

ORIGINAL ARTICLE

Single center experience of uniportal VATS anatomical lung resections: Mid-term oncological outcomes

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Keywords

Lung cancer; outcomes; thoracoscopy; uniportal VATS.

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Received: 22 October 2020;
Accepted: 23 November 2020.

doi: 10.1111/1759-7714.13774

Thoracic Cancer **12** (2021) 1006–1013**Abstract**

Background: Uniportal video-assisted thoracoscopic surgery (VATS) anatomical lung resection has become widely accepted for its favorable outcomes with regard to pain. However, oncological outcomes, especially mid- or long-term outcomes, are still lacking. The objective of this study was to present our eight-year experience of uniportal VATS anatomical lung resection, including mid-term oncological outcomes.

Methods: All consecutive patients undergoing uniportal VATS anatomical lung resection between June 2012 and February 2020 were reviewed retrospectively.

Results: We analyzed data of 170 patients (100 male and 70 female), with a median age of 67 years. The median follow-up time was 21 months (range 11–41). The DFS of the entire cohort was 66.3 months. Stage-correlated DFS was 73.1 months for stage I, 42.6 months for stage II, 30.6 months for stage III and 12.5 months for stage IV. The OS of the entire cohort was 67 months. Stage-correlated OS was 75.6 months for stage I, 50.2 months for stage II, 31.7 months for stage III and 12.5 months for stage IV.

Conclusions: Uniportal VATS anatomical lung resection for lung cancer can be performed with satisfactory mid-term histology- and stage-related outcomes, which is consistent with prior results of traditional VATS or thoracotomy.

Introduction

In the field of thoracic surgery, video-assisted thoracoscopic surgery (VATS) has become the favored approach. The advantages of VATS include less postoperative pain and shorter hospital stay for patients compared to thoracotomy,¹ and this approach is recommended as the standard treatment method for clinical stage I non-small cell lung cancer (NSCLC) by the American College of Chest Physicians² and the National Comprehensive Cancer Network.³ Recently, the VATS technique has been further developed and uniportal VATS anatomical lung resection has become increasingly popular worldwide. The indications of uniportal VATS anatomical lung resection have also been expanded as well as early stage NSCLC. Large studies have so far reported low complication rates and encouraging outcomes in patients in which uniportal VATS has been used.^{4–8} Although uniportal VATS anatomical lung resection has become more widely accepted, mid- or long-term oncological outcomes are lacking. The objective of our

study is to present our eight-year experience of uniportal VATS anatomical lung resection, including mid-term oncological outcomes such as overall survival (OS), and disease-free survival (DFS).

Methods**Patients**

A retrospective observation study was performed in patients who underwent uniportal VATS anatomical lung resection for major pulmonary resections in the thoracic surgery department at Haeundae Paik Hospital between June 2012 and February 2020. This study was approved by the Institutional Review Board of Haeundae Paik Hospital at the Inje University of Korea.

The indication for uniportal VATS anatomical lung resection for lung cancer included (i) Clinical stage I–II patients; (ii) clinical stage IIIA patients with resectable N2

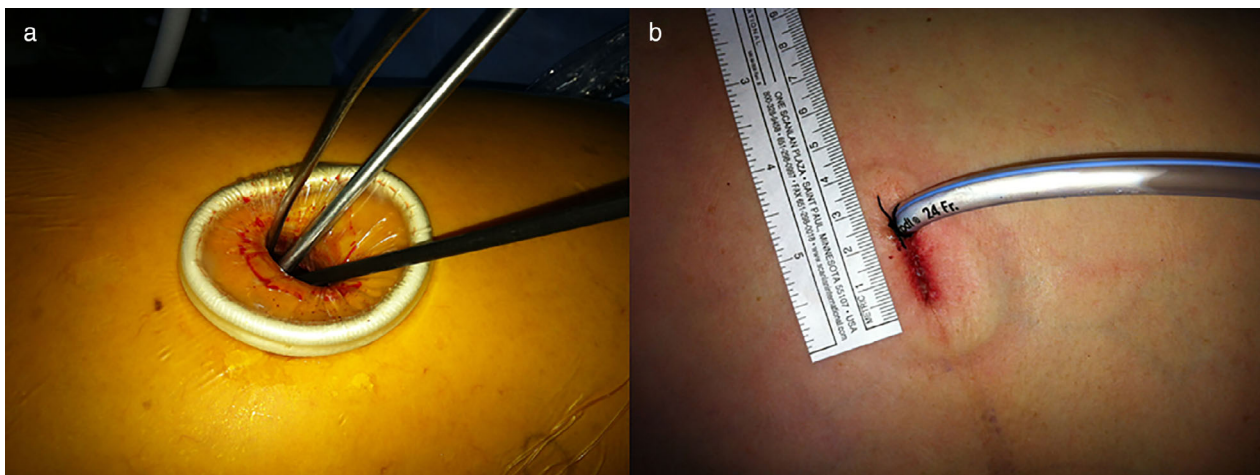


Figure 1 (a) Surgical incision (b) Postoperative surgical wound.

station metastasis; and (iii) clinical stage IV with single brain or adrenal metastasis. Patients with benign pulmonary disease requiring anatomical lung resection were included in the inclusion criteria of uniportal VATS anatomical lung resection.

The preoperative workup included chest radiography, bronchoscopy, spirometry, chest tomography (CT) and in case of malignant lung tumor, positron emission tomography (PET) and brain images for distant metastasis. During the follow-up, low dose chest CT was performed on the first six months of the follow-up period. After that, low dose chest CT was performed at intervals of one and two years, and the follow-up was performed regularly until five years after surgery. PET-CT, bronchoscopy or other imaging study were performed when considered necessary. The clinical records of each patient were reviewed for demographic data including age, gender, smoking status, preoperative pulmonary function and clinical data including type of surgery, operation time, duration of drainage, length of postoperative hospital stay, postoperative complication, histology, lymph node dissection numbers and pathological stage, OS, DFS. OS was defined as the time from surgery until death from any cause and DFS was defined as the time from surgery until disease relapse during the study period. The disease was staged according to the eighth edition of the International Association for the Study of Lung Cancer (IASLC) TNM classification.

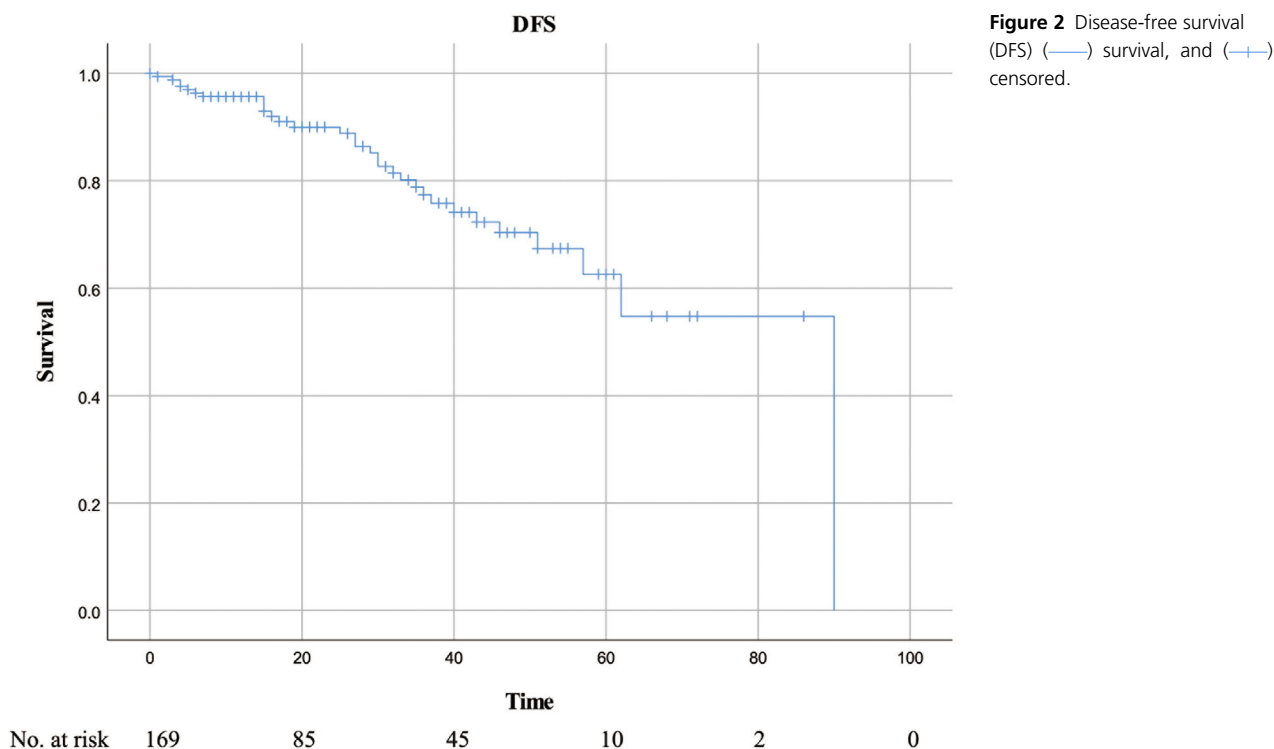
Surgical technique: Uniportal VATS

In all patients, an incision measuring 4–5 cm was made in the fifth or sixth intercostal space on the anterior axillary line. The soft tissue and intercostal muscles were retracted with an X-small wound retractor (Alexis; Applied Medical, Rancho Santa Margarita, CA, USA) to secure the

Table 1 Perioperative outcomes

Category	Outcomes
Male (n, %)	100 (58.8%)
Age (years)	67 (61, 72)
Chest tube duration (days)	5 (3, 7)
Length of stay (days)	8 (6, 10)
Operative time (minutes)	180 (140, 226)
Removed lymph nodes (n)	30 (21, 38)
Type of operation (n, %)	
RUL lobectomy	42 (24.7%)
Middle lobectomy	14 (8.2%)
RLL lobectomy	38 (22.4%)
LUL lobectomy	39 (22.9%)
LUL upper division segmentectomy	1 (0.6%)
LUL lingular segmentectomy	1 (0.6%)
LLL lobectomy	31 (18.2%)
Upper bilobectomy	3 (1.8%)
Lower bilobectomy	1 (0.6%)
Histology (n, %)	
Adenocarcinoma	116 (68.2%)
Squamous cell carcinoma	24 (14.1%)
Other type of carcinoma	27 (15.9%)
Benign disease	3 (1.8%)
Pathological stage (n, %)	
IA1	34 (20%)
IA2	29 (17.1%)
IA3	21 (12.4%)
IB	31 (18.2%)
IIA	5 (2.9%)
IIB	15 (8.8%)
IIIA	17 (10%)
IIIB	5 (2.9%)
IV	2 (1.2%)
Postoperative complication (n, %)	
Prolonged air leak	17 (10%)
Chylothorax	2 (1.2%)
Pneumonia	3 (1.8%)
Acute renal failure	1 (0.6%)
Postoperative delirium	1 (0.6%)
Atrial fibrillation	1 (0.6%)

LLL, left lower lobe; LUL, left upper lobe; RLL, right lower lobe; RUL, right upper lobe.



intercostal space. All procedures were performed with a 5 mm, 30° video thoracoscope, endoscope instruments, Ligasure (Valleylab, Covidien, Boulder, CO, USA) and an endoscopic linear stapler. Systemic lymph node dissection was performed for all malignant lung tumor patients. For the right lung, stations 2R, 4R, 7, and 10R lymph node dissection was done; for the left lung, stations 4, 5, 6, 7, and 10L lymph node dissection was done. At the end of the procedure, a chest tube (24 Fr) was placed in the thoracic cavity. The chest tube was inserted through a single incision (Fig 1).

Statistical analysis

The continuous variables are presented as median and interquartile range. The categorical variables are presented as numbers and percentages. The survival data was created using the Kaplan-Meier method. The statistical analyses were conducted using SPSS (Version window 18.0; SPSS Inc., Chicago, IL, USA).

Results

Perioperative outcomes

From June 2012 to February 2020, 170 patients underwent uniportal VATS anatomical lung resection. There were 100 male (58.8%) and 70 female (41.2%) patients with a median age of 67 years (range 61–72). A total of 42 patients

(24.7%) underwent right upper lobectomy, 14 (8.2%) middle lobectomy, 38 (22.4%) right lower lobectomy, 39 (22.9%) left upper lobectomy, one (0.6%) upper division segmentectomy of left upper lobe, one (0.6%) lingular segmentectomy of left upper lobe, 31 (18.2%) left lower lobectomy, three (1.8%) upper bilobectomy and one (0.6%) lower bilobectomy. The median number of removed lymph nodes was 30 nodes (range 21–38). The median operative time was 180 minutes (range 140–226), median chest drainage duration was five days (range 3–7) and median postoperative hospital stay was eight days (range 6–10). A total of 25 (14.7%) patients presented with postoperative complications: 17 (10%) cases of prolonged air leak (not requiring intervention); two (1.2%) chylothorax (treated by conservative approach); three (1.8%) pneumonia (treated by medical therapy); one (0.6%) acute renal failure (treated by medical therapy); one (0.6%) postoperative delirium (resolved by conservative approach) and one (0.6%) atrial fibrillation (resolved by medical therapy). There were no intraoperative deaths and the postoperative mortality was 0.6% (one patient died on the 103th postoperative day as a result of pneumonia). Pathological diagnosis confirmed 116 (68.2%) patients with adenocarcinoma, 24 (14.1%) with squamous cell carcinoma, 27 (15.9%) with other types of carcinoma (metastatic carcinoma, small cell carcinoma, carcinoid tumor, neuroendocrine carcinoma, large cell carcinoma, sarcomatoid, adenosquamous carcinoma) and three (1.8%) with benign disease (organizing pneumonia,

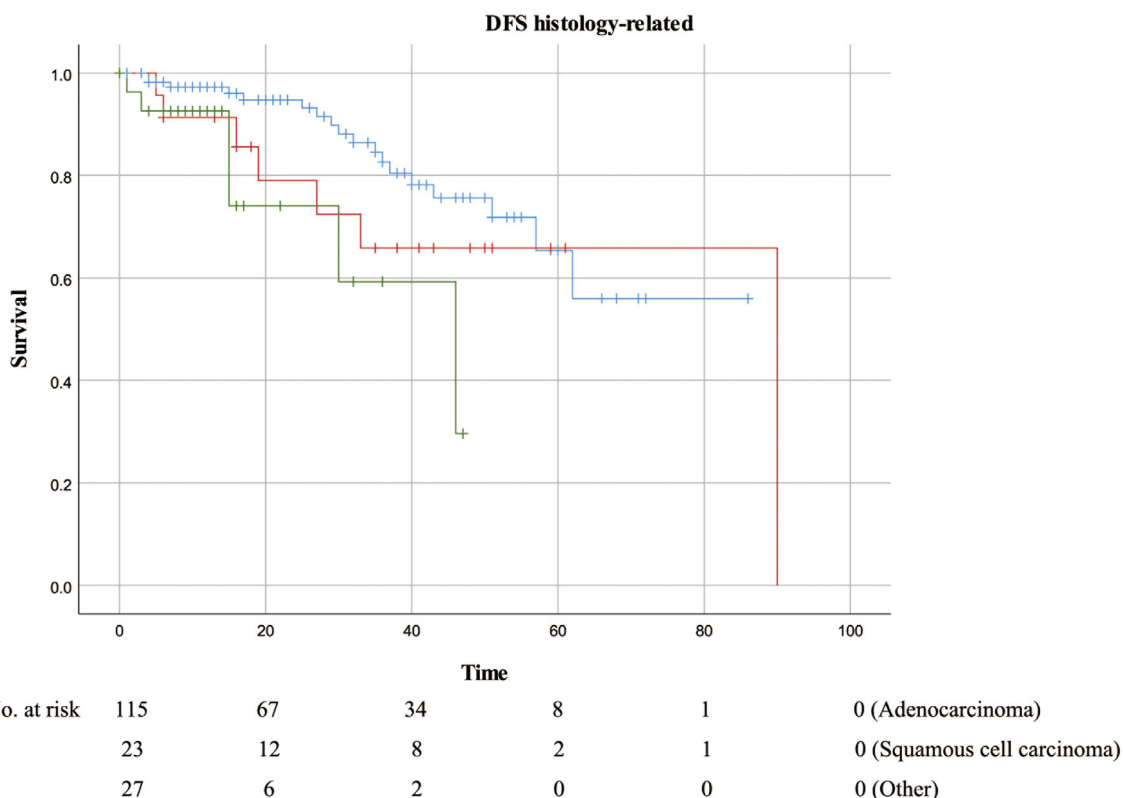


Figure 3 Histology-related disease-free survival (DFS) Histology (—) Adenocarcinoma, (—) Squamous cell carcinoma, (—) Other, (++) Adenocarcinoma-censored, (++) Squamous cell carcinoma-censored, and (++) Other-censored.

bronchial stenosis, bronchiectasis). According to the eighth edition of IASLC TNM classification, 34 pIA1 (20%), 29 pIA2 (17.1%), 21 pIA3 (12.4%), 31 pIB (18.2%), five pIIA (2.9%), 15 pIIB (8.8%), 17 pIIIA (10%), five pIIIB (2.9%) and two pIV (1.2%), were diagnosed (Table 1). A total of 51 (30%) patients underwent adjuvant chemotherapy based on pathological results.

Oncological outcomes

The median follow-up time was 21 months (range 11–41). During the follow-up period, a locoregional recurrence was observed in four patients (2.4%) and in eight patients (4.7%) a distant recurrence was observed. Locoregional recurrence was defined as recurrence in the ipsilateral thorax (lung, mediastinum, hilum, and pleura) or at the surgical margin. Distant recurrence was determined when cancer developed in the contralateral thorax (lung, mediastinum, hilum, and pleura), supraclavicular lymph node, or a distant organ. The DFS of the entire cohort was 66.3 months (Fig 2). The disease free cancer-related survival was 66.7 months for adenocarcinoma patients; 65.9 months for squamous cell carcinoma and 34.8 months

for patients with other lung cancer histotypes (Fig 3). The DFS was 73.1 months for stage I; 42.6 months for stage II; 30.6 months for stage III and 12.5 months for stage IV (Fig 4). The actuarial DFS related to the stage at 12, 24 and 36 months were analyzed. The actuarial DFS at 12 months was 96.4, 91.7, 90.5 and 50% for stage I, II, III and IV respectively; at 24 months was 92.4% for stage I, 83.3% for stage II, 70% for stage III and 0% for stage IV; at 36 months was 86.2% for stage I, 59.5% for stage II, 42% for stage III and 0% for stage IV. The OS of the entire cohort was 67 months (Fig 5). The overall cancer related survival was 66.7 months for patients with adenocarcinoma; 67.7 months for patients with squamous cell carcinoma and 48.3 months for patient with other histotypes (Fig 6). According to the Stage, the OS was 75.6 months for stage I; 50.2 months for stage II; 31.7 months for stage III and months 12.5 for stage IV (Fig 7). The actuarial OS according to the Stage at 12, 24 and 36 months showed: at 12 month 97.1, 91.7, 90.5 and 50% for stage I, II, III and IV respectively; at 24 months 94.3% for stage I, 81.5% for stage II, 70% for stage III and 0% for stage IV; at 36 months 88% for stage I, 58.2% for stage II, 42% for stage III and 0% for stage IV, respectively.

Discussion

In the field of thoracic surgery, various studies have previously demonstrated benefits relating to VATS compared with open surgery. With respect to oncological outcomes, VATS showed equivalent or better intermediate to long-term outcomes compared with conventional thoracotomy. Yang *et al.*, reported on the long-term after VATS lobectomy or thoracotomy based on the National Cancer Data Base of United States. About 3,000 patients with stage I non-small cell lung cancer (NSCLC) were matched with propensity score. The five-year OS rates of the two groups were similar.⁹ Flores *et al.* reported the results of a retrospective study that compared the curability between VATS lobectomy and thoracotomy for stage I NSCLC. A total of 398 patients who underwent VATS lobectomy and 343 patients who underwent thoracotomy demonstrated similar five-year OS rates, 79 and 75%, respectively.¹⁰

Since the introduction of the uniportal VATS approach, numerous reports have shown that uniportal VATS anatomical lung resection can be a feasible and safe alternative compared with traditional VATS anatomical lung resection with regard to short-term oncological outcomes, effective postoperative pain control, shorter duration hospital stay, in-hospital mortality and postoperative complication rates. According to Ng *et al.* the two-year overall

DFS rates for stage I NSCLC, stage II or greater NSCLC of uniportal VATS major lung resections were 96 and 83%, respectively.⁸ Wu *et al.* analyzed the mid-term survival outcomes of uniportal VATS anatomical lung resection. The two-year DFS and two-year OS were 92.3 and 100% for 1A1, 73.7 and 91.4% for 1A2, 75.2 and 93.4% for 1A3, 62.1 and 85.9% for 1B, 55.6 and 72.7% for 2A, 47.1 and 64.2% for 2B, 42.1 and 60.3% for 3A, respectively.¹¹ However, to date few studies have analyzed mid- or long-term oncological outcomes and only for early stage NSCLC patients treated with uniportal VATS. Currently, studies with mid- or long-term oncological outcomes for NSCLC advanced stage are lacking. The OS and DFS in our uniportal VATS group compared favorably with those in reports of traditional VATS mid- or long-term outcomes. Indeed our oncological results confirm that uniportal VATS has good mid-term oncological outcomes.

This study has several limitations. First, it was a retrospective study based on a relatively small cohort from a single institution. To evaluate mid- or long-term oncological outcomes of uniportal VATS anatomical lung resection more accurately, a larger multi-institutional study may be necessary. Second, lack of comparative information on multiport VATS or thoracotomy anatomical lung resections makes oncological outcomes of uniportal VATS less persuasive. Further studies to distinguish mid- or long-

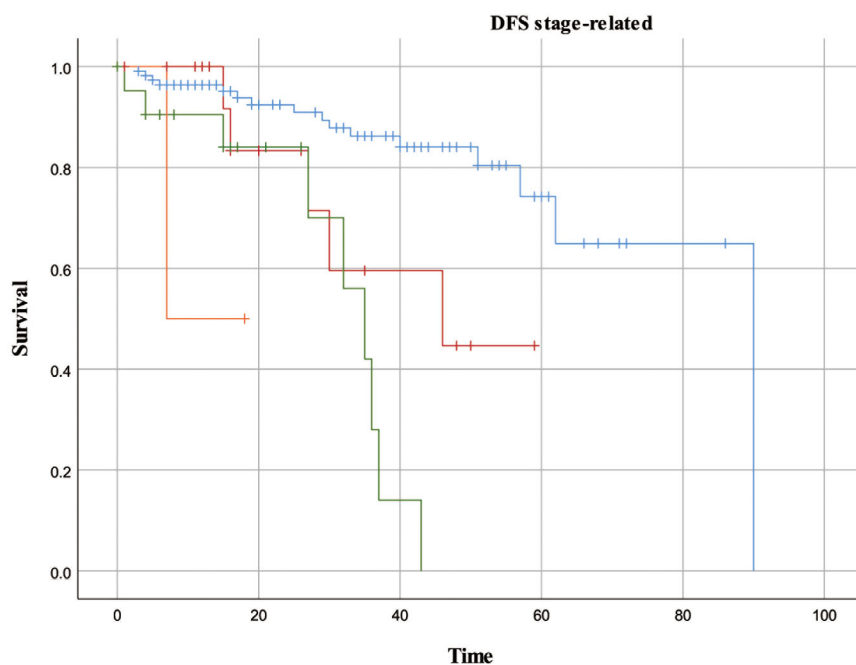
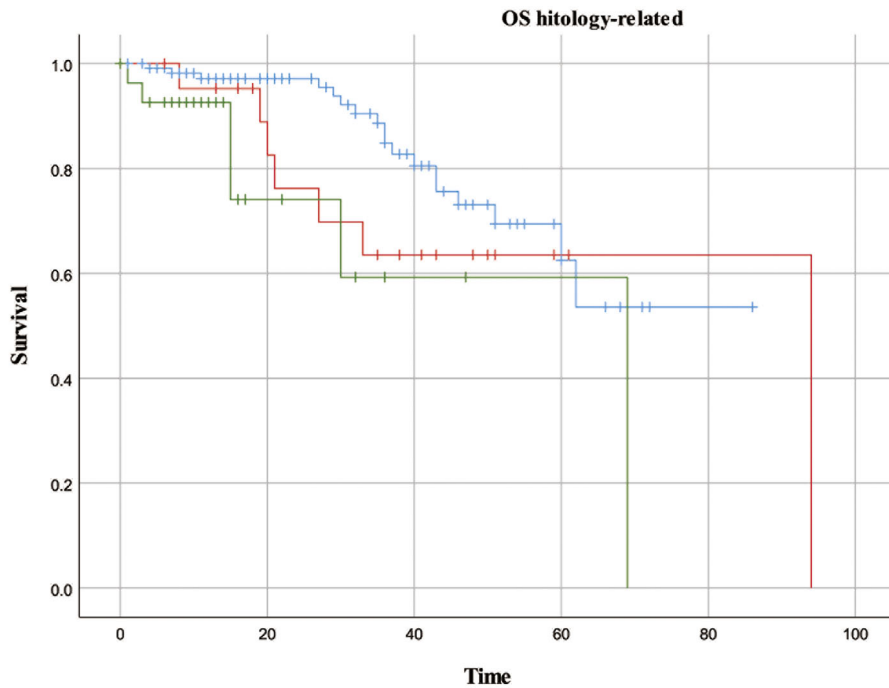
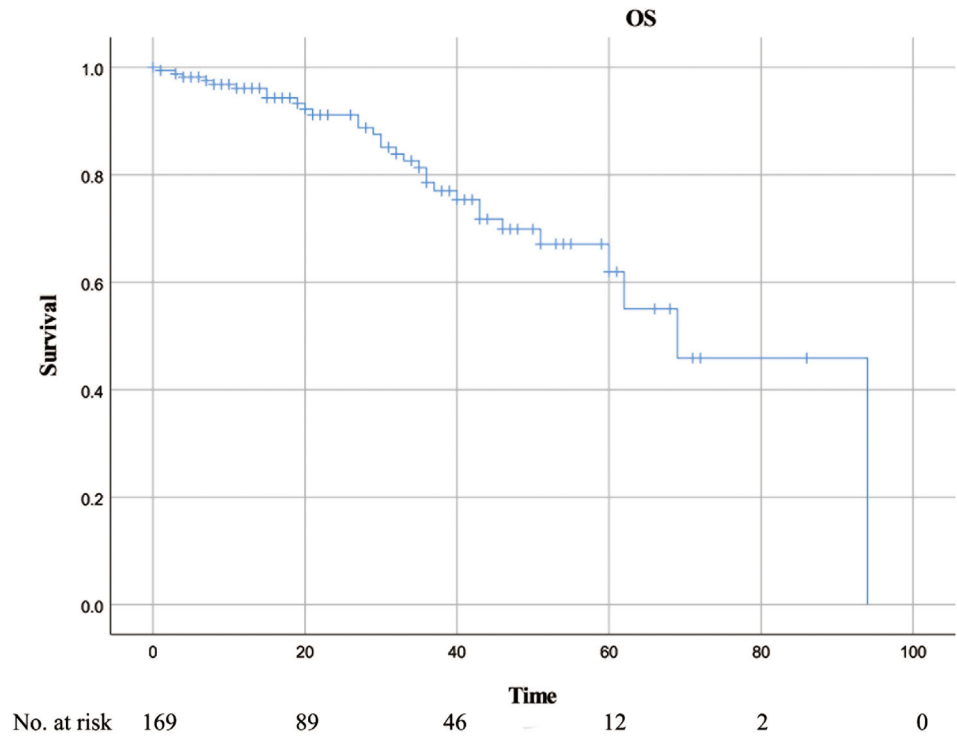


Figure 4 Stage-related disease-free survival (DFS) Stage (—) I, (—) II, (—) III, (—) IV, (—+) I-censored, (—+) II-censored, (—+) III-censored, and (—+) IV-censored.

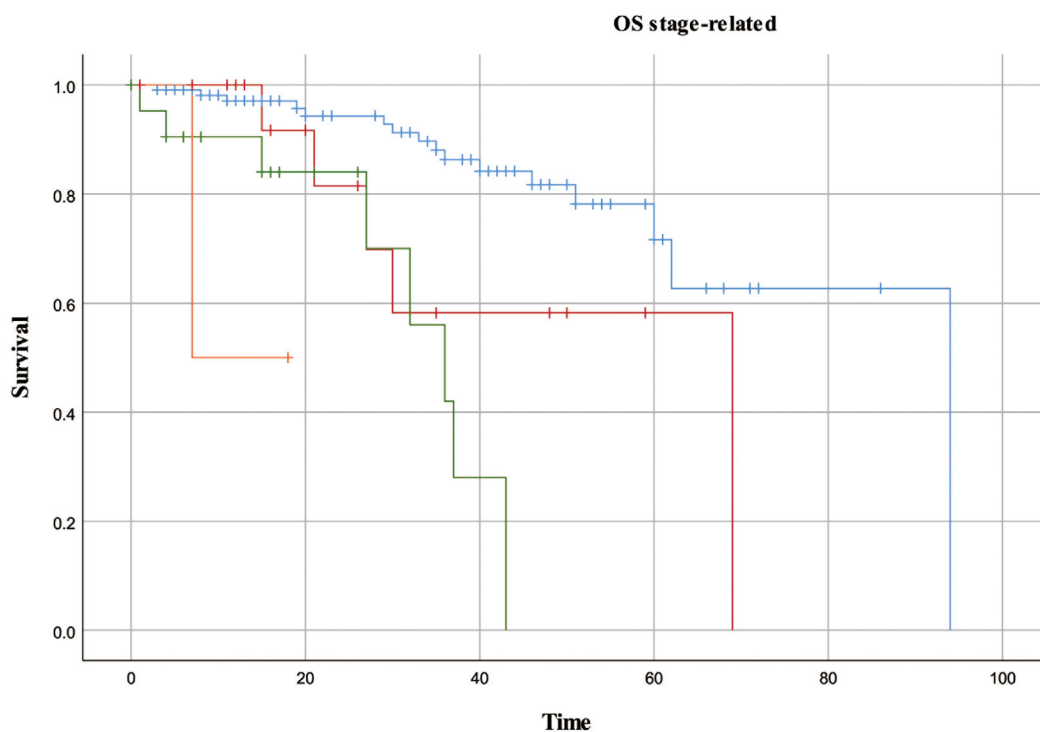
	0	20	40	60	80	100
No. at risk	113	65	39	10	2	0 (Stage I)
	19	8	4	0	0	0 (Stage II)
	21	10	1	0	0	0 (Stage III)
	1	0	0	0	0	0 (Stage IV)

Figure 5 Overall survival (OS) (—) Survival, and (++) Censored.



No. at risk	115	69	36	9	1	0 (Adenocarcinoma)
	23	13	8	2	0	0 (Squamous cell carcinoma)
	27	6	2	1	0	0 (Other)

Figure 6 Histology-related overall survival (OS) Histology (—) Adenocarcinoma, (—) Squamous cell carcinoma, (—) Other, (++) Adenocarcinoma-censored, (++) Squamous cell carcinoma-censored, and (++) Other-censored.



No. at risk	113	65	39	10	2	0 (Stage I)
	19	8	4	0	0	0 (Stage II)
	21	10	1	0	0	0 (Stage III)
	1	0	0	0	0	0 (Stage IV)

Figure 7 Stage-related overall survival (OS) Stage (—) I, (—) II, (—) III, (—) IV, (—+) I-censored, (—+) II-censored, (—+) III-censored, and (—+) IV-censored.

term oncological outcomes with multiport VATS or thoracotomy surgery are necessary.

The results of our retrospective study showed that uniportal VATS anatomical lung resections for lung cancer is feasible and satisfactory with respect to oncological mid-term outcomes. In conclusion, we affirm that uniportal VATS anatomical lung resection for lung cancer is feasible and satisfactory with respect to oncological mid-term outcomes..

Disclosure

The authors declare that there are no potential conflicts of interest.

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