Original Article

Modified procedure of uniportal video-assisted thoracoscopic lobectomy with muscle sparing incision

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Contributions: (I) Conception and design: R Yang; (II) Administrative support: R Yang; (III) Provision of study materials or patients: R Yang; (IV) Collection and assembly of data: Z Liu; (V) Data analysis and interpretation: Z Liu; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Background: To describe modified procedure for uniportal video-assisted thoracoscopic surgery (UVATS) lobectomy with a small, total muscle-sparing incision.

Methods: Forty-eight UVATS leucotomy were attempted and successfully completed. A single incision of approximately 3 cm was made in an intercostal space along the anterior axillary line. Muscle-sparing technique was applied with this single-incision approach using muscle sparing technique.

Results: Incision size was kept to a minimum, with a median of 3 cm. Mediastinal lymph node dissection was performed in all patients with malignancy. Overall median operative time was 1.3 hours. Median hospitalization was 13.5 days (range, 6–21 days). Morbidity rate was low at 3%. There were no other postoperative complications, mortality, or re-admissions.

Conclusions: Modified procedure of lobectomy with UVATS might be easy to operate with less surgical time and morbidity rate, muscle sparing technique might reduce post-operation pain.

Keywords: Uniportal; video-assisted thoracoscopic surgery (VATS); lobectomy

Submitted May 23, 2016. Accepted for publication Jul 26, 2016.
doi: 10.21037/atm.2016.09.07
View this article at: http://dx.doi.org/10.21037/atm.2016.09.07

Introduction

Conventional video-assisted thoracoscopic surgery (cVATS) uses multiple incisions, which may still create significant postoperative pain. It is also more difficult to perform lobectomy with uniportal video-assisted thoracoscopic surgery (UVATS), a modified procedure should be explored. Some evidence suggests that UVATS may improve postoperative pain, paresthesia, and patient satisfaction as compared with traditional video-assisted thoracoscopic surgery (VATS) (1). The objective is to describe modified procedure for UVATS lobectomy with a small, total muscle-sparing incision.

Methods

Patient selection

A retrospective review of prospectively maintained database identified 100 patients who underwent curative thoracoscopic surgery at Nanjing Chest Hospital during March 2015 to April 2016. The final decision to perform UVATS or cVATS in each patient was determined at the surgeon's discretion. All surgeries were lobectomy, and UVATS and cVATS were performed in 48 and 102 patients by the same surgeon (R Yang), respectively. cVATS was defined as thoracoscopic surgery through two or three port holes. The wound protector was used to open incisions, and a small rib retractor was not used. Trocars were used in the port holes. This study was approved by the Institutional Review Board (number of the ethics approval: 2014-KL002-02), and all patients provided written informed consent before operation.

Forty-eight UVATS lobotomy were attempted, and 46 cases were successfully completed. Inclusion criteria for UVATS lobectomy were clinical stage I or II lung cancer, tumor less than 7 cm, benign lung disease with failure of

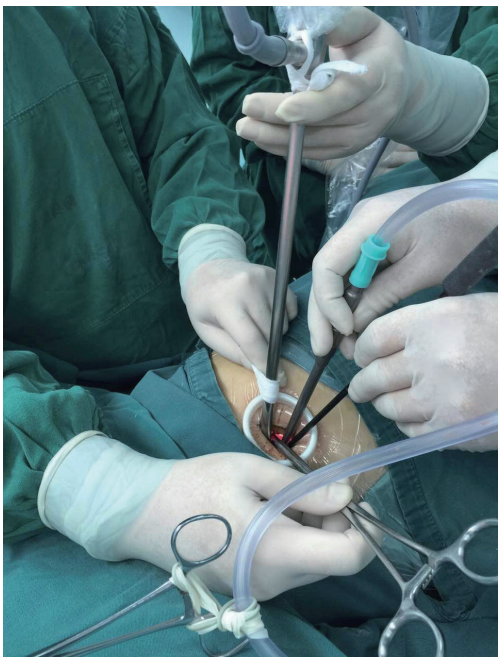

Figure 1 A single incision of approximately 3 cm was made in an intercostal space along the anterior axillary line.

medical therapy, and physiologic operability.

Exclusion criteria were tumor greater than 7 cm, chest wall or mediastinal involvement, known N2 or N3 disease, complete pleural symphysis, and inability to tolerate single-lung ventilation. Neoadjuvant chemotherapy or radiotherapy was considered as a relative contraindication.

All patients underwent chest computed tomography scan and pulmonary function testing as a standard preoperative workup. Mediastinoscopy was performed for patients with radiographic criteria for mediastinal adenopathy.

All qualified patients had UVATS lobectomy performed through a single, small incision with muscle-sparing.

Incision placement with muscle-sparing technique

Surgery was performed under general anesthesia in the lateral decubitus position with single-lung ventilation. Both the surgeon and the assistant who maneuvered the thoracoscope stood anteriorly facing the patient, and a second assistant stood posteriorly.

A single incision of approximately 3 cm was made in an intercostal space along the anterior axillary line (*Figure 1*). Upper lobectomy was performed through either the fourth or fifth intercostal space, and lower lobectomy was performed through the fifth intercostal space.

Muscle-sparing technique can be applied with this single-incision approach. The latissimus dorsi muscle was left intact by placing the incision anterior to it as defined by surface anatomy. Fibers of the serratus anterior muscle were split apart without cutting. Incisions of intercostal muscles were located at the inferior margin for preservation without retraction or hurting periosteum and rib. Plastic wound protector (Johnson & Johnson, New Brunswick, NJ, USA) was used to stretch open the incision.

Standard minimally invasive instruments for VATS were used (Karl Storz, Tuttlingen, Germany). A 10-mm 30-degree thoracoscope (Karl Storz) was inserted. The thoracoscope and several thoracoscopic instruments were simultaneously fitted into the uniport. No additional skin incisions or counter-incisions were made for any purpose such as placement of thoracoscope, graspers, or drains. Ribs were not spread, resected, or fractured during the operation, and there was strict avoidance of metallic retraction. It is very important to keep the camera in the posterior part of the incision, a gauze sling around the thoracoscope was used to maintain the position. Other instrument should be operated below the camera.

Upper lobe resection

Fissureless technique was applied with upper lobe resection. Once the right side of the chest has been entered, the lung is retracted medially and dissection along the posterior pleura is performed at the level of the bronchial bifurcation. The truncus anterior was mobilized and divided first to avoid being hurt when dissection pulmonary vein. The lung is then reflected posteriorly and the pulmonary veins are identified and divided with a vascular stapler. This procedure reveals the underlying posterior ascending artery. The last structure to be dissected is usually the bronchus; however, occasionally the bronchus is divided before dissection of the posterior ascending artery. After dividing the bronchus, the fissures are divided using stapling devices, and the specimen is extracted from the chest in a protective bag.

Thoracoscopic left upper lobectomy is performed in a manner similar to that performed on the right side. Usually the branches of the arterial trunk was individually exposed and divided at first, followed by division of the posterior branch. The superior pulmonary vein is then encircled and divided, revealing the remaining underlying pulmonary artery and upper lobe bronchus. Dissection and division is now easily accomplished. The major fissure is divided with the stapling device.

Lower lobe resection

One way approach and fissureless technique was applied with lower lobe resection. Fissure is divided at first near pulmonary artery. Dissection of bronchus is begun at the bifurcation with the middle lobe, which must be preserved, then bronchus is divided, followed by division of arterial trunk. Inferior pulmonary vein is quite clear and easy to be encircled and divided. Division of the inferior pulmonary ligament would be the last step.

Middle lobe resection

Middle lobe tributary to superior pulmonary vein should be divided first, it may be difficult with staple, however, ligation and division with ultrasonic knife was recommended. Usually oblique fissure was well developed, and middle lobe pulmonary artery is easy to be encircled and divided with middle lobe retracted posteriorly. After resection of station 11 lymph modes, bronchus was divided, the only remaining horizontal fissure could be divided with stapler.

Mediastinal nodal dissection and specimen remove

Systematic mediastinal lymph node dissection was routinely performed for malignant disease in the same fashion (stations 5, 6, 7, 8, 9 for left, and stations 2, 4, 7, 8, 9 for right).

For tumor with size 5 to 7 cm, it was hard to remove thorough incision. Specimen was inserted into a specimen bag (Ethicon, Cornelia, GA, USA) and cut into pieces without contamination before removing.

Postoperative follow-up routine

Patients were followed up at 1 week, 1 and 3 months after discharge. Presence of pain or paresthesia, shoulder dysfunction, and return to full normal activities were assessed. The latter is defined as restoration of baseline functionality and the return to normal daily routines as before surgery. Patients were subsequently seen in the clinic every 4 months for cancer surveillance. Measurement of postoperative paraesthesia and shoulder dysfunction was based on an open question to assess patients.

Statistical analysis

Data was exported from Excel (Microsoft Corp, Redmond, WA, USA) to SPSS 19 for Windows software (IBM, Armonk, NY, USA). Descriptive statistics were used to determine the frequency of categorical variables. Quantitative variables were expressed using mean ± standard deviation or median and range.

Results

Between June 2014 and April 2016, a total of 48 patients underwent lobectomy by a single surgeon, and 46 cases were successfully completed, 52 patients underwent cVATS successfully. *Table 1* shows the preoperative patient characteristics. Of those patients in UVATS group with benign diseases, 2 had sequelae of pulmonary sequestration (infection, pneumothorax), 2 had inflammatory pseudotumors, 1 had mycetoma, and 1 had constrictive bronchiolitis obliterans with complete lobar collapse.

Table 2 illustrates the tumor characteristics including pathologic type and stage. The median tumor size is 2.5 cm (range, 1–8 cm). Resection of any lobe can be performed by UVATS. There were a total of 21 (55%) upper leucotomy (10 left and 11 right), 4 (11%) middle leucotomy, and 13 (34%) lower leucotomy (8 left and 5 right).

Of 48 attempted major resections, 46 patients (95.8%) successfully completed UVATS lobectomy in our early experience. There were two conversions to open thoracotomy, which included planned conversions. One patient had chest wall invasion requiring *en-bloc* resection, one patient had complete pleural symphysis.

Table 3 illustrates postoperative data. Incision size was kept to a minimum, with a median of 3 cm. Mediastinal lymph node dissection was performed in all patients with malignancy. The mean number of nodal stations explored was 7.5, with a range of 6 to 9 stations. Overall median operative time was 89 min, with a trend toward reduction as more cases were performed. Although the median duration of air leak was 1 day, median chest tube duration was 4 days as a result of increased fluid drainage after extensive mediastinal nodal dissection in malignant patients. No patient required postoperative thoracentesis. Median hospital stays after surgery was 7.4 days (range, 5–11 days). Morbidity rate was low at 3%, with only 1 patient exhibiting postoperative atrial fibrillation. There were no other postoperative complications, mortality, or re-admissions. Complications did not differ significantly between the two groups. There were no deaths in either group.

Patient controlled analgesia fentanyl pumps were given. Most of the patients required only oral analgesia (33 patients used only oral tramadol). Thirteen patients reported mild

Table 1 Characteristics of patients who underwent UVATS lobectomy and cVATS lobectomy

Patient characteristics	UVATS	cVATS	P value
Total number of patients	48	52	0.811
Malignant diseases	43	41	0.764
Benign diseases	5	11	0.542
Sex (No. of patients)			
Male	33	30	0.741
Female	15	22	0.459
Age (median and range)	63 [14–88]	69 [45–82]	0.924
Smoking history (No. of smokers)	35	29	0.758
FEV_1 (L)	1.95	2.01	0.832
ECOG status (median and range)	1 [0–2]	1 [0–2]	1.000
ASA score (median and range)	1 [1–2]	1 [1–2]	1.000
Number of coexisting conditions (median and range)	1 [0–5]	1 [0–5]	1.000
≥3 coexisting conditions (No. of patients)	5	4	0.896

ASA, American Society of Anesthesiologists; ECOG, Eastern Cooperative Oncology Group; UVATS, uniportal video-assisted thoracoscopic surgery; cVATS, conventional video-assisted thoracoscopic surgery.

Table 2 Tumor characteristics of patients with malignant disease who underwent total muscle-sparing uniportal video-assisted thoracoscopic surgery lobectomy

Tumor characteristics	No. of patients
Pathologic type	
Adenocarcinoma	38
Squamous cell carcinoma	5
Metastasis	0
Pathologic stage	
Stage IA	30
Stage IB	8
Stage IIA	3
Stage IIB	1
Stage IIIA	1
Stage IIIB and IV	0
Tumor size (cm)	
≤2	29
2–3	8
3–5	4
5–7	1
≥7	1

Table 3 Postoperative data of patients who underwent uniportal video-assisted thoracoscopic surgery lobectomy and conventional video-assisted thoracoscopic surgery lobectomy

Perioperative outcomes	UVATS	cVATS	P value
Operation time [range] (min)	89 [25–155]	109 [65–220]	0.321
Blood loss [range] (mL)	85 [15–435]	95 [15–475]	0.311
Mean tumor size (range) (cm)	2.5 (1.0–8.0)	3.1 (1.5–9.0)	0.434
Mean number of nodal stations explored (range)	7.5 (6.0–9.0)	7.1 (6.0–9.0)	0.821
Mean number of dissected lymph nodes (range)	12.8 (5.0–25.0)	13.6 (6.0–24.0)	0.853
Drainage duration (range) (days)	4.1 (3.0–7.0)	5.5 (3.0–12.0)	0.564
Hospital stays after surgery (range)	7.4 (5.0–11.0)	7.6 (5.0–14.0)	0.918
The number of autosuture's cartridges that was used (range)	5.2 (3.0–7.0)	4.1 (1.0–6.0)	0.763
Postoperative complications (No. of patients)	1	3	0.235
Prolonged air leak (>5 days) (No. of patients)	0	2	0.001
Postoperative atrial fibrillation (No. of patients)	1	1	1.000
Atelectasis (No. of patients)	0	0	1.000
Pneumonia (No. of patients)	0	0	1.000
Conversion to thoracotomy (No. of patients)	2	1	–

UVATS, uniportal video-assisted thoracoscopic surgery; cVATS, conventional video-assisted thoracoscopic surgery.

local paraesthesia adjacent to the wound, which resolved by the 1-month visit. No patients developed chronic pain syndrome or shoulder dysfunction postoperatively. The median duration of returning to full normal activities at baseline was 7 days (range, 5–19 days).

Discussion

UVATS is feasible with perioperative outcomes comparable to those of three-port VATS (2). The view is directed to the target tissue with the single-port approach, it is the same as with open procedures when performed through an anterior thoracotomy, and instrumentation is somehow similar with a suitable sagittal plane (2).

Although UVATS may appear to be simply a variation to standard multiportal VATS, it actually entails several important changes to the angles for visualization, dissection, and instrumentation (3,4). We used an approximately 3 cm incision for UVATS lobectomy, balancing the needs for pain reduction, dissection, and retrieval. It was possible for operation with small incision as none of our patients was morbidly obese.

One possible disadvantage is that less entry points for introducing staplers, which affects access to the vein and artery. We observed that fissureless technique is more suitable, especially when fissure is not well developed during upper lobectomy. The view from the utility incision facilitates artery dissection as the first step. It seems always to be easier to manage artery as the first step except for middle lobe resection, which is the biggest change different from lobectomy with thoracotomy or other traditional VATS. First sectioning the arterial trunk helps access to the upper lobe vein with the aid of staplers, which is the most uncomfortable structure to access with staplers. It might be quite uncomfortable to divide pulmonary vein in UVATS lower lobe resection, a modified sequence from arteries and bronchus would greatly facilitate managing vein. Sometimes staplers is not feasible for arteries, we may use vascular clips or single ligation. The specific anatomical structure makes it easier for middle lobe resection achieved with a sequence of vein, arteries and bronchus, then divide fissure at last.

Although stapling the fissure at the end of the procedure might be a difficult step, especially in patients with advanced disease or emphysema (5). This could explain air leak in some patients.

The most significant advantage of UVATS is that it allows a total muscle-sparing approach. The uniportal incision was strategically placed to allow full sparing of all intrathoracic muscles, reducing the risk of intercostal neuralgia. The single incision is made closer to the hilar structures. With this uniportal technique, there is a change in the angle of dissection and stapling from the acute angles used in cVATS lobectomy to more-obtuse angles in UVATS lobectomy (6,7). Although this may seem to be a limitation at the beginning, it actually represents an improvement.

One other potential advantage of this approach may be a reduction in postoperative pain. Pain is sometimes referred toward the posterior and inferior incisions in patients operated on by cVATS, and fewer referred to the utility incision (8). Further studies should be required to demonstrate that there is less pain with single-incision techniques compared with cVATS for lobectomy. Patients underwent UVATS usually had less pain, less medication used, and better satisfaction. No patient experienced chronic pain syndrome or any shoulder dysfunction.

Gonzalez-Rivas and colleagues reported a 14% complication rate in UVATS, mostly occurring in upper lobe surgeries (9). In our group, the complication rate is low, and there is no postoperative mortality, possibly because of our total muscle-sparing technique and the use of modified procedure to avoid hyperacute angulation and compression.

Overcrowding of instruments may occur and restrict their maneuvering (10), however, we usually only place three or up to four thoracoscopic items through the uniport and we do not find this to pose a major challenge when they are properly positioned.

A very important consideration is the performance of mediastinal lymphadenectomy (11). In any case, we have performed the adequate mediastinal staging defined as systematic node dissection.

Thoracoscopic lobectomy for advanced stages or complex cases may be performed safely, with results equivalent to open techniques (12,13). Consequently, the more experience we accumulate, the more complex the cases we performed (14). In our study, there were complex benign cases and advanced-stage tumors. Bronchus sleeve lobectomy, double sleeve lobectomy, trachea resection was perform with UVATS in our institute.

Conclusions

Modified procedure of lobectomy with UVATS might be easy to operate with less surgical time and morbidity rate, muscle sparing technique might reduce post-operation pain. Out experience would be further examined.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: This study was approved by the Institutional Review Board (number of the ethics approval: 2014-KL002-02), and all patients provided written informed consent before operation.

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Cite this article as: Liu Z, Yang R, Shao F, Pan Y. Modified procedure of uniportal video-assisted thoracoscopic lobectomy with muscle sparing incision. Ann Transl Med 2016;4(19):367. doi: 10.21037/atm.2016.09.07

