Original Article

Effect and feasibility of uniportal thoracoscopic surgery in the treatment of early-stage lung cancer in a primary hospital

Xiaoping Zuo[1#], Guofeng Liu[1#], Xiaochuan Liu[1], Yongjian Feng[1], Haijun Zhang[2]

[1]Department of Thoracic Surgery, Guang'an Hospital, West China Hospital, Sichuan University, Guang'an, China; [2]Department of Thoracic Surgery, Dazhou Central Hospital, Dazhou, China

Contributions: (I) Conception and design: H Zhang; (II) Administrative support: X Liu; (III) Provision of study materials or patients: Y Feng; (IV) Collection and assembly of data: X Zuo; (V) Data analysis and interpretation: G Liu; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Haijun Zhang. Department of Thoracic Surgery, Dazhou Central Hospital, Dazhou, China. Email: 492588955@qq.com.

Background: Thoracoscopic radical lobectomy is a routine procedure for radical surgery of lung cancer. Meanwhile, thoracoscopic surgery has been gradually transformed from assisted small incision and multiport thoracoscopic radical surgery to uniportal thoracoscopic surgery for treatment of early-stage lung cancers. However, there are still controversies regarding the efficacy and feasibility of 2 surgical methods. The purpose of this study is to investigate the effect and feasibility of uniportal thoracoscopic surgery for treatment of early-stage lung cancer in a primary hospital.

Methods: Clinical data of 142 patients with early-stage lung cancer were retrospectively chosen in the period from September 2019 to March 2021 in our hospital and divided into 2 groups: a control group (66 patients) with 3-port thoracoscopic radical surgery and an experimental group (76 patients) with uniportal thoracoscopic radical surgery. The baseline clinical data, perioperative clinical data, and lymph node dissection of 2 groups were compared.

Results: There was no significant difference in baseline general clinical data between 2 groups (P>0.05), and no significant difference in the incidence of postoperative complications, conversion rate, or operation time between 2 groups (P>0.05). The intraoperative blood loss volume, postoperative chest drainage volume, postoperative hospitalization time, and postoperative catheter time of experimental group were significantly lower than those of control group (P<0.05). There was no significant difference in the total number of lymph node dissection stations and lymph node dissections, the number of N2 lymph node dissection stations, or N2 lymph node dissections between 2 groups (P>0.05). There was also no significant difference in the number of left and right lymph node dissection stations between 2 groups (P>0.05).

Conclusions: Compared with 3-port thoracoscopic radical surgery, uniportal thoracoscopic radical surgery in the treatment of patients with early-stage lung cancer provides the same effect of lymph node dissection and has advantages in reducing surgical trauma and accelerating postoperative rehabilitation, popularizing for use in primary hospitals.

Keywords: Uniportal thoracoscopic surgery; early-stage lung cancer; primary hospital; clinical effect; feasibility

Submitted May 04, 2021. Accepted for publication Jul 13, 2021.
doi: 10.21037/tcr-21-1002
View this article at: https://dx.doi.org/10.21037/tcr-21-1002

Introduction

Lung cancer is still one of the most common malignant tumors worldwide, and in China, ranks first in incidence and fatality. As these rates continue to rise, lung cancer increasingly presents a dire threat to the physical and mental health of the population (1). Currently, surgical

treatment is still considered a method to achieve cure. With the development of minimally invasive surgical techniques, thoracoscopic radical lobectomy has become a routine surgical procedure for radical lung cancer surgery, and has gained recognition from researchers worldwide by virtue of its efficacy and safety (2). With the near-constant advancements in imaging technology over the recent years, the detection rate of various early lung cancers has increased, and the concept of rapid recovery has been improved. Numerous clinical studies have indicated that (3,4), the effect of uniportal thoracoscopic surgery for radical resection is similar to that of multiport thoracoscopic surgery, with a more obvious short-term effect. The uniportal thoracoscopic surgery is a kind of complete endoscopic anatomical pulmonary lobotomy with single-hole incision, soft chest support opening the main operating aperture and no rib dissection. However, there are opposing views to this, which suggest that uniportal thoracoscopic surgery has a poor field of visual exposure, that the instruments involved tend to interfere with one another, and that the safety of the operation is inferior to that of conventional multiport thoracoscopic surgery, all of which point to uniportal thoracoscopic surgery being unsuited to extensive development due to its general lack of convenience.

Our hospital is part of the western prefecture-level hospital. After mastering conventional thoracoscopic surgery, we began conducting uniportal thoracoscopic surgery to treat early lung cancer in 2019. In this study, the clinical data of 142 patients with early-stage lung cancer admitted to our hospital from September 2019 to March 2021 were retrospectively analyzed. The perioperative clinical indicators of uniportal thoracoscopic surgery and traditional 3-port thoracoscopic surgery from patients with early-stage lung cancer were compared and analyzed. The aim of our study was to explore the efficacy and the feasibility of uniportal thoracoscopic surgery in the treatment of early-stage lung cancer in primary hospitals. We have evaluated the overall efficacy between uniportal thoracoscopic surgery and multiportal thoracoscopic surgery by a retrospective study, expected to better inform uniportal thoracoscopic surgery for treatment of early-stage lung cancer, further to improve the cure rate of patients with early-stage lung cancer in primary hospitals. We present the following article in accordance with the STROBE reporting checklist (available at https://dx.doi.org/10.21037/tcr-21-1002).

Methods

Clinical data

The clinical data of a total of 142 patients with early-stage lung cancer admitted to our hospital from September 2019 to March 2021 were retrospectively analyzed. Among them, 66 cases underwent 3-port thoracoscopic radical surgery (control group) and 76 cases underwent uniportal thoracoscopic radical surgery (experimental group). The inclusion criteria were the following: (I) the patient was diagnosed with clinical stage I–II lung cancer by postoperative pathological examination; (II) the patient had the required thoracoscopic surgery indications in accordance with the National Comprehensive Cancer Network (NCCN) guidelines; (III) the patient had successfully completed single lobectomy and hilar/mediastinal lymph node dissection; (IV) the patient's age ranged from 18–75 years; and (V) the patient had complete clinical data. The exclusion criteria were the following: (I) the tumor was larger than 5 cm or accompanied by lymph node metastasis; (II) the tumor had invaded adjacent tissues or metastasized at distance; (III) the patient's procedure was converted to thoracotomy; (IV) the patient underwent combined lobectomy or sublobectomy; or (V) the patient was unable to tolerate surgery or refused to accept surgery.

Surgical methods

All selected patients underwent plain chest scan + enhanced computed tomography (CT) for the evaluation of lung lesions before operation. The same preoperative preparations were conducted in the 2 groups, and included general anesthesia and double-lumen endotracheal intubation. The patients were lain and received ventilation on their unaffected side; the observation group underwent uniportal thoracoscopic lobectomy and regional lymph node dissection, and a 3-cm incision was made between the fourth or fifth intercostal space of the anterior axillary line and midaxillary line of the affected side. After the thoracoscope was inserted, the presence of the thoracic adhesion and spreading nodules were evaluated, the locations of the lesions were marked, and the anatomy of the hilum was determined. If the case was considered peripheral lung cancer, wedge resection was first performed. Lobectomy and mediastinal lymph node dissection were performed after it the case was identified with invasive cancer; among the patients treated in this manner, the

arteries of those patients with well-developed lung fissures were prioritized for treatment, and those with poorly developed lobules underwent tunnel-based or one-way resection. The blood vessels with a diameter of less than 5 mm after double ligation were transected by an ultrasonic knife, while the blood vessels with a diameter of more than 5 mm, along with the trachea, and underdeveloped lung fissures, were transected with a linear cutting suture under the endoscope. The right lung cancer was dissected in group 2R, 3A, 3P, 4R, 7–10, and intrapulmonary lymph nodes, and the left lung cancer was dissected in group 4L, 5–10, and intrapulmonary lymph nodes. After the operation, a 26-gauge drainage tube was indwelled into the posterior end of the incision.

The control group was treated with 3-port thoracoscopic radical lobectomy and lymph node dissection, for which the anesthetic method and posture were the same as those in the observation group. A 3-cm-long incision was made in the fourth or fifth intercostal space of the anterior axillary line (the main operating port), and a 1.5-cm-long incision was made in the eighth intercostal space of the midaxillary line (observation port). A 1.5-cm-long incision was made in the seventh intercostal space of the posterior axillary line (auxiliary operation hole). The surgical assistant ensured that the surgical field was exposed through the auxiliary operation port, and that the surgery could be completed by mechanical stapling through the auxiliary operation port if necessary; the other operation methods were performed in the same fashion as that of the observation group, with a 26-gauge tube left in the observation port.

Observation indicators

Observation indicators for this study included the following: (I) Basic clinical data including age, gender, postoperative tumor (pT) stage, postoperative node (pN) stage, postoperative tumor-node-metastasis (TNM) stage, lesion location, histopathological type, degree of pathological differentiation, and underlying diseases; (II) perioperative clinical indicators, including types of postoperative complications, conversion to thoracotomy, intraoperative blood loss, 3D postoperative thoracic drainage, postoperative hospitalization time, and postoperative catheterization time; (III) the type of postoperative complications, including lung infection, atelectasis, arrhythmia, pulmonary air leak, celiac disease, anastomotic leak, secondary surgery, and infection of incision; (IV) the status of lymph node dissection, including the number of lymph node dissection stations, the number of lymph node dissections, the number of N2 lymph node dissection stations, and the number of N2 lymph node dissections.

Statistical processing

The data were processed by SPSS 20.0 software (IBM Corp., Armonk, NY, USA); the comparison of measurement data were performed by t test and are expressed as ($\bar{x}$±s); the comparison of count data was performed by χ^2 test or Fisher's exact probability method, and the data are expressed as percentages; a P value <0.05 indicated that the difference was statistically significant.

Ethical statement

The study design complied with the tenets of the Declaration of Helsinki (as was revised in 2013), and all the patients or their family members provided informed consent. The article is a retrospective study in which only clinical data were collected from patients, and no interventions were made in their treatment. This study is exempt from approval according to the rules and regulations of the ethics committee of Guang'an Hospital affiliation.

Results

Comparison of baseline clinical data levels between the 2 groups

There was no significant difference in the level of baseline clinical data between the 2 groups (P>0.05; *Table 1*).

Comparison of perioperative clinical indicators between the 2 groups

There was no significant difference in the incidence of postoperative complications, conversion rate to thoracotomy, or operation time between the 2 groups (P>0.05); the amount of intraoperative blood loss, postoperative thoracic drainage volume of 3 days, postoperative hospitalization time, and postoperative catheterization time were significantly shorter in the experimental group than in the control group (P<0.05); refer to *Table 2*.

Comparison of lymph node dissections between the 2 groups

There was no significant difference in the number of lymph node dissection stations, the number of lymph node

Table 1 Comparison of baseline clinical data levels between the 2 groups

Index	Experimental group (n=76)	Control group (n=66)	P value
Age (years old)	62.82±4.10	63.44±4.51	0.10
Male (cases)	42	39	0.72
pT stage			0.32
T1a	37	26	
T1b	11	12	
T1c	10	8	
T2a	15	14	
T2b	2	3	
T3	1	3	
pN stage			0.89
N0	58	51	
N1	12	11	
N2	6	4	
pTNM stage			0.65
IA	43	34	
IB	11	9	
IIA	2	3	
IIB	12	12	
IIIA	7	7	
IIIB	1	1	
Lesion location			0.41
Left side	27	27	
Right side	49	39	
Type of histopathology			0.87
Adenocarcinoma	60	52	
Squamous cell carcinoma	7	9	
Adenosquamous carcinoma	3	2	
Others	6	3	
Degree of pathological differentiation			0.95
High	14	12	
Middle	33	28	
Low	29	26	
Combining underlying diseases			0.90
Essential hypertension	12	11	
T2DM	4	5	
Cardiovascular diseases	8	7	
Cerebrovascular disease	10	9	

pT, postoperative tumor stage; pN, postoperative node stage; pTNM, postoperative tumor-node-metastasis (TNM) stage; T2DM, type 2 diabetes mellitus.

Table 2 Comparison of perioperative clinical indicators between the 2 groups

Index	Experimental group (n=76)	Control group (n=66)	P value
Postoperative complications (cases)			
Lung infection	7	6	0.92
Atelectasis	6	6	0.95
Arrhythmia	4	3	0.90
Lung leak	6	4	0.87
Chylothorax	1	0	0.41
Anastomotic leakage	1	1	0.87
Second surgery	1	2	0.75
Incision infection	1	2	0.66
Transition to open chest (example)	2	2	0.88
Intraoperative blood loss (mL)	128.56±48.44	173.20±60.21	0.03
Operation time (min)	131.84±183.21	127.47±165.69	0.51
3D postoperative thoracic drainage volume (mL)	516.73±20.49	580.63±25.05	0.01
Postoperative hospitalization time (d)	5.46±0.64	7.51±1.77	0.00
Postoperative catheterization time (d)	4.13±1.65	7.15±2.39	0.00

dissections, the number of N2 lymph node dissection stations, and the number of N2 lymph node dissections between the 2 groups (P>0.05); there was no statistically significant in the difference in the number of left and right lymph node dissection stations between the 2 groups (P>0.05; *Tables 3-5*).

Discussion

In 2004, Rocco *et al.* (5) first reported the application of uniportal thoracoscopy for lung nodule biopsy. With the emergence of cutting and suture devices with flexible head, separation devices, and the refinement of optical lenses, the application range of uniportal thoracoscopic technology has been gradually expanded to the current resection of almost all lung cancers. Currently, it is believed that uniportal thoracoscopic surgery can be performed on same projection surface of the visual field and of the operation. In these conditions, the preservation of visual depth enables easier determination of the operating distance, improving the accuracy of surgical operation and avoiding the occurrence of accidental injuries, which is crucial to accelerating the postoperative recovery process (6).

The high rate of open-chest surgery in the early and intermediate stage of uniportal thoracoscopic surgery reported in the literature is mainly related to the presence of extensive thoracic adhesions, local tumor invasion, intraoperative hemorrhage, and critical organ tissue structure damage (7). In the early days of our hospital, uniportal thoracoscopic surgeons were able to proficiently perform multiport thoracoscopic surgeries. In the results of this study, there was no statistically significant difference between the 2 groups in conversion to thoracotomy (P>0.05). While patients converted to thoracotomy during uniportal thoracoscopic surgery often occurred within 3 months since the operation was carried. In one study, conversion rates to thoracotomy of uniportal and multiport thoracoscopic lung surgery was reported to be 4% and 2%, respectively, with the conversion to thoracotomy in the uniportal thoracoscopy group being precipitated by tumor invasion (8). Another study retrospectively analyzed the reasons for converting to thoracotomy during uniportal thoracoscopic surgery, among which included pleural adhesions, local tumor invasion, lymph node metastasis or tracheal injury (9), with the authors suggesting that the visual field of uniportal thoracoscopic surgery is equivalent to that of thoracotomy. Meanwhile, the combination of the elbow electric hook can complete most of the thoracic

Table 3 Comparison of lymph node dissections between the 2 groups

Index	Experimental group (n=100)	Control group (n=82)	P value
Number of lymph node dissection stations	6.83±0.71	6.90±0.87	0.70
Number of lymph node dissections	15.89±3.42	16.92±3.68	0.32
Number of N2 lymph node dissection stations	3.18±0.57	3.92±0.53	0.12
Number of N2 lymph node dissections	13.05±2.30	14.20±2.83	0.48

Table 4 Comparison of the number of left lymph node dissection stations of the 2 groups

Numbers of dissection stations	Experimental group (n=27)	Control group (n=26)	P value
4L	16	14	0.84
5	18	15	0.33
6	15	14	0.85
7	26	24	0.29
8	4	4	0.94
9	21	20	0.90
10	27	26	0.64
11	20	18	0.79
12	5	7	0.52
13	0	1	0.48

Table 5 Comparison of the number of right lymph node dissection stations between the 2 groups

Numbers of dissection stations	Experimental group (n=49)	Control group (n=40)	P value
2R	31	26	0.80
4R	17	18	0.24
3	42	33	0.82
7	44	34	0.67
8	6	4	0.61
9	34	28	0.90
10	48	38	0.57
11	33	25	0.64
12	14	15	0.33
13	1	1	0.51

adhesion tissue separation; moreover, as the proficiency of the operation increases, the separation can be managed in good time, even if an accidental injury occurs during uniportal thoracoscopic surgery; however, if the tumor has been confirmed to have locally invaded the pulmonary artery or other important organs in the intraoperative exploration, conversion to thoracotomy should be immediately performed to ensure the safe and successful completion of the operation (10).

The effect of lymph node dissection is one of the important evaluation indicators for the radical cure of lung cancer surgery. Furthermore, it can also be used for postoperative clinical staging and prognostic evaluation (11). Currently, combination of anatomical lobectomy and systemic lymph node dissection is recommended for patients with resectable lung cancer, and relevant international guidelines recommend that N2 lymph node resection should be ≥3 stations (12). The results of this study indicated that there was no significant difference between the 2 groups in the number of lymph node dissection stations, number of N2 lymph node dissection stations, and number of N2 lymph node dissection stations (P>0.05); there was no statistically significant difference in the comparison of the number of left and right lymph node dissection stations between the 2 groups (P>0.05), suggesting that uniportal thoracoscopic surgery for early-stage lung cancer can achieve similar lymph node dissection results as those of 3-port thoracoscopic surgery; furthermore, the range of removal met the requirements of relevant guidelines. For N2 lymph node dissection, the number of lymph node dissection stations were all >3 stations in the 2 groups, which was consistent with the safety and efficiency results of uniportal thoracoscopic surgery reported by other researchers in lymph node dissection in patients with lung cancer (13). Another report suggests that the clinical effect of uniportal thoracic surgery is inferior to that of multiport thoracoscopy, due to learning curve factors in the earlier implementation of uniportal thoracoscopic surgery; however, as the proficiency of surgeons improves, the clinical effect of uniportal thoracoscopic lymph node dissection is gradually approaching that of multiport thoracoscopy (14). We have summarized our clinical experiences and believe that ensuring reasonable placement of medical devices and adequate local exposure during uniportal thoracoscopy is essential to improving the effect of lymph node dissection; therefore, the thoracoscopic lens should always be located at the upper edge of the incision during the operation, and the traction exposure forceps should be at the lower edge of the incision. We further recommend that surgeons should complete all necessary lymph node dissections by applying relevant instruments in the central area of the incision.

Studies relevant to this subject indicate that the lymph node metastasis of primary lung cancer patients with lung disease in different lobes show a regular pattern in which mediastinal lymph node metastasis of the left lung cancer mostly occurs in the 4L and 5–7 groups of lymph nodes, as well as the hilar and intrapulmonary lymph nodes, while the metastasis of right lung cancer can mainly be observed in the 2R, 4R, and 7 groups of lymph nodes, as well as the hilar and intrapulmonary lymph nodes; therefore, in clinical practice, intraoperative lymph node dissection for right lung cancer should include 2R, 4R and the 7–10 groups of lymph nodes, while left lung cancer should include the 2L and 4L–10L groups of lymph nodes (15,16). The results of this study indicated that there was no statistically significant difference in the number of left and right lymph node dissection stations between the 2 groups (P>0.05), which further confirmed that uniportal thoracoscopy in the treatment of early-state lung cancer lymph node dissection is similar to that of multiportal thoracoscopy. For uniportal thoracoscopic lymph node dissection, our clinical experiences indicate the following: (I) lymphadenectomy should be conducted as far as possible along the adventitia of the lymph node. If it is a regional lymph node group, this will ensure a group resection in lymphadenectomy and avoid or reduce the impact of intraoperative bleeding on the visual field of surgery. (II) During lymphadenectomy on the group 2 and 4 of lymph nodes on the right side, the space between the lymph nodes and the anterior wall of the trachea should be opened from the azygos vein posterior, the space between the superior vena cava and the lymph nodes should then be fully separated, and the superior mediastinal pleura should be opened. Finally, lymphadenectomy of group 2 and 4 lymph nodes in the superior mediastinum should be completed in one piece. (III) During the lymphadenectomy of group 7 lymph node, the mediastinal pleura from the lower lung ligament should be opened first, and then the space between the esophagus and lymph nodes as well as the space between the pericardium and lymph nodes should be separated in turn. Finally, the total resection of all group 7 lymph nodes should be completed with the angle between the left and right main bronchus.

There are certain limitations in this study that should be addressed. First, our study was single-center and retrospective in design, and the included sample size was

relatively small. Therefore, the influence of confounding factors cannot be completely ruled out. Second, the follow-up time was short, and there was a lack of long-term prognostic assessment data, so further confirmation is still needed from studies with a longer follow-up period. There are also some limitations of uniportal thoracoscopic radical surgery. First, the uniportal thoracoscopic radical surgery has a poor visual field for the lesions on the dorsal side or near the diaphragm, which brings great difficulty to the surgeons to resect the dorsal and diaphragmatic lesions and increases the operation time. Second, for the uniportal thoracoscopic radical surgery, it is difficult to deal with severe adhesion or intraoperative bleeding intraoperatively. With the development of medical technology, we hope the limitations of the uniportal thoracoscopic radical surgery can be improved one day.

In conclusion, compared with 3-port thoracoscopic radical surgery, the uniportal thoracoscopic radical surgery can achieve the same lymph node dissection effect for treatment of early-stage lung cancer without increasing the conversion rate of thoracotomy. Meanwhile, it has the advantages of reducing surgical trauma and accelerating postoperative recovery, which can be promoted in primary hospitals with a certain foundation of thoracoscopic surgery.

Acknowledgments

Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://dx.doi.org/10.21037/tcr-21-1002

Data Sharing Statement: Available at https://dx.doi.org/10.21037/tcr-21-1002

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/tcr-21-1002). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study design complied with the tenets of the Declaration of Helsinki (as was revised in 2013) , and all the patients or their family members provided informed consent. The article is a retrospective study in which only clinical data were collected from patients, and no interventions were made in their treatment. This study is exempt from approval according to the rules and regulations of the ethics committee of Guang'an Hospital.

References

1. Thomas PA, Couderc AL, Boulate D, et al. Early-stage non-small cell lung cancer beyond life expectancy: Still not too old for surgery? Lung Cancer 2021;152:86-93.
2. Han D, Cao Y, Wu H, et al. Uniportal video-assisted thoracic surgery for the treatment of lung cancer: a consensus report from Chinese Society for Thoracic and Cardiovascular Surgery (CSTCVS) and Chinese Association of Thoracic Surgeons (CATS). Transl Lung Cancer Res 2020;9:971-87.
3. Batihan G, Ceylan KC, Usluer O, et al. Video-Assisted Thoracoscopic Surgery vs Thoracotomy for Non-Small Cell Lung Cancer Greater Than 5 cm: Is VATS a feasible approach for large tumors? J Cardiothorac Surg 2020;15:261-7.
4. Jiang Y, Su Z, Liang H, et al. Video-assisted thoracoscopy for lung cancer: who is the future of thoracic surgery? J Thorac Dis 2020;12:4427-33.
5. Rocco G, Martin-Ucar A, Passera E. Uniportal VATS wedge pulmonary resections, Ann Thorac Surg 2004;77:726-8.
6. Yan Y, Huang Q, Han H, et al. Uniportal versus multiportal video-assisted thoracoscopic anatomical resection for NSCLC: a meta-analysis. J Cardiothorac Surg 2020;15:238-44.
7. Dai L, Jiang L, Gu Y, et al. Modified double lumen tube for a unique bronchial and carinal resection in a patient undergoing uniportal VATS for tumour: A case report. Transl Cancer Res 2020;9:2077-81.

8. Tsou KC, Hsu HH, Tsai TM, et al. Clinical outcome of subcentimeter non-small cell lung cancer after VATS resection: Single institute experience with 424 patients. J Formos Med Assoc 2020;119:399-405.
9. Moon Y. Initial experience with uniportal video-assisted thoracoscopic surgery for the treatment of lung cancer performed by a surgeon who did not have previous experience performing multiportal thoracoscopic surgery: a single center retrospective study. J Thorac Dis 2020;12:1972-81.
10. Bulgarelli Maqueda L, García-Pérez A, Minasyan A, et al. Uniportal VATS for non-small cell lung cancer. Gen Thorac Cardiovasc Surg 2020;68:707-15.
11. Kneuertz PJ, Cheufou DH, D'Souza DM, et al. Propensity-score adjusted comparison of pathologic nodal upstaging by robotic, video-assisted thoracoscopic, and open lobectomy for non-small cell lung cancer. J Thorac Cardiovasc Surg 2019;158:1457-1466.e2.
12. Federici S, Gonzalez M. Uniportal video-assisted thoracoscopic right upper sleeve lobectomy. Multimed Man Cardiothorac Surg 2019. doi: 10.1510/mmcts.2019.043.
13. Venkitaraman B, Lei J, Liang W, et al. Uniportal video-assisted thoracoscopy surgery in lung cancer: largest experience. Asian Cardiovasc Thorac Ann 2019;27:559-64.
14. Sier R, Onugha O. Review of Procedures and Outcomes of Video-Assisted Thoracic Surgery for the Treatment of Non-Small Cell Lung Cancer in 45 Patients Undergoing Segmentectomy. Surg Technol Int 2020;36:245-50.
15. Zeng W, Zhang W, Zhang J, et al. Systematic review and meta-analysis of video-assisted thoracoscopic surgery segmentectomy versus lobectomy for stage I non-small cell lung cancer. World J Surg Oncol 2020;18:44-50.
16. Bongiolatti S, Gonfiotti A, Vokrri E, et al. Thoracoscopic lobectomy for non-small-cell lung cancer in patients with impaired pulmonary function: analysis from a national database. Interact Cardiovasc Thorac Surg 2020;30:803-11.

(English Language Editor: J. Gray)

Cite this article as: Zuo X, Liu G, Liu X, Feng Y, Zhang H. Effect and feasibility of uniportal thoracoscopic surgery in the treatment of early-stage lung cancer in a primary hospital. Transl Cancer Res 2021;10(7):3507-3515. doi: 10.21037/tcr-21-1002

