A prospective study examining the impact of uniportal video-assisted thoracic surgery on the short-term quality of life in patients with lung cancer

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Keywords
Lung neoplasms; quality of life; thoracoscopy; uniportal.

Abstract
Background: The aim of this study was to evaluate the effect of uniportal and three-portal VATS in lung cancer patients on the postoperative short-term quality of life (QOL).

Methods: A single-center, prospective, nonrandomized study was performed on patients who underwent uniportal or three-portal video-assisted thoracoscopic surgery (VATS) lobectomy and systemic mediastinal lymph node dissection. QOL was measured before surgery at baseline and at one, two, four, and eight weeks after the operation. The measured data of normal distribution were indicated by the mean ± standard deviation, the independent sample t-test was used among the groups, and the χ2 test was used to compare the counting. Non-normal distribution of the measurement data was carried out using the Mann-Whitney test.

Results: Preoperative functional areas, symptom areas and overall health scores were similar in the two groups. The physical, role, emotional and social functions and overall health status of the uniportal group were significantly higher than those of the three-portal group in postoperative time. The score of symptom field was higher in one week after operation, the score of two, four and eight weeks decreased gradually, but it was still above the preoperative level, and the fatigue and pain of the uniportal group were significantly lower than that of the three-portal group.

Conclusion: The advantages of uniportal VATS include a shorter hospital stay, more rapid recovery and superior cosmetic results compared to three-portal VATS. Additionally, uniportal VATS is superior to three-portal thoracoscopic surgery in terms of the immediate postoperative short-term QOL.

Introduction
Lung cancer is the leading cause of cancer deaths worldwide.1,2 Surgical resection is the main treatment for resectable non-small cell lung cancer. Lobectomy and systemic mediastinal lymph node dissection are standard surgical methods for lung cancer treatment. A traditional thoracotomy produces greater trauma and has a slow recovery, which seriously affects quality of life after the operation. The use of video-assisted thoracoscopic surgery (VATS) for anatomic lung resections was first described in 1992 for lobectomy in the surgical treatment of lung cancer. VATS has been increasing in popularity over the last two decades in thoracic surgery practices worldwide, and multiportal VATS has become the mainstream surgery for the majority of medical centers.3,4 Compared to thoracotomy, VATS demonstrates not only a significant reduction in pain, recovery and complications but also an improvement in postoperative quality of life (QOL) for patients.2,3,5 Since uniportal...
VATS was reported, it has triggered a new wave of innovative research in the field of thoracic surgery, which has been progressively extended from the pulmonary wedge resection to lobectomy, sleeve lobectomy and pneumonectomy. Uniporal VATS minimizes the surgical incision, further reduces surgical trauma and accelerates recovery. Few reports have examined whether uniportal VATS can further improve QOL of patients with lung cancer.

Here, we designed a prospective nonrandomized controlled study to evaluate the effect of uniportal and three-portal VATS in lung cancer patients on the postoperative, short-term QOL.

Methods

A single-center, prospective, nonrandomized study was performed by including patients who had undergone uniportal or three-portal VATS lobectomy and systemic mediastinal lymph node dissection from September 2017 to November 2017. All patients read and signed an informed consent statement, and the study was approved by the ethics committee of The First Affiliated Hospital of the University of Science and Technology of China. The vast majority of patients were randomly enrolled, and the patient was informed of the surgical procedure before surgery. However, a small number of patients indicated a strong willingness to choose their own surgical methods. For ethical considerations, the patients’ wishes were respected, and as a result they could not be completely randomized.

Patients

From September 2017 to November 2017, patients with lung cancer admitted to the First Hospital of the University of Science and Technology of China were enrolled in two different groups that underwent uniportal or three-portal VATS lobectomy and systemic lymph node dissection. Patients were selected based on the following eligibility criteria: (i) Pathologic diagnosis of non-small cell lung cancer, (ii) thorascopic lobectomy in the lobe of the tumor and systemic lymph node dissection, and (iii) R0 resection. Patients were excluded based on the following criteria: (i) Patients who had undergone preoperative radiotherapy or chemotherapy or (ii) patients with sublobectomy combined-lobectomy or pneumonectomy.

The preoperative staging workup included fiberoptic bronchoscopy, computed tomography (CT) scanning of the chest, abdominal and adrenal ultrasonography, enhanced magnetic resonance imaging (MRI) of the brain, whole-body bone scintigraphy, electrocardiography, a pulmonary function test, echocardiography, and routine preoperative blood examinations. TNM staging was based on the International Association for Lung Cancer Research (IASLC), eighth edition.

Surgical technique

For uniportal VATS, double-lumen endotracheal intubation and single-lung ventilation were performed with the patient in the lateral position on the nonaffected side. The incision was located between the midaxillary line and the anterior axillary line on the fourth or fifth intercostal space. The length of the incision was 3–5 cm, and a soft wound protector was used. A 10 mm, 30 degree thoracoscope was placed on the upper edge of the incision, and its position was adjusted if necessary. The thoracoscopy was performed to detect the presence of adhesion, effusion and disseminated nodules in the thoracic cavity and to determine the specific location of the lesion and the anatomy of the lung. In patients with a confirmed preoperative diagnosis, lobectomy and systemic mediastinal lymph node dissection were directly performed. In patients without a pathological diagnosis, a wedge resection was performed if possible, and frozen sections were examined first. A lobectomy and systemic lymph node dissection were performed only if the frozen sections showed malignancy. If the pulmonary fissure developed well, the arteries were treated preferentially; if not, a “single-direction” method was used to remove lobes. Vessels below 5 mm were treated with an ultrasonic harmonic scalpel (Ethicon Endo-Surgery, LLC, Guaynabo, Puerto Rico, USA) after double ligation, and in vessels above 5 mm, the trachea and dysplastic lung fissure were cut off using endoscopic staplers (Ethicon Endo-Surgery, LLC, Guaynabo, Puerto Rico, USA). For right lung cancer, the 2R, 3A, 3P, 4R, 7, 8, 9, 10 groups and intrapulmonary lymph nodes were routinely probed and resected. For left lung cancer the 4L, 5, 6, 7, 8, 9, 10 groups and intrapulmonary lymph nodes were routinely probed and resected. A 28F chest tube was placed in the incision.

For three-portal VATS, three incisions were performed in a standard manner. The anesthesia and position were the same as those used for uniportal VATS. A 3–5 cm anterior utility incision located in approximately the fourth or fifth interspace between the midaxillary line and the anterior axillary line, a 10 mm camera port located in the seventh interspace in the midaxillary line and a trocar were inserted in the camera port, and a 1.5 cm incision in the eighth interspace was made in the posterior axillary line. The operative steps, such as frozen sectioning and lymph node dissection, were the same as those used for uniportal VATS. A 28F chest tube was placed through the camera port.

For both groups, the chest tube was removed according to the following criteria: (i) the amount of daily chest
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drainage was less than 200 mL without air leakage, and (ii) no pneumothorax or localized pleural effusion were observed on chest X-rays.

Controlled and observed variables

The clinical and pathological data included age, sex, body mass index (BMI), pathological type, tumor location, TNM staging and preoperative complications. The perioperative indicators included operative time, surgical blood loss, chest tube duration, postoperative admission duration, the total number of lymph nodes, the locations of all lymph nodes, postoperative complications and QOL.

Assessment of QOL

QOL was measured with functional and symptom scales using the European Organization for Research and Treatment of Cancer (EORTC) QLQ-C30 (version 3.0) and the EORTC QLQ-LC13 questionnaires before surgery at baseline and at one, two, four, and eight weeks after the operation. QOL included functional areas (social function, cognitive function, physical function, emotional function, and role function), symptom areas (fatigue, nausea and vomiting, and pain), overall health status, and six single items (dyspnea, sleep disturbance, loss of appetite, constipation, diarrhea, and financial difficulties). A higher functional index indicated a better QOL, and higher symptom scores indicated increased symptoms and a worse QOL. The medical staff completed all the scales through interviews or telephone follow-up.

Statistical analysis

Statistical analyses were performed with SPSS 19.0 software (SPSS Inc., Chicago, IL, USA). Normally distributed data are shown as the means ± standard deviation, and independent samples t-tests were used to compare groups. χ² tests were used to compare two groups, and the Mann-Whitney test was utilized for non-normal distribution of measurement data. QOL was drawn by GraphPad Prism 5.0 software (GraphPad Software Company, La Jolla, CA). All P-values were two-sided, with statistical significance evaluated at the level of 0.05.

Results

Comparison of patient characteristics

During the study period, 120 patients were included, of which 64 were male, and 56 were female; the average age was 62.43 ± 10.23 years. A total of 60 patients were included in the uniportal group, and 60 patients in the three-portal group. Comparisons of general clinicopathological data including age, sex, BMI, pathological type, tumor differentiation, tumor location, preoperative complications, and TNM staging showed no significant differences between the two groups (Table 1).

Comparison of perioperative outcomes

No statistically significant differences were observed in the operative time, number of total lymph nodes, locations of lymph nodes and postoperative complications (P > 0.05). Compared to the three-portal group, the uniportal group had less surgical blood loss, the chest tube duration and postoperative admission duration (P < 0.05) (Table 2).

QOL from time to surgery

Of 120 patients, 115 patients completed the entire QOL questionnaire, and five patients failed to complete the entire QOL assessment by refusing follow-up or missing visits; 586 complete scales were available. The preoperative functional areas, symptom areas and overall health scores were similar in the two groups (P > 0.05).

The functional areas and overall health status of multiple were significantly decreased dimensions at one week postoperatively, and the node scores at two, four and eight weeks after the operation gradually increased but were still lower than the preoperative level. The functional areas such as physical function, role function, emotional function and social function, and the overall health status of the uniportal group were significantly higher than those of the three-portal group (P < 0.05).

The symptom scores were higher at one week after the operation, and the scores after two, four and eight weeks decreased gradually but were still higher than the preoperative level. The fatigue and pain scores in the uniportal group were significantly lower than those of the three-portal group (P < 0.05) (Figure 1).

Discussion

As an invasive treatment, surgery can remove lesions, treat disease and improve the prognosis but inevitably produces physical and psychological trauma that affects a patient’s QOL after the operation. The medical model is changing from a simple biomedical model to a bio-psycho-social medical model, and clinicians are no longer simply concerned with prolonging the survival period but also paying more attention to QOL. Therefore, avoiding a decrement of the patient’s QOL is a problem that thoracic surgeons should address. In this study, compared to three-portal thoracoscopic surgery, uniportal VATS achieved the same range of tumor resection and had obvious advantages in
surgical blood loss, chest tube duration and postoperative admission duration. Additionally, this technique clearly improved QOL in many functional dimensions, such as physical function, role function, emotional function and social function, and the overall health status and had obvious advantages for postoperative pain and fatigue. These data suggest that uniportal VATS is advantageous and less invasive than three-portal VATS.

Rocco et al. reported the use of uniportal VATS for the diagnosis and treatment of thoracic diseases in 2004, which was limited to wedge resection. Since then, the indications for uniportal thoracoscopic surgery had expanded. 

| Table 1 | Comparison of patients' clinical characteristics of the two groups |
|---------|-------------------------------------------------|
| Characteristics | Uniportal (n = 60) | Three-portal (n = 60) | t/Z | P-value |
| Sex | | | 0.134 | 0.714 |
| Male | 33 | 31 | | |
| Female | 27 | 29 | | |
| Age (years) | 61.35 ± 10.76 | 63.50 ± 9.64 | 1.153 | 0.251 |
| BMI | 21.70 ± 2.24 | 22.38 ± 2.88 | 1.451 | 0.149 |
| Pathology | | | 0.377 | 0.828 |
| Squamous carcinoma | 10 | 8 | | |
| Adenocarcinoma | 47 | 48 | | |
| Other type | 3 | 4 | | |
| Tumor location | | | 0.346 | 0.987 |
| RUL | 17 | 19 | | |
| RML | 5 | 4 | | |
| RLL | 11 | 10 | | |
| LUL | 15 | 16 | | |
| LLL | 12 | 11 | | |
| Differentiation | | | 0.093 | 0.926 |
| High | 15 | 13 | | |
| Middle | 24 | 27 | | |
| Lower | 21 | 20 | | |
| Preoperative complications | | | 0.581 | 0.901 |
| Hypertension | 7 | 8 | | |
| Diabetes | 4 | 5 | | |
| Arrhythmia | 3 | 2 | | |
| Cerebrovascular disease | 3 | 2 | | |
| TNM stage | | | 0.071 | 0.943 |
| I | 35 | 34 | | |
| II | 14 | 16 | | |
| III | 11 | 10 | | |

| Table 2 | Comparison of perioperative clinical data of the two groups |
|---------|-------------------------------------------------|
| Item | Uniportal (n = 60) | Three-portal (n = 60) | t/Z | P-value |
| Operative time (minutes) | 138.02 ± 65.75 | 151.50 ± 76.22 | 1.037 | 0.302 |
| Surgical blood loss (mL) | 92.50 ± 85.12 | 130.83 ± 90.71 | 2.387 | 0.019 |
| Chest tube duration (days) | 4.42 ± 3.09 | 5.95 ± 3.86 | 2.401 | 0.018 |
| Postoperative admission duration (days) | 6.20 ± 4.01 | 8.28 ± 4.65 | 2.626 | 0.010 |
| Total number of lymph nodes | 14.96 ± 9.04 | 15.32 ± 7.97 | 0.230 | 0.818 |
| Locations of all lymph nodes | 6.64 ± 0.82 | 6.65 ± 1.04 | 0.597 | 0.551 |
| Postoperative complications | | | 0.071 | 0.943 |
| Pneumonia | 4 | 5 | 0.041 | 0.840 |
| Atelectasis | 2 | 3 | 0.126 | 0.722 |
| Arrhythmia | 4 | 3 | 0.329 | 0.566 |
| Pulmonary air leakage | 8 | 9 | 0.001 | 0.973 |
Gonzalez-Rivas et al. described the first series of uniportal VATS lobectomies in 2011.12 Uniportal VATS lobectomy has subsequently been widely used and optimized. Uniportal thoracoscopic surgery can be used to complete all types of lung resections. The operative time, surgical blood loss, chest tube duration, postoperative admission duration and complication rates are important indexes for evaluating the safety and feasibility of the operation. As shown by our results, significant differences were found in operative time and complication rates between the two groups. The surgical blood loss in the uniportal group was markedly decreased, and the chest tube duration and postoperative admission duration were shortened, which showed that the uniportal operation had the same safety, reduced surgical trauma and accelerated postoperative recovery time. Wang et al.13 presented their results from a prospective comparative study, which showed no significant differences in postoperative admission duration or complication rates between the uniportal and three-portal groups, and the operative time and surgical blood loss in the uniportal group were significantly lower than those in the three-portal group. Ji et al.14 published a retrospective study that showed that the uniportal group had shorter chest tube duration and postoperative admission duration and a lower complication rate than the multiple-portal group. The main reasons for these findings may include the following: (i) Due to the lack of an auxiliary incision and camera port and the use of a soft wound protector, uniportal VATS can reduce incision bleeding caused by repeated extrusion of the incision during the operation, local exudation of the incision, surgical blood loss and postoperative drainage. (ii) The advantage of using the thoracoscope in the same port and in coordination with the instruments is that vision is directed to the target tissue. It is easier to judge the operation distance, improve the accuracy of the operation, and reduce accidental injury during the operation. (iii) In uniportal VATS, only one intercostal nerve is affected, and therefore chest pain after surgery is decreased, which may be associated with the lack of impairment of effective breathing and coughing. These differences might help patients achieve earlier ambulation and a shorter recovery time.

Radical resection of lung cancer includes anatomical lobectomy and systematic lymph node dissection. Lymph node dissection not only evaluates the index of the operation but can also directly affect the follow-up treatment and the long-term prognosis of patients. The literature reports that after completion of the learning curve by the surgeon, uniportal thoracoscopic surgery can achieve the same extent of lymph node dissection as traditional open surgery.15,16 All the surgeons in our center were able to perform three-portal thoracoscopic surgery before performing uniportal VATS. The study showed no significant differences in the number or location of total lymph nodes between the two groups. Liu et al.17 found no significant differences in the number or locations of total lymph nodes between the uniportal and three-portal groups. Additionally, French et al.18 found no significant differences in the number of total lymph nodes between the uniportal and three-portal groups. In our opinion, due to improvements in the surgical technique and apparatus, most thoracic surgeons would be able to reach similar lymph node dissection ranges as with three-portal thoracoscopy and open operation after completing the learning curve for uniportal thoracoscopic surgery. The most difficult aspect of uniportal VATS is reducing or
avoiding instrument interference. Our experience is that the thoracoscopic lens is always located on the upper edge of the incision to allow the surgeon to pull the exposed loop clamp gauze, which is located at the lower edge of the incision. Holding these to the center of the incision using energy devices and a suction device can provide access to the thoracic cavity in all locations needed for dissection of lymph nodes.

Due to improvements in living standards, patients not only wish to be satisfied with treatment for lung cancer but they also focus on QOL after surgery. Improving the QOL of cancer patients has been listed as an important index by the Food and Drug Administration. QOL is a comprehensive concept influenced by many factors involving characteristics of physiology, psychology and emotion, and QOL is a comprehensive evaluation index that adapts to the modern medical model and comprehensively reflects changes in the condition, treatment effects and health of patients. The biological factors influencing QOL in lung cancer patients include TNM staging, pathological typing, treatment and complications associated with the treatment. Social factors influencing QOL include marital status, age, sex, cultural quality, religious beliefs, and ethics. Psychological factors influencing QOL include negative emotions and positive psychological quality. This study showed that the uniportal group had significantly better physical function, role function, emotional function, social function and overall health status than the three-portal group. To further demonstrate the advantages of the reduced trauma and faster recovery of uniportal thoracoscopic surgery, this study is the first, to the best of our knowledge, to compare QOL of patients who received uniportal and three-portal VATS.

QOL was assessed using the EORTC QLQ-C30 and QLQ-LC13 evaluation questionnaires which included functional areas, symptom areas, overall health status and six single items. We found that the functional areas and overall health status in multiple dimensions at one week postoperatively were significantly decreased, and the node scores at two, four and eight weeks after the operation gradually increased, but were still lower than the preoperative levels. The functional areas such as physical function, role function, emotional function and social function, and the overall health status in the uniportal group were significantly higher than those in the three-portal group postoperatively. The symptom scores were higher at one week after the operation, and the scores at two, four and eight weeks after the operation decreased gradually, but were still above the preoperative level. The fatigue and pain scores in the uniportal group were significantly lower than those in the three-portal group. The QLQ scores after thoracoscopic surgery have been recognized as better than those after open surgery, but an early study compared only three-portal thoracoscopic surgery via open surgery. Hao et al. also presented their results from a prospective comparative study, which showed that the baseline level of QOL in the two groups of patients was similar, and the functional and emotional states of the patients in the uniportal group at three months postoperatively were better than those of the three-portal group. The overall QOL was better in the uniportal group than in the three-portal thoracoscopic group. This result is similar to the results of our study. The main reasons include that: (i) Uniportal VATS results in a smaller incision and better appearance, and the patients’ subjective view of the surgery is that it is less invasive, easier to accept, and more likely to restore positive emotions. (ii) The chest tube duration and postoperative admission duration were shorter, and patients could exercise earlier and reduce nutritional support, which restores normal life and work status. (iii) Injury to the intercostal nerves is reduced, postoperative pain is decreased, and the incision numbness rate is lower, making it easier to reduce postoperative discomfort and negative emotions, which improves the postoperative QOL.

There were some limitations to our study. First, this study was a single-center analysis, and there was a certain degree of selection bias. Second, the sample size was relatively small due to objective reasons. Third, the follow-up time was only two months and some patients in this study were unavailable for follow-up. Finally, this study was limited to the mutual learning and discussion among peers, which is related to the professional foundation, clinical experience, operation proficiency, and tacit cooperation of the surgical team, among other factors. Prospective studies that include a larger number of patients and have a longer follow-up are necessary.

In conclusion, uniportal VATS can minimize the amount of surgical trauma, the advantages of which include a shorter hospital stay, more rapid recovery and superior cosmetic results compared to pulmonary lobectomy via three-portal VATS. Additionally, uniportal VATS is superior to three-portal thoracoscopic surgery in terms of the immediate postoperative short-term QOL.

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

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