Am J Cancer Res 2023;13(11):5138-5150
www.ajcr.us /ISSN:2156-6976/ajcr0150539

Original Article

Clinical therapeutic effects and prognosis of video-assisted thoracoscopic surgery-guided pulmonary lobectomy combined with mediastinal lymph node dissection in lung carcinoma

Guangchao Lv, Shiyun Feng, Yan Zhang, Yang Li, Youbin Cui

Second Department of Thoracic Surgery, The First Hospital of Jilin University, Changchun, Jilin, China

Received April 4, 2023; Accepted September 18, 2023; Epub November 15, 2023; Published November 30, 2023

Abstract: We investigated the clinical therapeutic effects and prognosis of video-assisted thoracoscopic surgery (VATS) in mediastinal lymph node dissection of lung carcinoma. A total of 312 patients were divided into high-risk and conventional risk groups according to the severity of the disease. High-risk group (n=137) received thoracoscope-guided anatomical pulmonary segmentectomy and systematic lymph node dissection as well as conventional risk group (n=175) received thoracoscope-guided pulmonary lobectomy and systematic lymph node dissection. The results revealed that there are significant differences in age, gender, location, lymph node resection methods, and histological classification in the two groups ($P<0.05$). Moreover, in comparison with the high-risk group, T stage was higher in the conventional group and showed significant statistical significance ($P<0.01$). The analysis of independent risk factors of the above differences showed that T staging and histological classification showed high-risk coefficients for lymph node dissection. The risk coefficient was increased with patients' age. The 5-year survival rate, disease-free survival, and postoperative recurrence rate of the patients in the two groups all indicated no obvious statistical differences. Consequently, thoracoscope-guided lymph node dissection could enhance the detection rate of lymph node metastasis. For the adenocarcinoma (AD) patients with T staging greater than T1, lymph node dissection could provide more accurate pathological staging. Anatomical pulmonary segmentectomy combined with systematic lymph node dissection should be applied in the treatment of elderly, high-risk, and advanced stage (prothrombin time (PT) state >2 cm, ≤3 cm) patients with non-small cell lung carcinoma (NSCLC). Taken together,thoracoscope-guided lymph node dissection could improve the detection rate of lymph node metastasis. In this case, the complete resection of lesions could be ensured. Besides, normal pulmonary tissues were preserved to the maximum extent with minimal trauma, safety, fast postoperative recovery, and definite long-term therapeutic effects.

Keywords: Therapeutic effects, video-assisted thoracoscopic, pulmonary lobectomy, mediastinal lymph node, lung carcinoma

Introduction

It is estimated that the annual number of patients with lung carcinoma in China will reach 100,000 by 2025. In the U.S., there are 174,000 new cases and 160,000 deaths caused by lung carcinoma each year. In contrast, the 5-year survival rate amount to only about 15%. The low survival rate of Chinese patients with lung carcinoma is closely associated with clinical treatment characteristics, such as late emergence, early transformation, and poor curative effect [1-3]. In general, the current diagnostic methods for lung carcinoma include postoperative treatment, chemotherapy, radiotherapy, interventional therapy, ablation, freezing, small molecule targeted treatment, immunotherapy, and Chinese medicine [4-6]. Since the early 1930s, clinical surgical medicine is still the first choice for the diagnostic method of lung carcinoma in the early and middle stages in China. In principle, modern surgical treatment for lung carcinoma still emphasizes surgical resection as early as possible. However, chemotherapy or radiotherapy can be performed firstly for lung carcinoma patients

with delayed staging. Alternatively, the combined new adjuvant chemotherapy, radiotherapy, immunology, and targeted treatment are carried out after some patients are performed surgical enucleation [7-9]. Nonetheless, it is proposed by many thoracic surgeons over a long period that thoracoscope-guided pulmonary lobe enucleation leads to a low safety coefficient with the complex operation. In addition, systemic lymphatic flushing can't be completed. Consequently, the technique is not disseminated rapidly and widely [10-13]. After the continuous progress in human thoracoscopic technique and the innovation of postoperative devices for over 20 years, the existing modern thoracoscopic minimally invasive thoracic surgery department is gradually established. It possesses two main characteristics. I) The first one is the minor injury of the functions of each organ after the surgery. II) The second one is the postoperative incision smaller than that caused by traditional thoracotomy [14-16].

On the other hand, a large number of data indicate that thoracoscope-guided pulmonary lobectomy causes little injury with low complexity of the disease and fast recovery. Besides, the comparison of cleanliness of flushing of lymph glands, tumor recurrence rate, and long-term activity between thoracoscope-guided pulmonary lobectomy and conventional thoracotomy pulmonary lobectomy showed no notable statistical differences [17-19]. In terms of thoracoscopic minimally invasive treatment for patients with lung carcinoma [20-22].

However, the adjuvant three-dimensional (3D) endoscope was used after blood, lymph nodes, and ligaments were treated in areas where small incisions were unavailable.

For elderly people and non-small cell lung carcinoma (NSCLC) patients with high postoperative risk, it was necessary to minimize the harm to them, realize faster postoperative recovery, and achieve the optimal clinical therapeutic effects with the best treatment methods. Hence, the scientific research work was specially designed. It was believed that thoracoscope-guided pulmonary segmentectomy with systematic (N1, N2) lymph node dissection could realize the 5-year survival rate same as that of traditional pulmonary lobectomy among some aged patients intolerant of extensive pulmonary lobectomy. The proposed objectives of this scientific research work were as follows. The efficiency, stability, and long-term therapeutic effects of thoracoscope-guided anatomical pulmonary seg-enucleation combined with lymph node dissection of operating system in elderly people and high-risk as well as advanced stage (3 cm ≥ prothrombin state (PT) >2 cm) NSCLC patients were investigated and evaluated. Based on the 70 edition of tumor lymph node metastasis (TNM) staging criteria of lung carcinoma formulated by IASSIC, the relevant studies on some key factors that could correctly evaluate the prognosis of NSCLC patients were carried out.

The major contribution of this paper is given below: (i) In this paper the researchers have analyzed the clinical therapeutic effects and prognosis of video-assisted thoracoscopic surgery (VATS) in mediastinal lymph node dissection. (ii) A total of 312 patients with video-assisted thoracoscopic surgery (VATS)-guided pulmonary lobectomy or anatomical pulmonary segmentectomy for the treatment of lung carcinoma were selected. (iii) In the high-risk group received thoracoscope-guided anatomical pulmonary segmentectomy and systematic lymph node dissection. In a conventional risk, the group received thoracoscope-guided pulmonary lobectomy and systematic lymph node dissection. (iv) Lesion positioning methods, conventional methods of pulmonary lobectomy, anatomical pulmonary segmentectomy methods, lung segment treatment methods, and statistical analysis are discussed. (v) Research in this study showed that thoracoscope-guided lymph node dissection could improve the detection rate of lymph node metastasis.

The outline of this paper is given below: In section 1, general information about patients is collected and classified into a high-risk group and a conventional risk group. The high-risk group referred to patients who had a higher surgical risk and require closer monitoring and treatment, as it had not yet been proven that surgery had absolute safety. The conventional group referred to patients receiving routine postoperative care. Pathological classification and staging are discussed for different patients. Different methods for the treatment of patients are discussed that includes, including lesion positioning methods, conventional methods of pulmonary lobectomy, anatomical pul-

Table 1. Inclusion criteria and exclusion criteria of research objects

Serial number	Inclusion criteria
1	Diagnosed with clinical I-III a stage NSCLC before the operation
2	Preoperative clinical staging of all patients was non-N2 patients
3	Clear pathological results were obtained after surgical resection
	Exclusion criteria
1	Patients receiving chemotherapy and radiotherapy before the operation
2	Patients with incomplete medical records
3	Patients whose two lobes and whole lungs were dissected

monary segmentectomy methods, lung segment treatment methods, and statistical analysis are discussed. In section 2, the general data of patients obtained in different groups are discussed. Gender comparison, comparison of ages, location of lesions, and the period between two groups are discussed. The data on pulmonary lobes and histological classification of lymph node dissection among the patients in the two groups is collected. The postoperative complication is evaluated. In section 3, anatomical pulmonary segmentectomy in a high-risk group and pulmonary lobectomy in a conventional group are discussed in detail.

In the end, it is concluded that thoracoscope-guided lymph node dissection could improve the detection rate of lymph node metastasis. For lung AD patients with T staging greater than T1 or with micro-papilla or solid components, lymph node dissection could offer more accurate pathological staging.

Methods

Research objects

All patients who underwent video-assisted thoracoscopic surgery (VATS) guided lung lobectomy or anatomical pulmonary segmentectomy for the treatment of lung carcinoma between August 2020 and December 2021 were selected for statistical analysis. All the patients were diagnosed with NSCLC and IB stage (3 cm≥ PT state >2 cm) by postoperative pathological examination or preoperative puncture biopsy. According to the severity of the disease, 312 patients were divided into high-risk group and conventional risk groups. A total of 137 cases in the high-risk group received thoracoscope-guided anatomical pulmonary segmentectomy and systematic lymph node dissection. A total of 175 patients in the conventional risk group received thoracoscope-guided pulmonary lobectomy and systematic lymph node dissection.

Inclusion criteria: Patients included for treatment are: i) diagnosed with clinical I-III a stage NSCLC before the operation, ii) preoperative clinical staging of all patients was non-N2 patients, iii) clear pathological results were obtained after surgical resection (**Table 1**).

Exclusion criteria: i) Patients receiving chemotherapy and radiotherapy before the operation, ii) Patients with incomplete medical records, iii) Patients whose two lobes and whole lungs were dissected (**Table 1**).

Pathological classification and staging

Pathological types were classified according to the 2004 edition World Health Organization (WHO) lung carcinoma classification. Lung adenocarcinoma (AD) was classified according to the new multidisciplinary classification of lung AD released by the International Association for the Study of Lung Cancer (IASLC), American Thoracic Society (ATS), and European Respiratory Society (ERS) in 2011. Pathological staging was staged according to the 7th edition 2009 IASLC (**Figure 1**).

Lesion positioning methods

Before the operation, the Hookwire hook was used for positioning under the guidance of computed tomography (CT). Methylene blue was injected into the lesions. Alternatively, it was injected into the blue spots around the lesions under a magnetically guided trichoscopy. Besides, medical adhesive was injected around the lesions. After that, local “whip areas” hardened by the injection of medical adhesive were dissected during the operation.

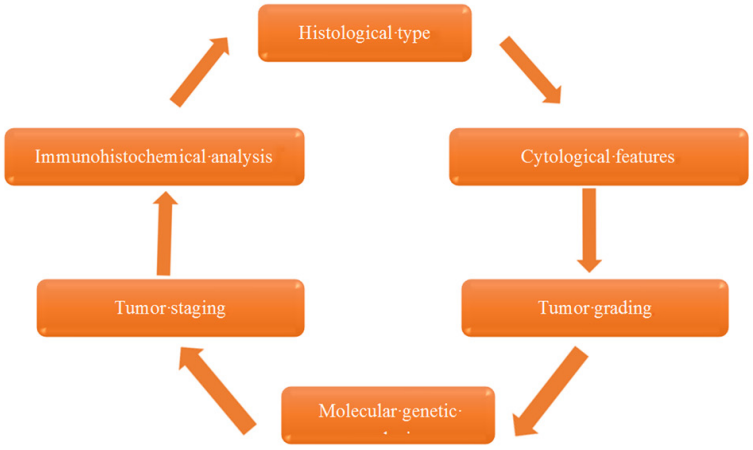

Figure 1. Pathological classification and staging criteria.

Before the operation, CT data were used for 3D reconstruction to determine the specific pulmonary segmentation positions of nodules. As a result, target pulmonary segments could be dissected immediately during the operation (**Figure 2**).

Conventional methods of pulmonary lobectomy

VATS-pulmonary lobectomy technique was the same as the surgical methods introduced by Shigemura et al. The anesthesia method was general anesthesia therapy with double chamber air intubation. The surgical processes were as follows. The operation was performed under a pure video-assisted thoracoscope rather than a breast wall-aided small slot. Postoperative incision size ranged from 3 cm to 5 cm with an average of 3.5 cm. All postoperative steps, including released pulmonary adhesion, pulmonary crack separation, general lymphatic flushing, bronchial treatment, and the dissection, ligation, and anastomosis of pulmonary capillaries, must be carried out under a stomatoscope. However, postoperative incisions couldn't be enlarged with a rib retractor during the entire postoperative procedure.

Anatomical pulmonary seg-mentectomy methods

General anesthesia was adopted. The two chambers in the trachea were inserted with tubes and a single lung was ventilated. Patients were instructed to take a side-lying position and place a pillow under their arms. Postoperative treatment bed or knife site was changed. During the treatment, the incision type should be selected according to the difficulty of the disease and the actual situations of the patients, it was suggested to select 1 to 3 incisions. The observation hole was usually located in the 7th intercostal space of the anterior axillary with a length of 1.5 cm. The septal muscle level among those with higher body mass index (BMI) was usually high. The observation hole could be extended to the intercostal spaces 6 to 8 by chest anteroposterior check. The main operation hole was usually set at the 4th or 5th intercostal space of the anterior axillary with a length of 3 to 5 cm (adjusted appropriately according to the depth of the thoracic cavity and tumor location). The secondary operation hole could be selected according to the surgeon's habit. In most cases, the incision with the length of 1.5 cm at the 7th, 8th, and 9th intercostal spaces in the posterior axillary line was selected, and the selected incision was in the same intercostal space with the observation hole (**Figure 3**).

The surgical processes of the dissection were as follows. According to the development of various pulmonary fissures in each pulmonary segment, the order of bronchi, artery, and vein of the pulmonary segment is also different. During the surgical process, the intersegmental level at the pulmonary hilum was firstly determined according to the direction of the pulmonary segment and vein. Next, pressure ventilation, low air pressure, and low-tide flow lung dilation were performed according to the anatomical direction and ventilation of lung segment and bronchi as well as the cooperation with anesthesiologists. After that, the boundaries of lung segments were determined. The diagnosis was carried out based mainly on the lung aeration process and collapse limit. In addition, many other methods were adopted to diagnose the boundaries of lung segments, as illustrated below. From the horizontal level of lung segments to the pulmonary hilum, the vertical incision stitching instrument was utilized when there was no clear anatomical mark after

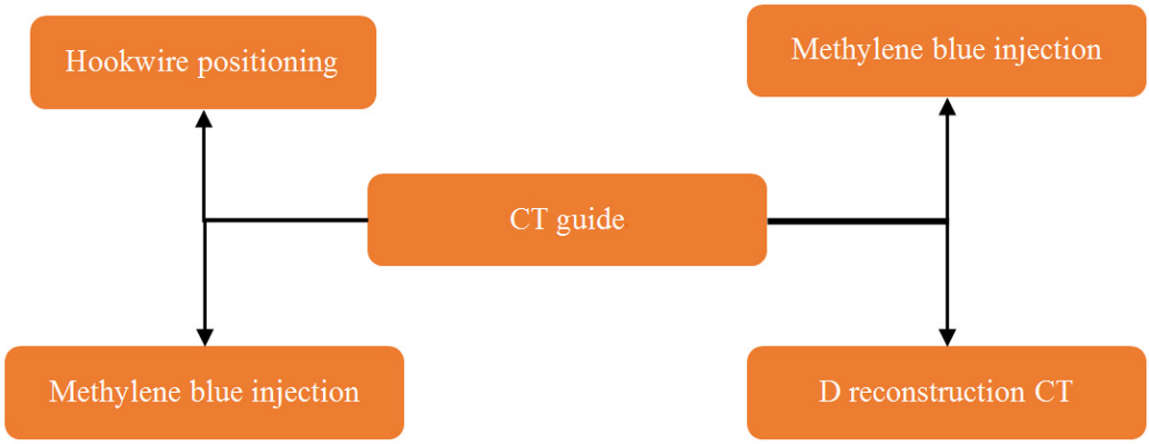

Figure 2. Structure of lesion positioning method.

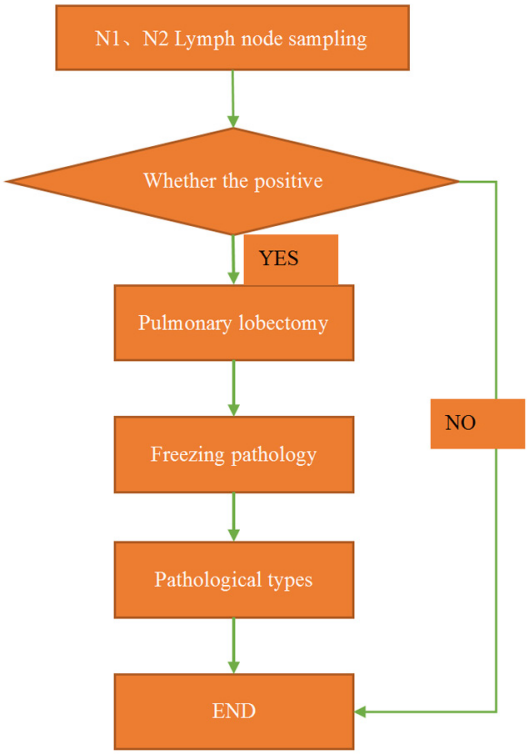

Figure 3. Brief procedures of anatomical pulmonary segmentectomy.

the dissection and separation by an electric hook or ultrasonic knife. In terms of the problem of surgical margin, it was necessary to ensure that the distance from the surgical incisal margin to the tumor was equal to or longer than 2 cm. If necessary, some adjacent lung segments and tissues could be removed. If the removal of systemic lymph nodes was completed (N1, N2), the number of the removed lymph nodes and groups was that by traditional pulmonary lobectomy. In terms of the lymph nodes between segments and between pulmonary lobes, sampling and frozen pathological examination must be completed at the same time in the operation.

Lung segment treatment methods

A. The anatomical bases of pulmonary segmentectomy were as follows. a. Lung segments contained the branches of pulmonary segmental bronchi and their associated lung tissues. b. The right lung contained 10 segments, and the left one consisted of 8 segments. c. Each lung segment contained its blood supply system and bronchi distribution, while the other two lung segments shared the same vein.

B. The anatomical technique of pulmonary segmentectomy was as follows. Each lung segment contained a relatively separate set of functional units, its blood supply system, and bronchiole branches. Dissection and excision techniques were effective in necropsy surgery.

C. The sequence of pulmonary segmentectomy was as follows. Similar to conventional thoracoscope-guided pulmonary lobectomy, the anatomic operation was performed from pulmonary root blood vessels distally. After the blood supply of each lung segment was determined, pulmonary veins were treated at first. Next, pulmonary coronary arteries and bronchi were treated. Finally, all lung tissues were dissected according to the scope of lung segments. In some cases, pulmonary veins might be treated together with lung tissues.

D. The questions about the postoperative approach to lung segment dissection were as follows. During the root of the lung, segments were dissected, and the anatomical operation might be proceeded step by step from one direction or different positions because of the difficulty of postoperative operation. After that, the anatomy occurred in deeper positions to dissect and expose the tissue structures and boundaries of each layer in lung segments successively. Besides, the postoperative approach was selected for various lung segments and actual situations without fixed positions. The final goal was to facilitate postoperative operation to reduce postoperative time. According to people's experience, the anatomy of dorsal and lingual segments of double lower lobes was relatively stable with little change. Consequently, excision was convenient. During the actual postoperative operation, the commonest pulmonary segmentectomy is left lingual segmentectomy and bilateral lower dorsal segmentectomy. The second most commonest one is left inherent upper lobectomy and basal segmentectomy. Anterior and posterior left upper lobectomy is rarely utilized, but it is still technically effective. Nevertheless, single basal segment resection of the upper and lower lobes is relatively seldom applied.

Statistical analysis

An excel data sheet was created to input into patient data. SPSS 25.0 software was employed to conduct the statistical analysis of data. All measurement data were denoted by mean ± standard deviation. The means between multiple groups were compared by least significant difference (LSD) in the one-factor analysis of variance. $P<0.05$ indicated that the differences revealed statistical differences. t-test or Z test was adopted. Enumeration data were tested by aptitude test or Fisher accurate probability test. Influencing factors were analyzed by logistic regression analysis. Odds ratio (OR) values and 95% confidence interval (CI) were calculated and all test levels were a=0.05.

Results

General data

A total of 312 patients were included in the research and performed thoracoscope-guided pulmonary lobectomy and systematic lymph node dissection or sampling. According to the severity of the disease, they were divided into a high-risk group (G1) and a conventional group (G2). A total of 137 cases in the high-risk group received thoracoscope-guided anatomical pulmonary segmentectomy and systematic lymph node dissection. A total of 175 patients in the conventional risk group received thoracoscope-guided pulmonary lobectomy and systematic lymph node dissection. In the high-risk group, the number of male patients (73 cases) was larger than that of female patients (64 cases). In contrast, the number of female patients (92 cases) was larger than that of male patients (83 cases) in the conventional group. The differences indicated statistical meaning ($P< 0.05$). The average age of the patients in the high-risk group reached 60.8±10.3, and that in the conventional group amounted to 58.9± 10.1. The proportion of the right lesions among the patients in the two groups was relatively higher, and the differences showed statistical meaning ($P<0.05$). In contrast to that in the high-risk group, T staging in the conventional group was superior, and the differences demonstrated notable statistical meaning ($P<0.01$) (**Figure 4**).

Comparison of position of pulmonary lobes and histological classification

The data on pulmonary lobes and histological classification of lymph node dissection among the patients in the two groups were collected. In the high-risk group, the proportion of the right upper lobe (RUL) was the highest (51 cases, 37.2%) and that of the right middle lobe (RML) was the lowest (10 cases, 7.3%) among RUL, RML, right lower lobe (RLL), left upper lobe (LUL) and left lower lobe (LLL). The proportions of RUL and RML in the conventional group were also the highest (67 cases, 38.3%) and the lowest (17 cases, 9.7%), respectively. In terms of tissue credit type, the proportion of AD in the high-risk group was very high (108 cases, 78.8%), while that of squamous cell carcinoma (SQ) was low (19 cases, 13.9%). The proportion of the rest of the other types was 7.3% (10 cases). The tissue credit type in the conventional group was similar to that in the high-risk group (**Figure 5**).

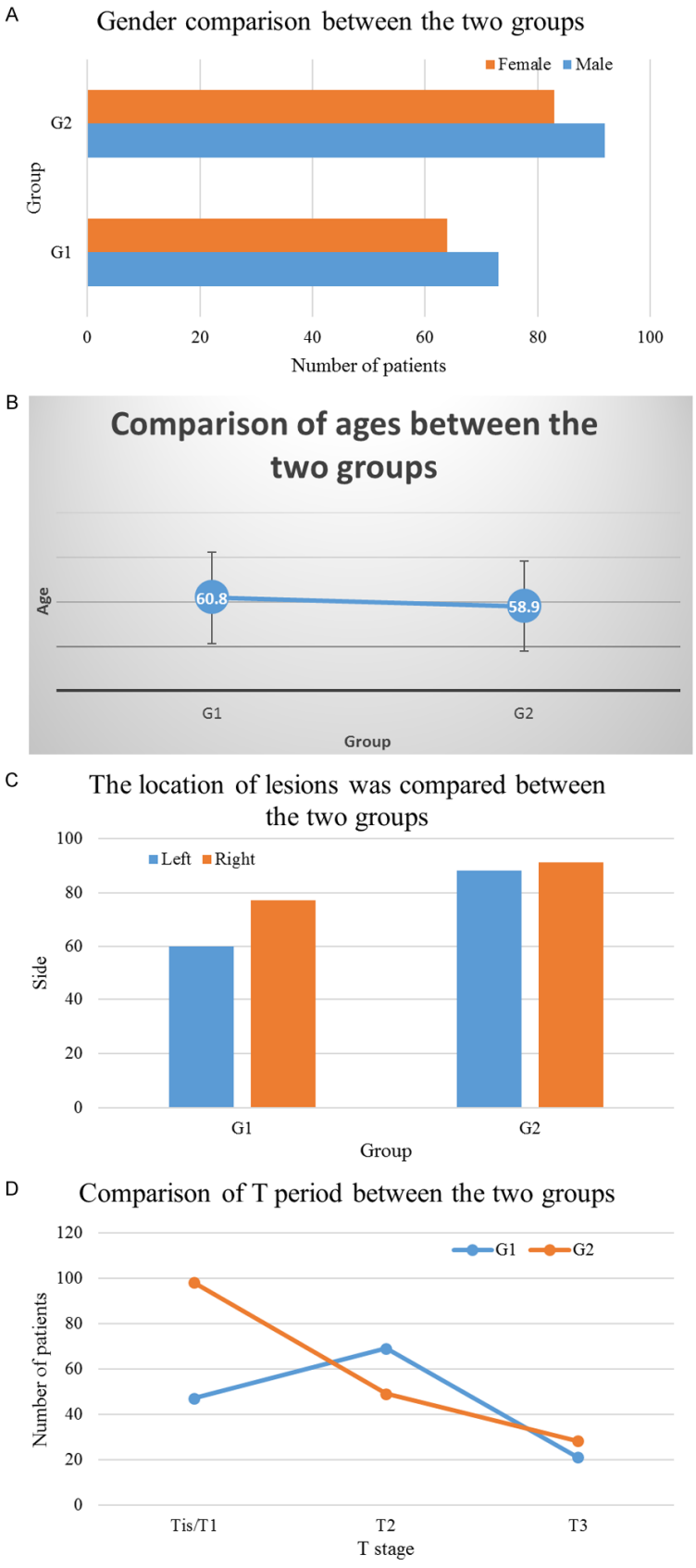

Figure 4. Comparison of general data on patients. A. Showed the gender comparison between the two groups. B. Displayed the comparison of ages between the two groups. C. Presented the comparison of the location of lesions between the two groups. D. Illustrated the comparison of the T period between the two groups. * indicated that the differences demonstrated statistical meaning (P<0.05). ** suggested that the differences showed remarkable meaning (P<0.01).

Analysis of risk factors of lymph node metastasis

The relevant factors with *P* values less than 0.1 (gender, age, position, T staging, and lymph node resection methods) were included for further analysis. T staging was a categorical variable. According to the above results, the proportion of the emergence of G1 lymph node metastasis at the Tis/T1 stage was the lowest. Hence, Tis/T1 stage was selected as the reference variable. The multivariate analysis demonstrated that tumor T staging and lymph node dissection were the independent risk factors of all lung carcinoma combined with G1 lymph node metastasis (the factors with OR greater than 1 were called risk factors, and those with OR less than 1 were called protective factors) (**Figure 6**).

In T staging, the proportion of the emergence of G1 lymph node metastasis in the Tis/T1 group was the lowest. After the patients participating in the experiment were tracked and visited, the proportion of GI lymph node metastasis in cancer patients with different histological subtypes was recorded and sorted out. Hence, it was set as the reference variable. Among the subtypes of histological classification, the proportions of the emergence of GI lymph node metastasis among atypical adenomatous hyperplasia (AAH), adenocarci-

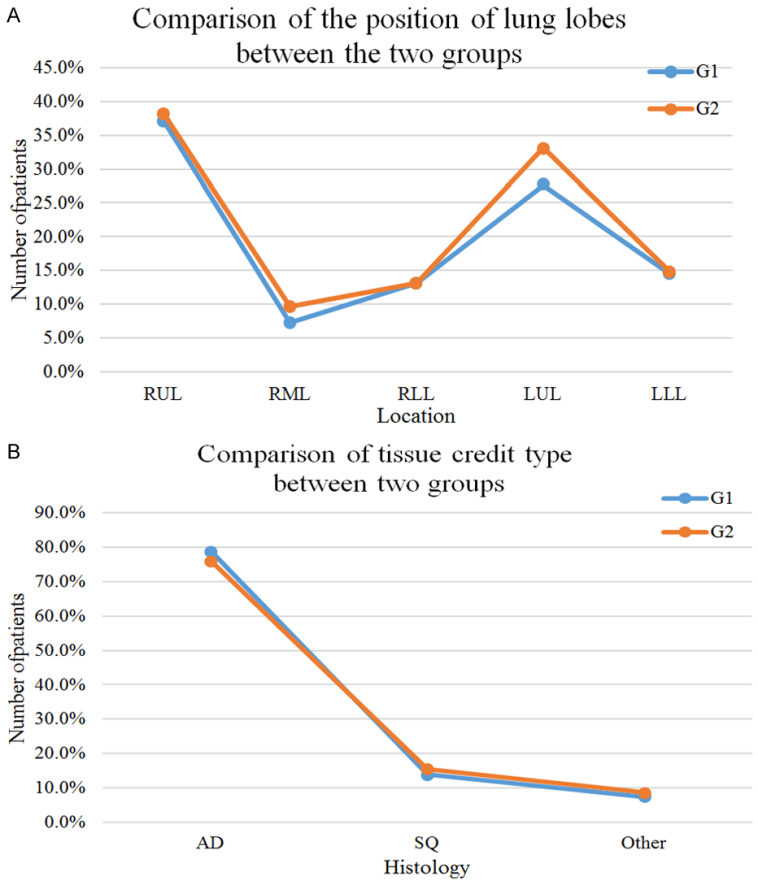

Figure 5. Comparison of the position of lung lobes and tissue credit type. A. Showed the comparison of the position of lung lobes between the two groups. B. Displayed the comparison of tissue credit type between the two groups.

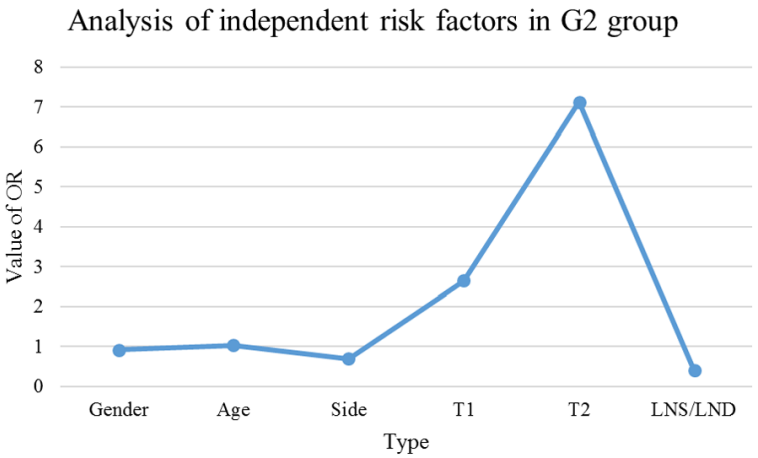

Figure 6. Analysis of independent risk factors of the patients in the G2 group. * indicated that the differences suggested statistical meaning (P<0.05). ** revealed that the differences demonstrated remarkable meaning (P<0.01).

noma in situ (AIS), micro-invasive adenocarcinoma (MIA), LPA, APA, and PPA were the lowest, and the differences demonstrated evident statistical meaning (P<0.01) (**Figure 7**).

The result of histological classification was set as the reference variable. According to the multivariate analysis, the invasive AD and lymph node dissection with micro-papilla and solid components in T staging and lung AD cells were the independent risk factors of all lung AD combined with G2 lymph node metastasis (**Figure 8**).

Evaluation of adverse prognosis after surgery

There were no intraoperative or postoperative deaths during the operation. Thoracic duct retention time, 1, 2, 3, 4, and 5-year survival rate, postoperative recurrence rate, and postoperative complication (air leak, atrial fibrillation, serious drainage, pneumonia, subcutaneous emphysema, empyema, myocardial infarction, and stomal leak) were recorded and analyzed in detail, as demonstrated in **Figure 9** below. The 5-year survival rate, disease-free survival, and postoperative recurrence rate among the patients in the two groups all revealed no obvious statistical differences (P>0.05). The 5-year survival rate of patients with stage I lung cancer after surgery was 76% to 94%. The 5-year survival rate of patients with stage I to III lung cancer after surgery was similar to that of traditional thoracotomy, slightly better than traditional thoracotomy, indicating that video-assisted thoracoscopic surgery had better therapeutic effects than traditional thoracotomy (**Figure 9**).

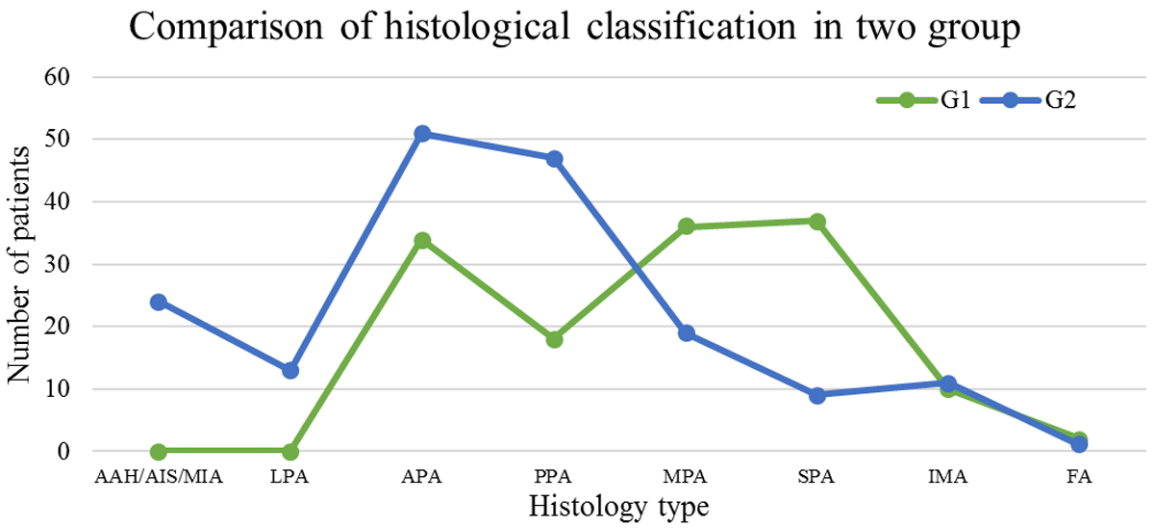

Figure 7. Comparison of histological classification between the two groups. * indicated that the differences suggested statistical meaning (P<0.05). ** demonstrated that the differences revealed significant meaning (P<0.01).

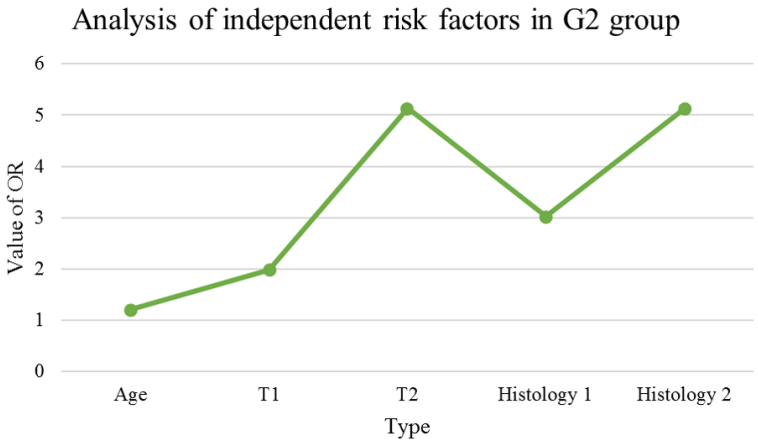

Figure 8. Analysis of independent risk factors of histological classification among patients in the G2 group. * indicated that the differences suggested statistical meaning (P<0.05). ** demonstrated that the difference revealed dramatic meaning (P<0.01).

Discussion

According to Pneumonia and Global TNM Staging Criteria 2013 released by Union for International Cancer Control (UICC), pneumonia was divided into different stages from 0 to iv. Stage 0 is carcinoma in situ, while stage iv is pneumonia with long-distance movement. NSCLC patients at stages IA, IB, IIA, and IIB are treated mainly with surgical medicine. 50% to 80% of the patients can survive for 5 years [23-25]. Among the cases with NSCLC, about 40% of the patients are at stages IIIA and IIIB when the disease is detected. Although the lesions at the stage become severe, the lesions still aggregate in the thoracic cavity without distant metastasis. Consequently, the feasibility of surgical operation on patients with small cell lung carcinoma varies from stage to stage. There is an opportunity of selecting surgical treatment for NSCLC patients at stage IIIA, but the risk of recurrence is extremely high and the 5-year survival rate reaches only 10% to 30% [26-28]. The majority of NSCLC patients at stage IIIB are advised not to select surgical treatment. Instead, they need to receive second adjuvant radiotherapy and chemotherapy. After the cancer reduction period, surgical therapy can be reconsidered. Therefore, NSCLC patients at stage III are often treated with individual comprehensive methods, including surgical treatment, radiotherapy, intraoperative supporting chemotherapy, postoperative chemotherapy, and various combination therapies. Because the lesions of NSCLC patients at stage iv move for a long distance, radical surgical excision can't be performed. In this case, adjuvant chemotherapeutic and radiotherapeutic patient ablation, cystoma freezing, targeted

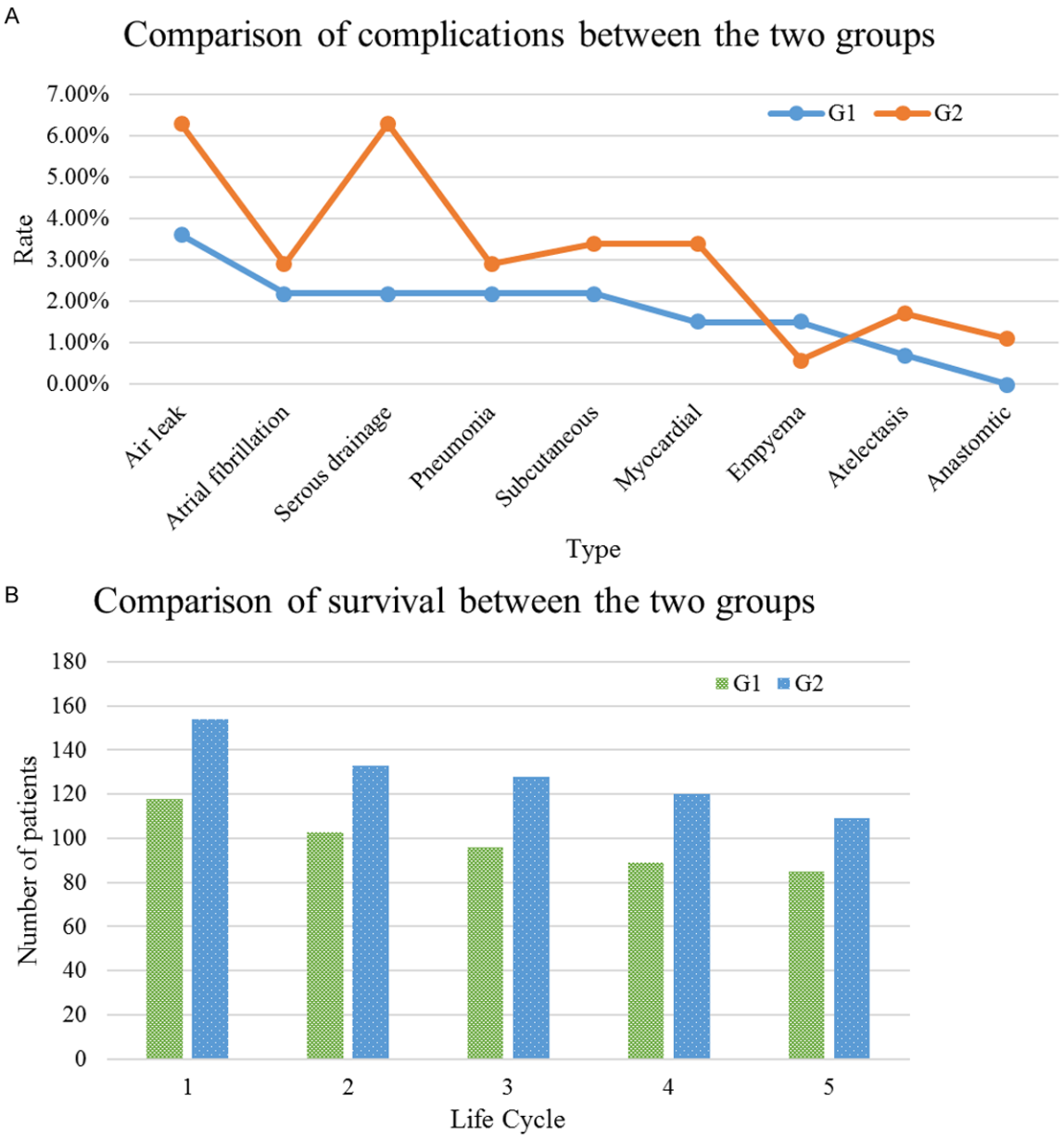

Figure 9. Evaluation of postoperative effects between the two groups. A. Showed the incidence of complications among patients. B. Displayed the assessment of the 5-year survival rate among patients.

therapy, immune therapy, and palliative therapy could be carried out [29-31]. However, the scope of early pneumonia suitable for pulmonary segmentectomy was limited to peripheral thyroid nodule diameter equal to or less than 2 cm by the indication proposed by National Comprehensive Cancer Network (NCCN). In the pneumonia TNM staging system of UICC 2013, bronchial pneumonia of stage TIaNOMO (stage IA) was identified [32, 33].

A key focus on lymph node dissection is whether it increases surgical complications. In several randomized controlled trials (RCT), the differences between lymph node dissection and sampling were investigated. All the included patients received thoracoscope-guided pulmonary lobectomy combined with systematic lymph node dissection or sampling. Among the data without propensity score matching, the operation time in the thoracoscope-guided lymph dissection group was longer than that in the lymph node sampling group with more drainage volume, longer hospitalization, and a greater number of excised lymph nodes and stations. Nonetheless, the data on the patients

included in the two groups were not fully matched because the study was not an RCT. In the lymph node dissection group, the proportion of males was higher with higher T staging and N staging. In addition, the proportion of non-AD patients (SQ, adenosquamous carcinoma, large cell pneumonia, pleomorphic carcinoma, carcinoid, and lymphoepithelioma-like carcinoma) was higher. The proportion of AD with micropapilla and solid components was relatively higher among lung AD. Based on the propensity score matching, there were no statistical differences in gender and T staging between the two groups. However, N staging and cytology classification of the two groups were not compared because they usually had more significant impacts on prognostic staging without direct correlation with operation difficulty and complications. The research was a non-RCT. The inclusion criteria for the lymph node dissection group were ground glass-like nodules with dense nodules or solid components greater than 50%. The inclusion criteria of the lymph node sampling group were ground glass-like nodules with pure ground glass-like nodules and solid components less than 50%. Due to the differences in inclusion criteria, N staging in the lymph node dissection group was undoubtedly superior to that in the lymph node sampling group. Besides, the proportion of invasive AD containing micro-papilla and solid components in lung AD cell subtypes was also obviously higher than that in the lymph node sampling group. If N staging and cytology classification are also matched, the final matched data will be decreased and the inspection effectiveness will also remarkably decline.

The comparison of 137 patients performed with anatomical pulmonary segmentectomy in a high-risk group and 175 patients receiving pulmonary lobectomy in a conventional group indicated that the postoperative complications, including cerebral hemorrhage, persistent air leak, hemoptysis, lung dilation dysfunction, and postoperative cardiac arrhythmia in the anatomical pulmonary segmentectomy group were common. Those in the thoracoscope-guided pulmonary lobectomy group were reduced. In addition, no cerebral hemorrhage and conversion to thoracotomy occurred during the treatment. During the treatment of the patients in the thoracoscope-guided anatomical pulmonary segmentectomy group, the number of cases of cerebral hemorrhage was smaller than that in the pulmonary lobectomy group. Consequently, the number of patients suffering from postoperative trauma was significantly decreased. The postoperative thoracic duct retention time, general drainage volume, and hospitalization time in the thoracoscope-guided anatomical acute pulmonary segmentectomy group were all inferior to those in the pulmonary lobectomy group. As a result, the patients recovered more quickly after the operation than those in the pulmonary lobectomy group. What's more, the number of dissected lymph nodes in the two groups was similar, but the comparison of total early recurrence, percentage of mortality, and the survival rate in recent 5 years between the two groups all demonstrated no statistically significant differences. Based on the above results, thoracoscope-guided pulmonary segmentectomy showed significant therapeutic effects on NSCLC-aged high-risk patients at stage IB with minor trauma, high safety, and apparent long-term efficacy. Lesions were excised completely and normal lung tissues were preserved to a large extent, which realized the rapid recovery after laparoscopic minimally invasive surgery. Thoracoscope-guided pulmonary segmentectomy was the best treatment method for this kind of middle-aged and elderly patients with small-cell lung cancer. For early aged patients and lung cancer patients, especially for those without complete lung functions or to be performed with a second thoracotomy but intolerant of pulmonary lobectomy, the surgery was very likely to be performed as a standard surgical approach to the surgical diagnosis of the patients with early pulmonary nodule tumor.

Conclusion

Thoracoscope-guided lymph node dissection could improve the detection rate of lymph node metastasis. For lung AD patients with T staging greater than T1 or with micro-papilla or solid components, lymph node dissection could offer more accurate pathological staging. Anatomical pulmonary segmentectomy combined with systematic lymph node dissection should be adopted to treat aged high-risk NSCLC patients at an advanced stage (pT state >2 cm, ≤3 cm), which could not only ensure the complete excision of lesions, but also preserve normal lung tissues to the maximum extent with little

trauma, high safety, rapid postoperative recovery, and clear long-term efficacy.

Disclosure of conflict of interest

None.

Abbreviations

VATS, video-assisted thoracoscopic surgery; AD, adenocarcinoma; PT, prothrombin time; NSCLC, non-small cell lung carcinoma; 3D, three-dimensional; WHO, World Health Organization; IASLC, International Association for the Study of Lung Cancer; ATS, American Thoracic Society; ERS, European Respiratory Society; CT, computed tomography; BMI, body mass index; LSD, least significant difference; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; LUL, left upper lobe; LLL, left lower lobe; AAH, atypical adenomatous hyperplasia; AIS, adenocarcinoma in situ; MIA, micro-invasive adenocarcinoma; UICC, Union for International Cancer Control.

Address correspondence to: Dr. Youbin Cui, Second Department of Thoracic Surgery, The First Hospital of Jilin University, Changchun, Jilin, China. Tel: +86-431-86176851; ORCID: 0000-0002-7434-3888; Fax: +86-431-86176851; E-mail: cuiyb@jlu.edu.cn

References

[1] Ding N, Zhou N, Li Q, Ren G and Zhou M. Analysis of middle- and long-term efficacy of thoracoscope-assisted segmental resection of the lung on non-small cell lung cancer in the early stage. Oncol Lett 2018; 15: 3662-3668.

[2] Han L, Gao S, Tan F, Zhao Z and Song P. Experience and progress processing policy of simultaneous multiple primary lung cancer. Zhongguo Fei Ai Za Zhi 2018; 21: 180-184.

[3] Lao AM, Matsumoto Y, Tanaka M, Matsunaga T, Sasada S and Tsuchida T. Pleural cryobiopsy during local anaesthetic thoracoscopy in dry pleural dissemination. Respirol Case Rep 2019; 8: e00503.

[4] Machida Y, Kobata T, Yamada S, Nakagawa K, Iguchi M, Toga H and Shimizu J. Resection of metastatic lung tumor with a right displaced segmental bronchus (B1+3);report of a case. Kyobu Geka 2020; 73: 389-391.

[5] Huang L, Zhao L, Tang H and Chai Y. Left bronchial isomerism in a lung cancer patient undergoing right upper pulmonary lobectomy via a thoracoscope. Thorac Cancer 2017; 8: 54-56.

[6] Pfannschmidt J and Kollmeier J. Results of N1 and N2 surgery in non-small cell lung cancer. Chirurg 2019; 90: 974-981.

[7] Bertolaccini L, Rocco G, Pardolesi A and Solli P. The geometric and ergonomic appeal of uniportal video-assisted thoracic surgery. Thorac Surg Clin 2017; 27: 331-338.

[8] Cui Z, Zhang Y, Xu C, Ding C, Chen J, Li C and Zhao J. Comparison of the results of two chest tube managements during an enhanced recovery program after video-assisted thoracoscopic lobectomy: a randomized trial. Thorac Cancer 2019; 10: 1993-1999.

[9] Zhong L, Hu W, Li S, Wei Z, Zhu Z, Jin G, Zhang H, Pang Y and Yu J. Clinical study of video-assisted thoracoscopic surgery wedge resection in early-stage lung cancer by tumor mapping with indocyanine green. Wideochir Inne Tech Maloinwazyjne 2019; 14: 545-550.

[10] Takizawa H, Kondo K, Kawakita N, Tsuboi M, Toba H, Kajiura K, Kawakami Y, Sakiyama S, Tangoku A, Morishita A, Nakagawa Y and Hirose T. Autofluorescence for the diagnosis of visceral pleural invasion in non-small-cell lung cancer. Eur J Cardiothorac Surg 2018; 53: 987-992.

[11] Madan K, Tiwari P, Thankgakunam B, Mittal S, Hadda V, Mohan A and Guleria R. A survey of medical thoracoscopy practices in India. Lung India 2021; 38: 23-30.

[12] Wu Z, Zhang L, Zhao XT, Zhou D and Yang XY. Localization of subcentimeter pulmonary nodules using an indocyanine green near-infrared imaging system during uniportal video-assisted thoracoscopic surgery. J Cardiothorac Surg 2021; 16: 224.

[13] Ujiie H, Kato T, Hu HP, Patel P, Wada H, Fujino K, Weersink R, Nguyen E, Cypel M, Pierre A, de Perrot M, Darling G, Waddell TK, Keshavjee S and Yasufuku K. A novel minimally invasive near-infrared thoracoscopic localization technique of small pulmonary nodules: a phase I feasibility trial. J Thorac Cardiovasc Surg 2017; 154: 702-711.

[14] Yang F, Zhou J, Li H, Yang F, Xiao R, Chi C, Tian J and Wang J. Near-infrared fluorescence-guided thoracoscopic surgical intervention for postoperative chylothorax. Interact Cardiovasc Thorac Surg 2018; 26: 171-175.

[15] Mei JD, Pu Q, Ma L, Liu CW and Liu LX. Strategies for the prevention and control of bleeding due to vascular injury in thoracoscopic lung surgery. Zhonghua Wai Ke Za Zhi 2017; 55: 898-902.

[16] Seastedt KP, Alyateem GA, Pittala K, Steinberg SM, Schrump DS, Nieman LK and Hoang CD. Characterization of outcomes by surgical management of lung neuroendocrine tumors asso-

ciated with cushing syndrome. JAMA Netw Open 2021; 4: e2124739.
[17] Liang Y, Liu P, Zhou XG, Li XL, Lin H, Chen N, Ge D and Dong J. En bloc resection with the assistance of video-assisted thoracoscopy for left lower lung cancer invading thoracic vertebrae and rib: a case report. Orthop Surg 2017; 9: 391-395.
[18] Ma JJ and Liu HP. Efficacy of Aidi injection on overexpression of P-glycoprotein induced by vinorelbine and cisplatin regimen in patients with non-small cell lung cancer. Chin J Integr Med 2017; 23: 504-509.
[19] Liu Y, Kang L, Hao H, Zhang X, Zheng G, Guo X and Zhao H. Primary synchronous colloid adenocarcinoma and squamous cell carcinoma in the same lung: a rare case report. Medicine (Baltimore) 2021; 100: e24700.
[20] Jiao P, Wu QJ, Sun YG, Ma C, Tian WX, Yu HB and Tong HF. Comparative study of three-dimensional versus two-dimensional video-assisted thoracoscopic two-port lobectomy. Thorac Cancer 2017; 8: 3-7.
[21] Mao Y, Wang K, He K, Ye J, Yang F, Zhou J, Li H, Chen X, Wang J, Chi C and Tian J. Development and application of the near-infrared and white-light thoracoscope system for minimally invasive lung cancer surgery. J Biomed Opt 2017; 22: 66002.
[22] Nakamura S, Hayashi Y, Kawaguchi K, Fukui T, Hakiri S, Ozeki N, Mori S, Goto M, Mori K and Yokoi K. Clinical application of a surgical navigation system based on virtual thoracoscopy for lung cancer patients: real time visualization of area of lung cancer before induction therapy and optimal resection line for obtaining a safe surgical margin during surgery. J Thorac Dis 2020; 12: 672-679.
[23] Xu H and Zhang L. The bronchus first and vessels simultaneously stapled technique: a safe and simple method for video-assisted right upper lobe lobectomy. Thorac Cardiovasc Surg 2019; 67: 131-136.
[24] Andriolo LG, Lopez C and Gregori D. Pros-cons debate about the role and evolution of biportal video-assisted thoracoscopic surgery. Shanghai Chest 2018; 2: 67.
[25] Manabe T, Kuwata T, Taira A, Shinohara S, Kuroda K and Tanaka F. Preoperative 4D-CT provided helpful evaluation of aorta invasion of left lower lobe lung cancer. J UOEH 2020; 42: 365-369.
[26] Kong M, Zheng H, Ding L, Jin K, Shen J, Ye M and Chen B. Perioperative pulmonary rehabilitation training (PPRT) can reduce the cost of medical resources in patients undergoing thoracoscopic lung cancer resection: a retrospective study. Ann Palliat Med 2021; 10: 4418-4427.
[27] Luan TMB, Bang HT, Vuong NL, Dung LT, Tin NT, Tien TQ and Nam NH. Long-term outcomes of video-assisted lobectomy in non-small cell lung cancer. Asian Cardiovasc Thorac Ann 2021; 29: 318-326.
[28] Wang Y and Chen C. Survival following video-assisted thoracoscopic versus open esophagectomy for esophageal carcinoma. J BUON 2016; 21: 427-433.
[29] Anayama T, Hirohashi K, Miyazaki R, Okada H, Yamamoto M and Orihashi K. Fluorescence visualization of the intersegmental plane by bronchoscopic instillation of indocyanine green into the targeted segmental bronchus: determination of the optimal settings. J Int Med Res 2021; 49: 300060521990202.
[30] Yasuda K, Kashu N, Yoshitake H, Mushiake Y, Takami T, Shintani H, Kataoka N, Yamaguchi T and Makimoto S. A case of lung adenocarcinoma with pulmonary hypertrophic osteoarthropathy. Gan To Kagaku Ryoho 2021; 48: 297-299.
[31] Zhu B, Yang J, Zhang P, Shen L, Li X and Li J. Safety and effectiveness of localized lung resection combined with neoadjuvant chemotherapy in the treatment of stage I-II non-small cell lung cancer. Oncol Lett 2017; 13: 2344-2348.
[32] Huang W, Liu J, Liang W, Shao W, Lan Z, Jiang L, Mo L, Gonzalez-Rivas D and He J. Outcome and safety of radical resection in non-small cell lung cancer patients via glasses-free 3-dimensional video-assisted thoracoscope versus 2-dimensional video-assisted thoracoscope. Surg Innov 2018; 25: 121-127.
[33] Xiao-Feng L, Guo-Qi Z, Wei H, Jing-Hong L, Chao-Xia D, Xiao-Yan C and Yang X. High-grade fetal adenocarcinoma of the lung with abnormal expression of alpha-fetoprotein in a female patient: case report. Medicine (Baltimore) 2021; 100: e24634.