data Base. J Thorac Oncol 2016;11:222-33.
20. Toker A, Özyurtkan MO, Kaba E. Nodal upstaging: effects of instrumentation and three-dimensional view in clinical stage I lung cancer. J Vis Surg 2017;3:76.
21. Licht PB, Jørgensen OD, Ladegaard L, et al. A national study of nodal upstaging after thoracoscopic versus open

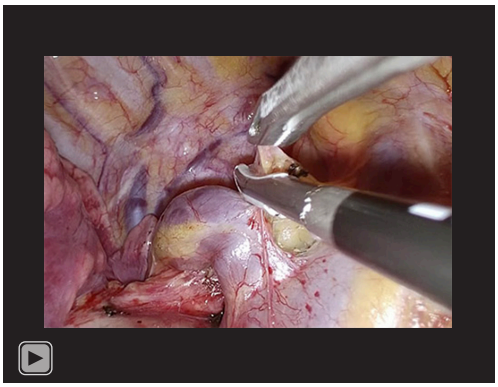
© Journal of Thoracic Disease. All rights reserved.

lobectomy for clinical stage I lung cancer. Ann Thorac Surg 2013;96:943-9; discussion 949-50.
22. Lee PC, Port JL, Korst RJ, et al. Risk factors for occult mediastinal metastases in clinical stage I non-small cell lung cancer. Ann Thorac Surg 2007;84:177-81.
23. Silvestri GA, Gould MK, Margolis ML, et al. Noninvasive staging of non-small cell lung cancer: ACCP evidenced-based clinical practice guidelines (2nd edition). Chest 2007;132:178S-201S.

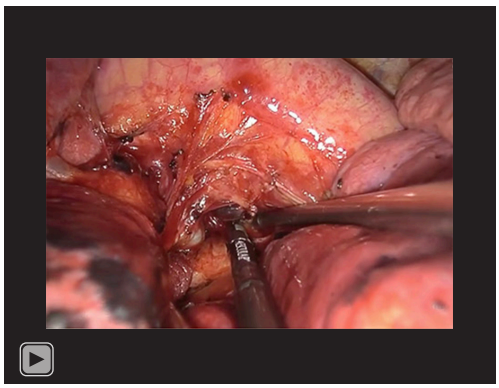
**Cite this article as:** Nii K, Igai H, Numajiri K, Ohsawa F, Kamiyoshihara M. Uniportal thoracoscopic mediastinal lymphadenectomy using appropriate surgical steps. J Thorac Dis 2024;16(1):321-332. doi: 10.21037/jtd-23-1350

© Journal of Thoracic Disease. All rights reserved.

Supplementary



**Video S1** Procedure for the LN#2R+4R lymphadenectomy. LN, lymph node.



**Video S2** Procedure for the LN#7 (left side) lymphadenectomy. LN, lymph node.

© Journal of Thoracic Disease. All rights reserved.
https://dx.doi.org/10.21037/jtd-23-1350