


## ORIGINAL ARTICLE

# Uniportal video-assisted thoracic surgery could reduce postoperative thorax drainage for lung cancer patients

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## Abstract

**Background:** Uniportal video-assisted thoracic surgery (VATS) has undergone significant development in recent years, yet its usefulness and value in the treatment of lung cancer remains controversial. We investigated the effect of uniportal VATS surgery for reducing postoperative thorax drainage in lung cancer patients.

**Methods:** The data of primary lung cancer patients who underwent VATS anatomical lung resection at the China National Cancer Center by a single surgeon were retrospectively collected. After propensity score matched analysis, 492 patients (246 uniportal VATS, 246 multiportal VATS) were included in the study. The clinicopathologic and surgery-related features, including drainage volume, were compared. Student's *t* and chi-square tests were used; all tests were two-sided.

**Results:** Patients in the two groups had similar demographic and clinicopathological features. Patients who underwent uniportal VATS surgery had significantly lower postoperative thorax drainage ( $830.0 \pm 666.0$  mL vs.  $1014.5 \pm 616.9$  mL,  $P = 0.002$ ) and a comparatively lower rate of unplanned return to the operating room (0 vs. 0.8%;  $P = 0.156$ ) than multiportal VATS patients. The surgical duration, blood loss, number of lymph nodes dissected, postoperative complications, and length of hospital stay were similar between the groups.

**Conclusions:** Uniportal VATS could reduce postoperative thorax drainage and the risk of unplanned return to the operating room for lung cancer patients. This study included the largest sample by a single surgeon and our results suggest the potential value of uniportal VATS for the faster recovery of lung cancer patients.

## Introduction

Surgical resection is the gold standard for the treatment of early stage lung cancer.<sup>1,2</sup> Traditionally, video-assisted thoracic surgery (VATS) is performed via two to four incisions, with one observation port for the thoracoscope and the others for the procedure.<sup>3,4</sup> In the last decade, however, uniportal VATS, which is performed with all instruments, including the thoracoscope, through a single 3–5 cm incision, has been significantly developed,<sup>5,6</sup> especially for the treatment of early stage lung cancer.<sup>7,8</sup> In this study we

focused on the less investigated aspect of uniportal lung cancer resection, the amount of drainage.

It is standard procedure to insert chest tubes after VATS to drain air and fluid. However, chest tubes are known to cause pain, increased risk of infection, longer hospital stay, and slower recovery.<sup>9,10</sup> Thus, the early removal of chest tubes is beneficial to patient recovery. The volume of thorax fluid production is a determinant factor of chest tube removal. Therefore, a reduced drainage volume could shorten the duration of postoperative thoracostomy, which would result in less pain and a faster recovery.<sup>11,12</sup> During

our clinical practice, we have observed that patients who undergo uniportal VATS surgery tend to have less postoperative thorax drainage compared to those who undergo multiportal VATS, which has also been reported in previous studies.<sup>13</sup> However, the postoperative drainage volume could be affected by many factors other than incisions, including surgical procedures, neoadjuvant therapy, and surgeons.

In our current study, we evaluated the value of uniportal VATS for reducing the thorax drainage volume in lung cancer patients. In order to eliminate the effect of confounding factors that may lead to biased results, we retrospectively analyzed primary lung cancer patients who had undergone VATS by a single surgeon. We compared the postoperative thorax drainage volume, as well as the clinicopathologic and surgery-related characteristics between patients who underwent uniportal and multiportal VATS.

## Methods

This was a single center, retrospective, observational study of primary lung cancer patients who had undergone VATS at the National Cancer Center, Cancer Hospital, Chinese Academy of Medical Sciences (CAMS) performed by a single senior thoracic surgeon between February 2015 and September 2017. This study was approved by the medical ethics committee of the Cancer Hospital, CAMS.

### Inclusion and exclusion criteria

The study included primary lung cancer patients who had undergone VATS anatomical lung resection as initial treatment by the same surgeon. The exclusion criteria were: patients who had used antiplatelet and anticoagulant drugs within one month before surgery;<sup>14</sup> patients with a past history of tuberculosis; patients administered neoadjuvant therapy; and patients who only undergone wedge resection.

### Study variables

The clinical features of patients, including gender, age, history of tobacco use, family history of malignant disease, postoperative drainage volume, duration of thoracostomy, and length of stay were obtained from medical records. Pathological variables, including tumor size and tumor node metastasis (TNM) stage, were identified from pathological exams. The TNM stage of the patients was defined according to the American Joint Committee on Cancer staging manual (8th edition).<sup>15</sup> For patients with multiple nodules, the tumor location was determined by the location of the major lesion. Surgery-related characteristics, including incisions, procedures, surgical duration, blood

loss, and number of lymph nodes dissected, were obtained from surgical records.

### Surgical techniques

During the surgery, patients were placed on a lateral decubitus position. Most of the multiportal surgeries were performed using three incisions. A 3–4 cm major working port was made in the middle axillary line in the third interspace for surgery to the upper and middle lobes and in the fourth interspace for lower lobes. A 1 cm camera port in the seventh interspace in the posterior axillary line and a 1.5 cm accessory working port in the ninth interspace in the line scapular line were also made. Wound protectors were applied to both of the working ports and a trocar was used for the camera port. A 10 mm, 30-degree optic thoracoscope (Karl Storz, Tuttlingen, Germany) was used for all surgeries. The hilum was dissected using an electrocoagulation hook or ultrasonic scalpel, generally from anterior to posterior. The major vessels, bronchus, pulmonary fissures, or parenchyma were dissected using a stapler. Hilum and intrapulmonary lymph nodes were removed during the lobectomy or sublobectomy. Mediastinal lymph node dissection or sampling was performed after lobectomy. Chest tubes were placed after the surgery and the incisions were closed in layers. A small portion of the surgery was performed using two incisions in the camera and major working ports in a similar position and size as the three portal surgeries.

For uniportal VATS, a 3–4 cm incision was made in the fifth interspace between the posterior and middle axillary line. A wound protector was used and all instruments and the thoracoscope were inserted through this port. Lobectomy/sublobectomy and lymph node dissection/sampling were performed using the same technique as the multiportal surgeries. A 28F silicone chest tube was placed through a muscle tunnel in the same incision.

### Statistical analysis

A total of 861 patients were initially selected, among which 246 underwent uniportal VATS and 615 multiportal VATS. Imbalanced distributions of age and TNM stage existed between the groups as a result of the study design. To overcome potential bias, a propensity score matched analysis by 1:1 match was performed, after which 492 patients (246 uniportal VATS, 246 multiportal VATS) were enrolled in the final analysis. Quantitative variables were presented using mean with standard deviation and compared between groups using the Student's *t*-test. Categorical variables were presented as percentage and compared using chi-square or Fisher's exact tests. All tests were two-sided and statistical significance was defined as  $P < 0.05$ .

## Results

Among the 492 patients enrolled, 229 (46.5%) were male; the average age was  $55.6 \pm 9.2$ ; and 246 (50%) underwent uniportal VATS, 10 (2%) underwent two-portal VATS, and 236 (48%) underwent three-portal VATS. Patients who underwent two-portal and three-portal VATS were combined into the multiportal group and compared to patients in the uniportal group.

### Demographic and pathological patient features

We analyzed the demographic features of the patients in the multiportal and uniportal groups. There were no significant differences in demographic characteristics, including age, gender, tobacco use, family history, or comorbidity (Table 1). The majority of the patients had adenocarcinoma (443/492, 90.0%) and there was no significant difference in the pathological subtype between the groups (Table 2). Tumor size and stage were also similar between the groups.

### Surgery and surgery-related patient features

We then evaluated the surgical features. The proportion of patients who underwent anatomical sublobectomy was significantly higher in the uniportal than in the multiportal group (12.6% vs. 5.7%;  $P = 0.008$ ), while there were no differences in surgical duration or intro-operative blood loss (Table 3). The necessity of blood transfusion and the rate of conversion to open surgery were also similar between the groups.

The number and stations of lymph node dissection were then compared between the groups. The number of lymph nodes dissected was similar between the groups. This result indicates that uniportal VATS has similar efficacy for lymph node dissection as multiportal VATS for lung cancer patients.

**Table 1** Demographic features of primary lung cancer patients

Features	Uniportal group (n = 246)	Multiportal group (n = 246)	P
Age, ≥ 60 years	111 (45.1%)	111 (45.1%)	1.000
Gender, male	112 (45.5%)	117 (47.6%)	0.651
Tobacco use, yes	72 (29.3%)	70 (28.5%)	0.842
Family history, † yes	82 (33.3%)	101 (41.1%)	0.076
Comorbidity, ‡ yes	74 (30.1%)	64 (26.0%)	0.316

†Family history of malignant tumors. ‡Major comorbidities including hypertension, diabetes mellitus, and coronary heart diseases. SD, standard deviation.

**Table 2** Pathological features of patients

Features	Uniportal group (n = 246)	Multiportal group (n = 246)	P
Subtype			0.587
ADC	220 (89.4%)	223 (90.7%)	
SCC	16 (6.5%)	16 (6.5%)	
SCLC	4 (1.6%)	1 (0.4%)	
Others	6 (2.4%)	7 (2.8%)	
Tumor size (cm)	$1.88 \pm 1.10$	$1.85 \pm 1.31$	0.783
T stage, 0–1	172 (69.9%)	176 (71.5%)	0.692
N stage			0.605
0	212 (86.2%)	205 (83.3%)	
1	16 (6.5%)	17 (6.9%)	
2	18 (7.3%)	24 (9.8%)	
TNM stage, 0-IA	166 (67.5%)	166 (67.5%)	1.000

ADC, adenocarcinoma; SCC, squamous cell carcinoma; SCLC, small cell lung cancer; TNM, tumor node metastasis.

### Uniportal VATS conferred lower postoperative thorax drainage volume and lower rate of unplanned operating room return

We evaluated the postoperative recovery of the patients. Comparison showed that the average postoperative thorax drainage volume in patients who underwent uniportal VATS was significantly lower than in multiportal VATS patients ( $830.0 \pm 666.0$  mL vs.  $1135.6 \pm 786.6$  mL;  $P < 0.001$ ) (Table 4, Fig 1). However, the time to chest tube removal was similar between the groups. In addition, none of the patients that underwent uniportal VATS had an unplanned return to the operating room (OR), compared to two out of 246 (0.8%) in the multiportal group. Although the  $P$  value was not significant ( $P = 0.156$ ), the difference was obvious. There was no difference between the groups regarding the necessity for postoperative blood transfusion, complication rates, or postoperative length of hospital stay.

**Table 3** Surgery-related features of the two groups

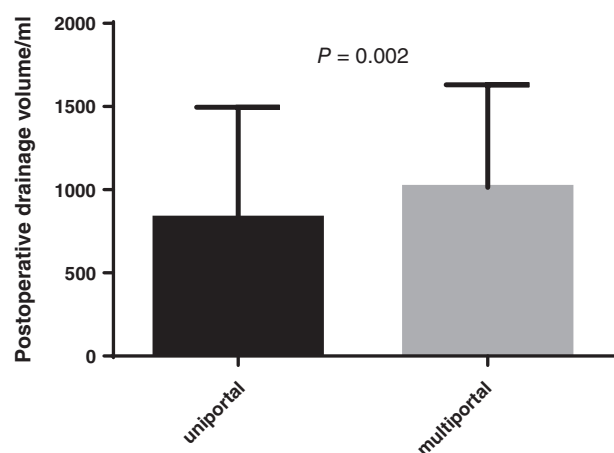
Features	Uniportal group (n = 246)	Multiportal group (n = 246)	P
Procedure, sublobectomy	31 (12.6%)	14 (5.7%)	0.008
Surgical duration (min), mean (SD)	115.8 (42.3)	119.8 (41.8)	0.290
Blood loss (ml), mean (SD)	22.6 (56.8)	20.8 (32.4)	0.661
Intro-operative blood transfusion, yes	2 (0.8%)	0	0.499
Conversion rate	2 (0.8%)	2 (0.8%)	1.000
Number of LND, mean (SD)	15.6 (9.1)	15.3 (7.2)	0.309

LND, lymph node dissection; SD, standard deviation.

**Table 4** Postoperative recovery of patients

Features	Uniportal group (n = 246)	Multiportal group (n = 246)	P
Drainage volume (mL), mean (SD)	830.0 (666.0)	1014.5 (616.9)	0.002
Time of chest tube removal (day), mean (SD)	3.7 (2.2)	3.6 (2.4)	0.812
Postoperative blood transfusion, yes	0	2 (0.8%)	0.499
Complication, yes	34 (13.8%)	27 (11.0%)	0.338
Unplanned return to OR, yes	0	2 (0.8%)	0.156
Postoperative LOS (day), mean (SD)	6.5 (2.5)	6.5 (3.1)	0.975

LN, lymph node; LOS, length of hospital stay; OR, operating room; SD, standard deviation.

**Figure 1** Postoperative thorax drainage volume in the uniportal and multiportal groups.

### The difference in drainage volume is caused by the number of incisions

Moreover, we investigated whether the difference in drainage volume between the uniportal and multiportal groups was a result of greater surgical experience in uniportal VATS. For this purpose, we assessed the distribution of drainage volume on the operation date using a four-month scale. As patient data was retrospectively collected for 32 months (from February 2015 to September 2017), the

patients were divided into eight groups. The drainage volume in uniportal and multiportal VATS patients in each four-month period is shown in Table 5. The results showed that in all but one period, the average drainage volumes of uniportal VATS patients were lower than in multiportal VATS patients. The difference was only statistically significant in one period, which is likely the result of the small sample sizes in each period. These results indicate that the number of incisions was the sole source of the difference in postoperative drainage volume.

## Discussion

In the present study, we compared the clinicopathologic and surgical features of a cohort of 492 primary lung cancer patients who underwent uniportal or multiportal VATS anatomical lung resection by a single surgeon. Our results showed that uniportal VATS surgery had similar surgical duration, blood loss, number of lymph nodes dissected, and complication rates as traditional multiportal VATS. Uniportal VATS could also reduce the postoperative thorax drainage volume and the risk of unplanned return to the OR, indicating its potential value for the faster recovery of lung cancer patients.

All of the cases included in our study were primary lung cancer patients who had undergone VATS anatomical sublobectomy or lobectomy (including bilobectomy, pneumonectomy, and sleeve lobectomy). Factors that may have caused bias of the results, such as the use of coagulation-affecting drugs and neoadjuvant therapy, were eliminated during patient enrollment. Wedge resection cases were also excluded to eliminate the bias caused by different procedures.<sup>16,17</sup> Propensity score matched analysis was applied to overcome any bias that may have been caused by imbalances in patient age and tumor stage. Thus, the surgical difficulty in the two groups is similar. Moreover, we only analyzed surgeries performed by a single surgeon because surgeries performed by different surgeons could have very different outcomes.<sup>18,19</sup> Thus, the results of our study are valid for the strict patient enrollment and large sample size. The lower rates of drainage and unplanned OR return of uniportal VATS were the result of fewer incisions rather than easier cases.

**Table 5** Postoperative drainage volume (mL)† in each four-month period

VATS	Feb. 2015 – May. 2015	Jun. 2015– Sep. 2015	Oct. 2015 – Jan. 2016	Feb. 2016 – May. 2016	Jun. 2016– Sep. 2016	Oct. 2016 – Jan. 2017	Feb. 2017 – May. 2017	Jun. 2017– Sep. 2017
Uniportal	753.3 (385.5)	818.2 (620.5)	865.0 (577.4)	675.9 (289.5)	845.6 (473.0)	1103.9 (767.3)	881.0 (939.4)	791.8 (638.7)
Multi-portal	845.8 (315.0)	1158.9 (572.7)	1017.5 (607.4)	954.6 (465.6)	1054.3 (593.4)	1009.1 (594.2)	1066.2 (938.0)	852.5 (432.9)
P	0.498	0.113	0.356	0.007	0.222	0.588	0.382	0.688

†The drainage volume is presented by mean (standard deviation). VATS, video-assisted thoracoscopic surgery.

Theoretically, thoracic drainage after VATS results from two factors: interior surgical trauma from lobectomy/sublobectomy plus lymph node dissection, and incisions.<sup>10</sup> As uniportal VATS causes the same internal surgical trauma, the reduced number of incisions might result in reduced drainage. This may also apply to postoperative bleeding, which is one of the major reasons that leads to an unplanned return to the OR.<sup>20,21</sup> Thus, fewer incisions also lead to a lower risk of bleeding, which in turn results in a lower rate of unplanned return to the OR. This explains the findings of our study. Both of the cases of unplanned return to the OR in our study were caused by bleeding, which resulted from incisions. These findings further support the conclusion that uniportal VATS has a lower risk of postoperative bleeding and unplanned return to the OR. The *P* value was not significant in our current study because the return rate in the multiportal group was also very low.

Although patients in the uniportal group experienced less postoperative thoracic drainage, there was no difference in the time to chest tube removal between the groups. This is because our study was a retrospective observation and the removal of the chest tube was not conducted strictly according to a unified standard. This is a major limitation of our current study. Further limitations include the lack of comparison of postoperative pain because this data was not recorded for all patients. These critical indices that reflect the postoperative recovery of patients have been included in our ongoing prospective study. Despite these factors, the findings of our study are important as they provide fundamental evidence of the value of uniportal VATS for the faster recovery of patients.

In summary, our results show that uniportal VATS is comparable to traditional multiportal VATS in terms of surgical duration, blood loss, number of lymph nodes dissected, and postoperative complications for primary lung cancer patients. Uniportal VATS leads to lower postoperative thorax drainage and a lower risk of unplanned return to the OR, indicating its potential value for the faster recovery of lung cancer patients.

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## Disclosure

No authors report any conflict of interest.

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