Thoracoscopic radical esophagectomy combined with left inferior pulmonary ligament lymphadenectomy for esophageal carcinoma via the right thoracic approach

A single-center retrospective study of 30 cases

Shijie Huang, MDa, Tianbao Yang, MDa, Wu Wang, MDa, Guozhong Huang, MDa, Boyang Chen, MDa, Pengfei Chen, MDa, Douli Ke, MDa, Wenhua Huang, PhDb, Jinbiao Xie, MDa,

Abstract
To evaluate the necessity, safety, and feasibility of left inferior pulmonary ligament lymphadenectomy during video-assisted thoracic surgery (VATS) radical esophagectomy via the right thoracic approach.

Thirty patients (20 men, 10 women) with thoracic esophageal squamous cell carcinoma (ESCC) were recruited for this study. The patients’ age ranged from 50 to 80 years, with an average age of 66.17 ± 7.47 years. After the patients underwent VATS radical esophagectomy and left inferior pulmonary ligament lymph node dissection (LIPLND) via the right thoracic approach, the operative outcomes included operative time, length of hospital stay, postoperative complications, number of lymph nodes removed, and postoperative pathologic results were evaluated.

There were no massive hemorrhages of the left inferior pulmonary vein during the operation. The operative time of LIPLND was 8.67 ± 2.04 minutes, and the length of postoperative hospital stay was 12.23 ± 2.36 days. The postoperative complications included 2 cases of left pneumothorax, 4 pulmonary infection cases, and no chylothorax. Moreover, 68 LIPLNs were dissected, 5 of which were positive, and the degree of metastasis was 7.4%. The postoperative pathologic results showed that 3 cases of LIPLNs were positive, with a metastasis rate of 10.0%. Among them, 2 cases were SCC of the lower thoracic esophagus, and 1 case was SCC of the middle thoracic esophagus, which involved the lower segment.

Thoracoscopic esophagectomy combined with left inferior pulmonary ligament lymphadenectomy for esophageal carcinoma via the right thoracic approach will not increase the difficulty of operation, increase the incidence of postoperative complications or prolong the postoperative hospital stay, and can theoretically reduce tumor recurrence. Therefore, we believe that LIPLND is necessary, safe, and feasible and is worthy of clinical popularization and application.

Abbreviations: AJCC = American Joint Committee on Cancer, CT = computed tomography, ESCC = esophageal squamous cell carcinoma, JES = Japan Esophageal Society, LIPLND = left inferior pulmonary ligament lymph node dissection, LIPLNs = left inferior pulmonary ligament lymph nodes, OS = overall survival, SCC = squamous cell carcinoma, UICC = Union for International Cancer Control, VATS = video-assisted thoracic surgery.

Keywords: esophageal squamous cell carcinoma, left inferior pulmonary ligament lymph nodes, right thoracic approach, video-assisted thoracic surgery
1. Introduction

Esophageal cancer is still one of the most common malignant tumors of the digestive tract.\(^1\) It was estimated that in 2018, there were over 0.57 million (ranking seventh in incidence) new cancer cases and approximately 0.51 million (ranking sixth in mortality) deaths from esophageal cancer.\(^2\) China has a high incidence of esophageal cancer, for which the morbidity and mortality rate is ranked third and fourth among malignant tumors in China,\(^3\) respectively, with esophageal squamous cell carcinoma (ESCC) accounting for approximately >90% of all esophageal cancer.\(^4\) At present, radical surgery is still the most effective method for the comprehensive treatment of esophageal cancer.\(^5,6\) However, the prognosis of locally advanced tumors is not satisfactory, and the 5-year overall survival (OS) rate of patients with stage IIA-III ESCC is 20.6% to 34.0%.\(^7-9\)

Moreover, among the clinical and pathological features of esophageal cancer, the depth of invasion and lymph node metastasis was the most important prognostic factors in patients with ESCC.\(^10-12\) Therefore, massive resection of esophageal cancer combined with standardized and systematic lymph node dissection is considered an essential part of radical resection of esophageal cancer and can prevent residual cancer, reduce tumor recurrence, and improve patient survival.\(^13,14\)

In video-assisted thoracic surgery (VATS) radical esophagectomy via the right thoracic approach, the lower mediastinal lymph nodes are dissected, the paraesophageal and right lower pulmonary ligament lymph nodes are routinely removed. In contrast, for the left inferior pulmonary ligament lymph nodes (LIPLNs), the dissection is sometimes not thorough enough or even ignored. Among the patients we treated, an elderly female patient was clinically diagnosed with mid-thoracic ESCC (stage cT3N0M0 II) before the operation. No obvious surgical contraindications were found after examination, so she underwent VATS radical esophagectomy, but the LIPLNs were not routinely removed during the operation. The patient recovered well during the perioperative period and received postoperative adjuvant chemotherapy. However, the enhanced chest computed tomography (CT) scan showed that the LIPLNs at the lower margin of the left inferior pulmonary vein was enlarged 7 months after the surgery, which is considered to indicate the possibility of lymph node metastasis (Fig. 1).

The lymph node maps for esophageal cancer from the American Joint Committee on Cancer (AJCC)/Union for International Cancer Control (UICC) and the Japan Esophageal Society (JES) noted that the LIPLNs were the drainage area for thoracic esophageal cancer.\(^15-18\) Additionally, the Chinese expert consensus on thoracic lymph node dissection in radical resection of esophageal cancer (2017 edition) strongly recommended that the thoracic lymph nodes be removed as thoroughly as possible in clinical practice, rather than just meeting the requirements of the number of lymph nodes removed. The C201–C209 lymph node group should be regarded as the target of thoracic lymph node dissection in radical esophagectomy\(^14\) (Table 1). Therefore, we believe that in VATS radical esophagectomy via the right thoracic approach, when the lower mediastinal lymph nodes are dissected, the LIPLNs should be removed entirely to ensure a standardized and systematic dissection of the thoracic lymph nodes, improve the radical resection of esophageal cancer and define the N stage.

In this retrospective study, we report the clinical outcomes of 30 patients with thoracic ESCC who underwent VATS radical esophagectomy and analyze the clinical observations of LIPLN dissection (LIPLND) with VATS radical esophagectomy via the right thoracic approach.

2. Methods

2.1. Subjects

In this study, we retrospectively analyzed the clinical outcomes of 30 patients with ESCC who underwent VATS radical resection of esophageal cancer in our hospital from November 1, 2018 to December 31, 2019. Written informed consent was obtained from all patients before the surgical operation.

The inclusion criteria for the patients were as follows: thoracic ESCC confirmed by gastroscopy; stage cT1-3N0-1M0 (UICC TNM classification, eighth Edition); treatment with VATS left inferior pulmonary ligament lymph node dissection; no distant metastasis in the preoperative examination and tolerance of general anesthesia; no preoperative neoadjuvant radiotherapy and chemotherapy; and no prior malignancy.

The exclusion criteria for the patients were as follows: thoracotomy for radical esophagectomy; intraoperative explora-

![Figure 1. (A) Preoperative chest CT; (B) 7 months after the operation, chest CT showed left inferior pulmonary ligament lymph node enlargement. CT = computed tomography.]
tion that revealed extensive pleural adhesions; and previous right thoracic surgery.

2.2. Surgical approaches

This study was approved by the Ethics Committee of The Affiliated Hospital of Putian University. All patients were informed of the method of VATS radical resection of esophageal cancer and signed the operative informed consent form. The right thoracic approach was selected, and the left prone position was adopted. Artificial pneumothorax was performed in the right chest of the patient.

For the LIPLND process, our team generally dissected the paraesophageal lymph nodes, left/right inferior pulmonary ligament lymph nodes, and other lower mediastinal lymph nodes while performing massive resection of the esophagus and its surrounding tissues. The specific steps are as follows:

After the posterior mediastinum was fully exposed, the mediastinal pleura was opened under the azygos venous arch with an electric hook. Then, the surgeon closed the thoracic aorta and divided the esophagus’s posterior margin space from the azygos venous arch to the diaphragm. Simultaneously, the assistant pulled the esophagus forward with 5 leaves fan-shaped forceps, continued to dissect the space between the esophagus and pericardia, and cleaned the paraesophageal lymph nodes. Then, the left inferior pulmonary vein, the left pleura, and the left lower lung lobe were exposed. The LIPLNs could be seen close to the lower edge of the left inferior pulmonary vein, thoroughly dissected (Fig. 2). Next, the assistant lifted the esophagus backward and exposed the field of vision between the esophagus and the lung’s right hilum with gastric forceps. The surgeon dissected the esophagus’ anterior margin and dissected the paraesophageal lymph nodes and the right inferior pulmonary ligament lymph nodes.

### Table 1

| Region           | Chinese classification and anatomical position                                                                 | UICC/AJCC standards | JES standards |
|------------------|-------------------------------------------------------------------------------------------------------------|---------------------|--------------|
| Upper mediastinum| C201: right recurrent laryngeal nerve lymph nodes (initial re-entry of right vagus nerves to the right terminal subclavian artery, peripheral lymph nodes, and adipose tissue of right recurrent laryngeal nerves) | 2R: right upper paratracheal nodes | 106recR: right recurrent laryngeal nerve lymph nodes |
|                  | C202: left recurrent laryngeal nerve lymph nodes (upper left 1/3 of the trachea, peripheral lymph nodes, and adipose tissue of left recurrent laryngeal nerves of the superior border of the aortic arch) | 2L: left upper paratracheal nodes | 106recL: left recurrent laryngeal nerve lymph nodes |
|                  | C203: upper thoracic paraesophageal lymph nodes (lymph nodes from apex pulmonis to inferior border of azygos vein) | 8U: upper thoracic paraesophageal lymph nodes | 105: upper thoracic paraesophageal lymph nodes |
|                  | C204: paratracheal lymph nodes (lymph nodes from right vagus nerves to esophagus, on the right side of trachea) | 4R: right lower paratracheal nodes | 106: paratracheal lymph nodes (106pre: pretracheal lymph paratracheal: right paratracheal lymph nodes) |
|                  |                                                                                                            | 4L: left lower paratracheal nodes | 106bl: left paratracheal lymph nodes |
|                  |                                                                                                            | 5: subaortic nodes | 113: lymph nodes of arterial ligament |
|                  |                                                                                                            | 6: anterior mediastinal nodes | 114: anterior mediastinal lymph nodes |
|                  |                                                                                                            | 7: subcarinal nodes | 107: subcarinal lymph nodes |
|                  | C205: subcarinal lymph nodes (caudal to the carina of the trachea)                                       |                     |              |
| Lower mediastinum | C206: middle thoracic paraesophageal lymph nodes (from the tracheal bifurcation to the caudal margin of the inferior pulmonary vein) | 8M: middle thoracic paraesophageal lymph nodes | 108: middle thoracic paraesophageal lymph nodes |
|                  | C207: lower thoracic paraesophageal lymph nodes (paraesophageal lymph nodes from the inferior border of inferior pulmonary vein to gastroesophageal junction) | 8Lc: lower thoracic paraesophageal lymph nodes | 110: lower thoracic paraesophageal lymph nodes |
|                  | C208: inferior pulmonary ligament lymph nodes (close lymph nodes to the inferior border of the right lower inferior pulmonary vein and within inferior pulmonary ligament) | 9L: left inferior pulmonary ligament nodes | 112L: left posterior mediastinal lymph nodes |
|                  |                                                                                                            | 9R: right inferior pulmonary ligament nodes | 112R: right posterior mediastinal lymph nodes |
|                  |                                                                                                            | 10L: left paratracheal bronchial nodes | 109L: left paratracheal bronchial nodes |
|                  |                                                                                                            | 10R: right paratracheal bronchial nodes | 109R: right paratracheal bronchial nodes |
|                  | C209: diaphragmatic nodes (lymph nodes on the right side of cardiophrenic angle)                           | 15: diaphragmatic nodes | 111: superior phrenic lymph nodes |

— refers to lymph nodes that were not included in the Chinese Criteria; “C” in the Chinese classification stands for the Chinese Criteria; “2” indicates thoracic lymph nodes. AJCC = American Joint Committee on Cancer, JES = Japan Esophagus Society, UICC = Union for International Cancer Control.

* It is based on literature.

† It is based on literature.

It is based on literature.
2.3. Outcome measures

The outcome measures were as follows: age, sex, preoperative comorbidities, tumor location, postoperative pathologic data, total operative time, operative time of LIPLND, hospitalization days, postoperative complications, and number of LIPLNs dissected.

2.4. Statistics

All statistical analyses were performed using SPSS for Windows version 19.0 (IBM Inc., Chicago, IL).

3. Results

In this study, 30 patients with ESCC were enrolled, including 20 men and 10 women, with an average age of 66.17 ± 7.47 years. Before the operation, there were 5 cases of hypertension, 4 cases of diabetes, and 1 case of coronary heart disease. Preoperative gastroscopy showed 2 cases of SCC of the upper thoracic esophagus, 18 cases of SCC of the middle thoracic esophagus, 10 cases of SCC of the lower thoracic esophagus; in total, 20 cases involved the lower esophagus. According to the 8th Edition AJCC/UICC TNM staging guidelines, the cases were divided into stages I (n=8), II (n=13), and III (n=9) (Table 2).

There were left inferior pulmonary vein injuries caused by LIPLND during the operation, no massive bleeding during the operation, and no perioperative deaths (Table 3). The postoperative complications included 2 cases of left pneumothorax caused by left mediastinal pleura rupture due to the LIPLND and 4 pulmonary infection cases. No postoperative chylothorax occurred.

A total of 68 LIPLNs were dissected, 5 of which were positive, and the degree of metastasis was 7.4%. Postoperative pathology showed that 3 cases of LIPLNs were positive, and the metastasis rate was 10.0%. Among them, 2 cases were lower thoracic ESCC, both were stage pT2N1M0 IIIa, and 1 case was middle thoracic ESCC (stage pT3N1M0 IIIb) but involved the lower segment. Figure 3A showed multiple polypoid lesions under endoscopy before surgery. Histopathologic examination showed the lesions were squamous cell carcinoma (Fig. 3B) with lymph node metastasis (Fig. 3C).

Table 2

| Characteristics                        | Patients (n=30), mean ± SD or n (%) |
|----------------------------------------|-------------------------------------|
| Age, y                                 | 66.17 ± 7.47                        |
| Male/Female                            | 20/10 (66.6/33.3)                   |
| Tumor location                         |                                     |
| Upper/middle/lower                    | 2/18/10 (6.6/60/33.3)               |
| Lower involvement                     | 20 (66.6)                           |
| Pathological T stage                   |                                     |
| T1/2                                   | 7/7 (23.3/23.3)                     |
| T3/4                                   | 16/0 (53.3/0)                       |
| Pathological N stage                   |                                     |
| 0/1                                    | 21/7 (70/23.3)                      |
| 2/3                                    | 2/0 (6.6/0)                         |
| Pathological TNM stage                 |                                     |
| I/II                                   | 8/13 (26.6/43.3)                    |
| II/IV                                  | 9/0 (30/0)                          |
| Preoperative comorbidities             |                                     |
| HD, DM, CHD*                           | 5/4/1 (16.6/13.3/3.3)               |

*CHD = coronary heart disease, DM = diabetes mellitus, HD = hypertension disease.

Table 3

| Characteristics                        | Patients (n=30), mean ± SD or n (%) |
|----------------------------------------|-------------------------------------|
| Operative time of LIPLND, min          | 8.67 ± 2.04                         |
| Total operative time, min              | 358.27 ± 42.26                      |
| Postoperative hospitalization days, d  | 12.23 ± 2.36                        |
| Left inferior pulmonary vein hemorrhage| 0                                   |
| Postoperative pulmonary infection      | 4                                   |
| Chylothorax                            | 0                                   |
| Left pneumothorax                      | 2                                   |
| Perioperative death                    | 0                                   |
| LIPLND                                 |                                     |
| Positive number (pieces)               | 5                                   |
| Total number (pieces)                  | 68                                  |
| Metastasis rate*                       | 10%                                 |

* Lymph node metastasis rate = patients with positive lymph nodes/total patients.
4. Discussion

At present, although the multimodal therapy of esophageal cancer has been increasingly matured and perfected, radical surgery for esophageal cancer remains the first-choice treatment for resectable esophageal cancer.\textsuperscript{[5,6]} Due to the longitudinal and horizontal lymphatic network communication between the esophagus and mediastinum, esophageal cancer has bidirectional and cervical-thoracic-abdominal jumping metastasis characteristics. Moreover, esophageal cancer’s multipoint origin naturally leads to mediastinal lymph node metastasis in the early stage.\textsuperscript{[19,20]} Thus, it is difficult to determine the extent of lymphatic metastasis before or during surgery. Therefore, many scholars believe that systemic, standardized, and thorough lymph node dissection plays an essential role in esophageal cancer’s postoperative prognosis. Lymph node dissection can prevent residual cancer and reduce tumor recurrence and ensure a satisfactory postoperative pathological TNM stage and guide postoperative adjuvant therapy, which is of great significance for improving patient survival.\textsuperscript{[11,21]}

In recent years, VATS radical resection of thoracic esophageal cancer via the right thoracic approach has gradually become the preferred surgical method for thoracic esophageal cancer because it can completely dissect the upper mediastinal lymph nodes, such as the left and right recurrent laryngeal nerve lymph nodes.\textsuperscript{[22–24]} However, in clinical practice, we found that neglecting the existence of LIPLNs during the radical resection of esophageal cancer or performing incomplete dissection will increase the probability of residual cancer and the possibility of the recurrence of lymph node metastasis.

The Chinese expert consensus on thoracic lymph node dissection in radical resection of esophageal cancer (2017 edition) noted that the LIPLNs were the lymph node drainage area of esophageal cancer and lymph node metastasis of thoracic esophageal cancer. Therefore, esophageal cancer is prone to metastasize to the LIPLNs.\textsuperscript{[14,19,20]}

Studies\textsuperscript{[25–27]} have shown that the lymph node metastasis rate of LIPLNs is 6.2% to 13.9%. The metastasis degree was 4.5% to 6% in radical resection of esophageal cancer via a left thoracic approach, which was consistent with our study. According to the 8th Edition AJCC/UICC TNM classification of esophageal cancer, N staging is based on the number of positive lymph nodes, so the greater the number of lymph nodes dissected, the less likely it is to miss positive lymph nodes, making N staging more accurate.\textsuperscript{[14,28,29]} Thus, it can be seen that in VATS radical resection of thoracic esophageal cancer via the right thoracic approach, the LIPLNs should be removed as thoroughly as possible to achieve radical resection of the lymph nodes in the mediastinal drainage area.

This study included 30 cases of thoracic ESCC, and 20 cases involved the lower thoracic segment. Three cases were positive, including 2 cases in the lower thoracic segment and 1 case in the esophagus’s middle thoracic segment, but the lower segment was involved. Many studies show that according to the rule of lymph node metastasis of esophageal cancer, the lymph node metastasis of lower thoracic ESCC is mainly to the inferior mediastinal and abdominal lymph nodes, and the lymph node metastasis of esophageal cancer also follows the principle of the nearest metastasis.\textsuperscript{[30,31]}

Based on the esophagus’s anatomic position, the lower thoracic esophagus is closer to the left lower pulmonary ligament. When esophageal cancer transversely penetrates the esophageal wall, it is more likely to invade the LIPLNs. Therefore, we believe that for patients with ESCC involving the lower thoracic segment of the esophagus, it is necessary to carefully and thoroughly dissect the LIPLNs in a standardized manner. Additionally, in the process of performing thorough LIPLND, the posterior margin space of the lower thoracic esophagus and its surrounding adipose and connective tissue can be freed to ensure radical resection of the lower thoracic segment esophagus. Reducing the residual cancer tissue is helpful, mainly when the tumor focus is located in the lower thoracic segment of the esophagus, reducing the possibility of local recurrence after the operation.

The results showed that the average operative time of LIPLND was 8.67 ± 2.04 minutes, which did not significantly increase the total operation time. Additionally, there were no left inferior pulmonary vein injuries caused by LIPLND, no massive bleeding during the operation, and no significant complications related to LIPLND, such as thoracic duct injury. The postoperative hospital stay was not prolonged. LIPLND does not increase the operation’s difficulty, increase the incidence of postoperative complications, or prolong the postoperative hospital stay. Therefore, we believe that during VATS radical resection of esophageal cancer via the right thoracic approach, LIPLND is safe and feasible.
There are several limitations in this study. As an observational cases serial study, there is a limited sample size in the current study. It is necessary to continue to increase the sample size of future studies, clarify the correlation between metastasis of the LIPLNs and the location and depth of invasion of esophageal cancer, and further follow-up evaluates the long-term effects of this approach.

5. Conclusion
In VATS radical esophagectomy via the right thoracic approach, the LIPLNs should be completely removed, especially for patients with ESCC involving the lower thoracic segment; this approach can ensure the extent of resection of the lower segment of the esophagus, reduce the recurrence of tumors, and improve the 5-year survival rate. LIPLND will not increase the operation's difficulty, increase the incidence of postoperative complications, or prolong the postoperative hospital stay. Therefore, we believe that LIPLND is necessary, safe, and feasible and is worthy of clinical popularization and application in VATS radical resection of esophageal cancer via the right thoracic approach.

Acknowledgments
The authors hereby certify that a professional editing service (AJE) has checked and corrected the English in the manuscript named above. A specialist editor with suitable professional knowledge reviewed and corrected the English. The editor is a native English speaker. Please direct any questions regarding this certificate or the English in the certified paper to support@aje.com.

Author contributions
Conceptualization: Wenhua Huang, Jinbiao Xie. Data curation: Tianbao Yang, Wu Wang, Pengfei Chen, Douli Ke. Formal analysis: Tianbao Yang, Wu Wang, Pengfei Chen. Funding acquisition: Jinbiao Xie. Investigation: Shijie Huang, Wu Wang, Pengfei Chen. Methodology: Shijie Huang, Douli Ke, Wenhua Huang. Project administration: Guozhong Huang, Wenhua Huang. Resources: Guozhong Huang, Boyang Chen, Jinbiao Xie. Software: Wenhua Huang. Supervision: Wenhua Huang, Jinbiao Xie. Validation: Tianbao Yang, Boyang Chen. Visualization: Guozhong Huang, Douli Ke. Writing – original draft: Shijie Huang, Boyang Chen. Writing – review & editing: Wenhua Huang, Jinbiao Xie.

References
[1] Bray F, Ferlay J, Soerjomatara I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018;68:394–424.
[2] Cai Z, Liu Q. Understanding the Global Cancer Statistics 2018: implications for cancer control. Sci China Life Sci 2019.
[3] Chen W, Zheng R, Baade PD, et al. Cancer statistics in China, 2015. CA Cancer J Clin 2016;66:115–32.
[4] Mao WM, Zheng WH, Ling ZQ. Epidemiologic risk factors for esophageal cancer development. Asian Pac J Cancer Prev 2011;12:2461–6.
[5] Swisher SG, Moughan J, Komaki RU, et al. Final results of NRG Oncology RTOG 0246: an organ-preserving selective resection strategy in esophageal cancer patients treated with definitive chemoradiation. J Thorac Oncol 2017;12:368–74.
[6] Markar S, Gronnier C, Duhamel A, et al. Salvage surgery after chemoradiotherapy in the management of esophageal cancer: is it a viable therapeutic option? J Clin Oncol 2015;33:3866–73.
[7] Zhang SW, Zheng RS, Zuo TT, Zeng HM, Chen WQ, He J. [Mortality and survival analysis of esophageal cancer in China]. Zhonghua Zhong Liu Za Zhi 2016;38:709–15.
[8] Smyth EC, Lagergren J, Fitzgerald RC, et al. Oesophageal cancer. Nat Rev Dis Primers 2017;3:17048.
[9] Shao LF, Gao ZG, Yang NP, Wei GQ, Wang YD, Cheng CP. Results of surgical treatment in 6123 cases of carcinoma of the esophagus and gastric cardia. J Surg Oncol 1989;42:170–4.
[10] Kato H, Fukuchi M, Miyazaki T, et al. Surgical treatment for esophageal cancer. Current issues. Dig Surg 2007;24:88–95.
[11] Tanaka H, Ohira M, Kubo N, et al. Association of location of lymph node metastases with postoperative recurrence of esophageal squamous cell carcinoma. Anticancer Res 2012;32:3421–6.
[12] Peyre CG, Hagen JA, DeMeester SR, et al. Predicting systemic disease in patients with esophageal cancer after esophagectomy: a multinational study on the significance of the number of involved lymph nodes. Ann Surg 2008;248:979–85.
[13] Peyre CG, Hagen JA, DeMeester SR, et al. The number of lymph nodes removed predicts survival in esophageal cancer: an international study on the impact of extent of surgical resection. Ann Surg 2008;248:549–56.
[14] Li H, Fang W, Yu Z, et al. Chinese expert consensus on mediastinal lymph node dissection in esophagectomy for esophageal cancer (2017 edition). J Thorac Dis 2018;10:2481–9.
[15] Fang W. [Interpretation of 2017 National Comprehensive Cancer Network (NCCN) guidelines for the diagnosis and treatment of esophageal squamous cell carcinoma through the new TNM staging of esophageal carcinoma (eighth Edition) by the Union for International Cancer Control (UICC) and the American Cancer Commission (AJCC)]. Zhonghua Wei Chang Wai Ke Za Zhi 2017;20:1122–6.
[16] Amin MB. The 2009 version of the cancer protocols of the college of american pathologists. Arch Pathol Lab Med 2010;134:526–30.
[17] Japanese classification of esophageal cancer, 11th edition: part I. Esophagus 2017;14:1–36.
[18] Edge SB, Compton CC. The American Joint Committee on Cancer: the 7th Edition of the AJCC cancer staging manual and the future of TNM. Ann Surg Oncol 2010;17:1471–4.
[19] Herbella FA, Del Grande JC, Colleoni R. Anatomical analysis of the mediastinal lymph nodes of normal Brazilian subjects according to the classification of the Japanese Society for Diseases of the Esophagus. Surg Today 2003;33:249–53.
[20] Lerut T, Nafteux P, Moons J, et al. Three-field lymphadenectomy for carcinoma of the esophagus and gastroesophageal junction in 174 R0 resections: impact on staging, disease-free survival, and outcome: a plea for adaptation of TNM classification in upper-half esophageal carcinoma. Ann Surg 2004;240:962–72. discussion 72–4.
[21] Udagawa H, Akiyama H. Surgical treatment of esophageal cancer: Tokyo experience of the three-field technique. Dis Esophagus 2001;14:110–4.
[22] Wang ZQ, Deng HY, Hu Y, et al. Prognostic value of right upper mediastinal lymphadenectomy in Sweet procedure for esophageal cancer. J Thorac Dis 2016;8:3625–32.
[23] Li H, Hu B, You B, et al. Combined laparoscopic and thoracoscopic Ivor Lewis esophagectomy for esophageal cancer: initial experience from China. Chin Med J (Engl) 2012;125:1376–80.
[24] Wang F, Zheng Y, Wang Z, Zheng Q, Huang Q, Liu S. Nodal skip metastasis in esophageal squamous cell carcinoma patients undergoing three-field lymphadenectomy. Ann Thorac Surg 2017;104:1187–93.
[25] Lu ZM, Zhang H, Wang MH, Cui DH, Yang YQ, Huang HZ. [Lymphatic metastasis intensity of and lymphadenectomy for thoracic esophageal squamous cell carcinoma]. Ai Zheng 2006;25:604–8.
[26] Wang Y, Zhu L, Xia W, Wang F. Anatomy of lymphatic drainage of the esophagus and lymph node metastasis of thoracic esophageal cancer. Cancer Manag Res 2018;10:6295–303.
[27] Miyata H, Sugimura K, Yamasaki M, et al. Clinical impact of the location of lymph node metastases after neoadjuvant chemotherapy for middle and lower thoracic esophageal cancer. Ann Surg Oncol 2019;26:200–8.
[28] Wu SG, Li FY, Zhou J, et al. Prognostic value of different lymph node staging methods in esophageal squamous cell carcinoma after esophagectomy. Ann Thorac Surg 2015;99:284–90.

[29] Lin CS, Cheng CT, Liu CY, et al. Radical lymph node dissection in primary esophagectomy for esophageal squamous cell carcinoma. Ann Thorac Surg 2015;100:278–86.

[30] Xue HC, Wu CR, Zhang ZB, et al. [Regulations and lymphadenectomy strategy of mediastinal and upper abdominal lymph node metastasis in thoracic esophageal carcinoma]. Ai Zheng 2007;26:1020–4.

[31] Igaki H, Tachimori Y, Kato H. Improved survival for patients with upper and/or middle mediastinal lymph node metastasis of squamous cell carcinoma of the lower thoracic esophagus treated with 3-field dissection. Ann Surg 2004;239:483–90.