

RESEARCH

Open Access



Export priority technique for Uni-portal thoracoscopic left upper lobectomy

Yanhui Yang¹, Ji Li¹, Xin Cheng¹, Sipeng Cheng¹ and Xiaoyang Xie^{1*}

Abstract

Background Further explore the safety and feasibility of Uni-portal video assisted thoracoscopic (UVATS) left upper lobectomy by optimizing the treatment of incisions and blood vessels.

Methods We conducted a retrospective analysis of data from 32 patients who underwent UVATS left upper lobectomy and systematic mediastinal lymph node dissection utilizing the Export priority technique between January 2021 and December 2022. We documented perioperative indicators, including surgical time, intraoperative blood loss, the number of lymph nodes dissected, and postoperative pathological staging.

Results All surgeries were conducted utilizing the Export priority technique in UVATS. The mean surgical duration was (98.93 ± 14.98) minutes, with an average intraoperative blood loss of (79.53 ± 37.96) ml. The mean count of dissected lymph nodes was (13.96 ± 2.69) . The length of hospital stay averaged (5.62 ± 1.81) days. On the first postoperative day, the thoracic drainage volume was (101.87 ± 49.46) ml. The mean duration of postoperative thoracic tube insertion was (3.1 ± 1.84) days. No occurrences of postoperative hoarseness, pulmonary infection, or complications such as bronchopleural fistula were observed.

Conclusion The application of the Export priority technique improves the safety and feasibility of UVATS left upper lobectomy.

Keywords UVATS, Left upper lobe, Export priority technique

Introduction

As thoracoscopic instruments and technology advance swiftly, the surgical approach has evolved from the initial three-hole and double-hole methods to the present Uni-portal approach [1, 2]. This modern approach allows the entire surgery to be conducted through a 3-4 cm incision on the chest wall [3, 4]. Currently, the majority of scholars advocate selecting the UVATS surgical incision at the 4th or 5th intercostal space [5–7]. Precision in selecting the optimal incision is imperative to enhance

the surgeon's experience and ensure the overall safety of the surgical procedure. Nevertheless, in the case of obese patients, the increased thickness of subcutaneous adipose tissue poses challenges to rib counting and positioning. Effectively addressing this, the swift and accurate localization of the incision becomes the initial crucial step for surgeons in achieving successful surgery.

UVATS minimally invasive surgery comprehensively addresses a wide spectrum of thoracic diseases, contributing to a significant enhancement in the long-term quality of life for patients post-surgery [8–11]. UVATS left upper lobectomy is often considered the most challenging with a higher risk of bleeding in minimally invasive lobectomy, primarily attributed to the following factors: Firstly, the left upper lobe of the lung contains numerous blood vessels with a high likelihood of variation, especially the left upper pulmonary artery,

*Correspondence:

Xiaoyang Xie
13990559066@163.com

¹ Department of Cardiothoracic Surgery, The First People's Hospital of Neijiang, 1866, West Section of Hanan Avenue, Shizhong District, Neijiang, Sichuan 641000, China



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

encompassing LA¹⁺²a + b, A¹⁺²c, LA³, LA⁴, LA⁵. Secondly, the left lung tissue features oblique fissures, and inadequate development of these fissures complicates arterial treatment via the interlobular fissure pathway, introducing challenges to the surgical process. Thirdly, the intricate arrangement of pulmonary veins and arteries, along with the deep positioning of the left upper lobe bronchus amidst blood vessels, prohibits direct severance, eliminating potential surgical shortcuts. Fourthly, the presence of the mediastinal lingual artery may elevate the risk of bleeding. Effectively addressing these challenges under UVATS conditions to reduce postoperative complications has been a persistent concern for surgeons. To tackle these issues and enhance the safety and feasibility of Uni-portal thoracoscopic left upper lobectomy, we propose a novel concept that primarily focuses on optimizing incision treatment and Export priority technique. This concept may offer valuable insights for future clinical practice, especially considering the current lack of systematic and modular reports on Uni-portal left upper lobectomy.

Method and materials

Clinical summery

We retrospectively analyzed clinical case data from 32 patients who underwent Uni-portal thoracoscopic left upper lung resection and lymph node dissection at the Department of Thoracic Surgery, First People’s Hospital of Neijiang City, between February 2021 and December 2022. Preoperative clinical variables recorded included age, gender, smoking history, BMI (Body Mass Index), FEV1 (Forced expiratory volume in 1 s), PO2 (Partial pressure of oxygen), Clinical TNM stage, history of malignancy, comorbidity, and maximum diameter of tumor, as outlined in Table 1. Perioperative clinical variables, such as pathologic staging, pathologic types, intraoperative bleeding volume, surgery time, number of lymph node dissections, postoperative thoracic tube insertion time, day 1 chest tube drainage, postoperative complications, and length of hospital stay, are detailed in Table 2.

Selection criteria

1). Chest CT or PET/CT (Positron emission tomography / Computed tomography) indicating a mass in the left upper lung and undergoing UVATS left upper lobectomy + lymph node dissection. 2). Surgery that conforms to the principle of prioritizing Exports 3). Clinical TNM staging is early or late stage (T1-3N0-2M0), with no invasion of the left lower lobe and surrounding tissues 4) Complete case data.

Table 1 Preoperative clinical variables

Preoperative clinical variables	N
Gender	
Male	12(37.50%)
Female	20(62.50%)
Age(years)	52.53 ± 12.66
Smoking	
Yes	11(34.38%)
No	21(65.62%)
BMI	21.37 ± 3.57
FEV1(L)	1.89 ± 0.41
PO2(mmHg)	80.43 ± 6.57
Maximum diameter of tumor(cm)	2.59 ± 0.70
Comorbidity	
Hypertension	6
Diabetes	5
COPD	3
Asthma	1
Others	1
History of malignancy	0
Yes	7(21.87%)
NO	25(78.13%)
Clinical TNM stage	
I	18(56.25%)
II	12(37.5%)
IIIA	2(6.25%)

Table 2 Perioperative clinical variables

Perioperative clinical variables	N
Pathologic staging	
I	18(56.25%)
II	11(34.38%)
IIIA	3(9.36%)
Pathologic types	
Adenocarcinoma	19(59.37%)
Squamous cell carcinoma	9(28.12%)
Others	4(12.50%)
Intraoperative bleeding volume (ml)	79.53 ± 37.96
Surgical time(min)	98.93 ± 14.98
Number of lymph node dissection (pieces)	13.96 ± 2.69
Postoperative thoracic tube insertion time (day)	3.1 ± 1.84
Day 1, chest tube drainage (ml)	101.87 ± 49.46
Hospital stay (day)	5.62 ± 1.81
Postoperative complications	
Bronchopleural fistula	0
Arrhythmias	0
chylothorax	1
Postoperative progressive hemothorax	0

Exclusion criteria

1). Patients with two or three orifices and transitioning to thoracotomy during surgery. 2). Intraoperative exploration revealed severe calcification and fusion of lymph nodes in the hilum and mediastinum of the lungs 3). Pre-operative neoadjuvant therapy. 4). Patients with poor cardiovascular and pulmonary function who cannot tolerate surgery.

Surgical technical

Preoperative preparation and incision

Surgical fixation is executed by the same group of physicians employing dual-lumen tracheal intubation for general anesthesia and a single-lung ventilation mode. The patient is positioned laterally at a 90° angle, and to further widen the intercostal space, a soft pillow can be

horizontally placed at the level of both nipples. Commencing with marking the inferior angle of the shoulder nail, a 3 cm incision is made on the anterior 5th intercostal plane along the axillary midline. Figure 1A, B). A disposable incision protective cover is inserted, and a 30° Storz thoracoscope is utilized with the endoscope body secured behind the incision using a 14# T-tube. Positioned on the patient’s ventral side, the surgeon’s supporting hand is on the dorsal side, with one hand supporting and the other wielding double-joint forceps to expose the surgical field. In the left hand, the surgeon holds an elbow suction device, while energy instruments such as electrocoagulation hooks or ultrasound knives are held in the right hand. Figure 1C, D). Irrespective of the development of the oblique fissure in the upper left lung, the principle of Export priority

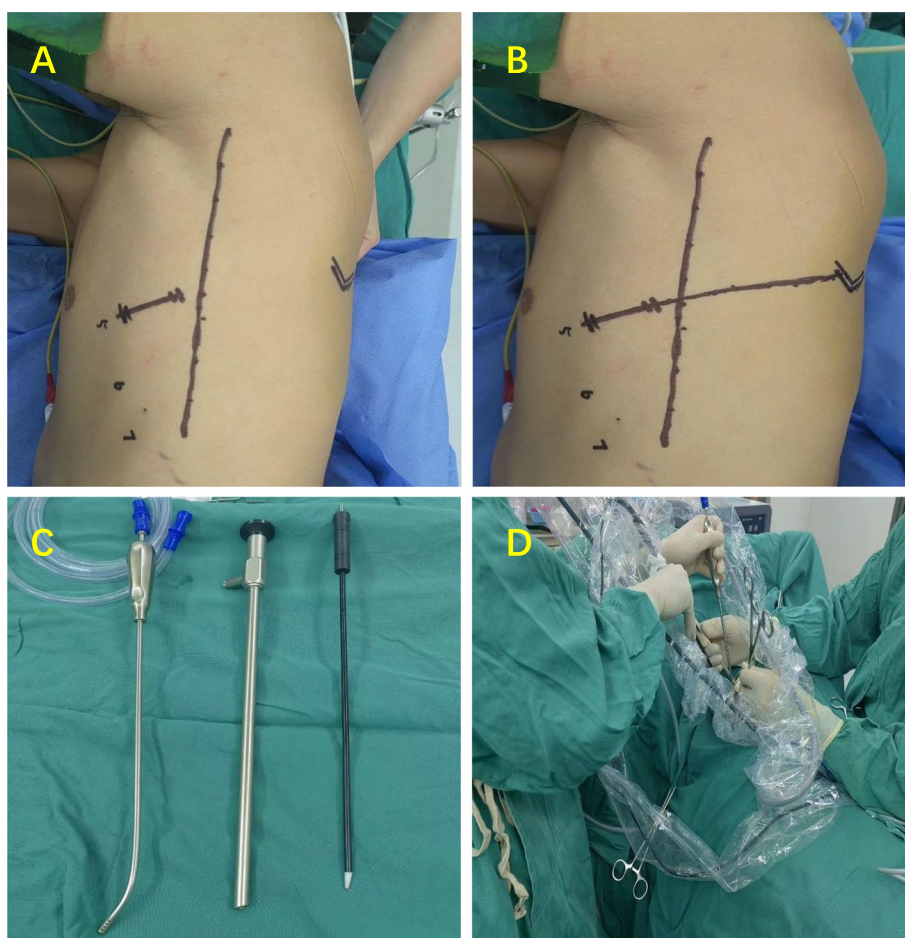


Fig. 1 **A, B** The parallel positioning method for the inferior angle of the shoulder armor first marks the position of the inferior angle of the shoulder armor, and the parallel corresponding method can be used to quickly mark the 5th rib gap. **C** The conventional instruments for Uni-pot thoracoscopy, from left to right, are elbow suction device, 30°Storz thoracoscope, and electrocoagulation hook in sequence. **D** Two surgeons can complete the surgery, with the main knife located on the patient’s ventral side and the assistant located on the patient’s dorsal side. Assistant with right hand holding mirror, left hand exposing field of view.

technique also applies to the anatomy of other single blood vessels.

Export priority surgical procedure

Upon entering the chest cavity, the initial procedure involves examining the left upper lung's lesion location, assessing for adhesions in the left chest cavity, evaluating interlobular fissure development, and determining the presence of pleural dissemination and pulmonary metastasis. Surgical interventions encompass left upper lobe resection coupled with systemic lymph node dissection.

- 1) The oblique fissure, well-developed, mandates a sequential approach beginning with the opening of the interlobular fissure for addressing the left upper pulmonary artery. The progression is from shallow to deep, specifically targeting $(A^4 + A^5) - (A^{1+2c}) - (A^{1+2a+b}) - (A^3) - (V^{1+5}) - B^{(1+5)}$, accompanied by systematic hilar and mediastinal lymph node dissection. Adhering to the Export priority principle, initial attention is directed toward (A^{1+2a+b}) and (A^3) , ensuring complete exposure of the left upper pulmonary vein Export before disconnection. Figure 2A, B). In the presence of a left upper mediastinal tongue artery, initiating the procedure from (A^{1+2c}) is advisable. Choosing linear cutting staplers demands a strategic approach, favoring those that allow angle adjustments. In cases of elevated vascular tension or difficulty advancing the cutting stapler, treatment options include silk thread ligation and arterial clipping. Subsequent to disconnecting all branches of the pulmonary artery in the left upper lobe, attention is turned to addressing the left upper lobe pulmonary vein and bronchus.
- 2) If the oblique fissure is poorly developed or undeveloped, it is essential to initially dissect away from the anterior mediastinal pleura to fully expose the left upper pulmonary artery trunk, (A^{1+2a+b}) , (A^3) , and the gap between the left upper pulmonary vein. Adhering to the principle of Export priority, pri-

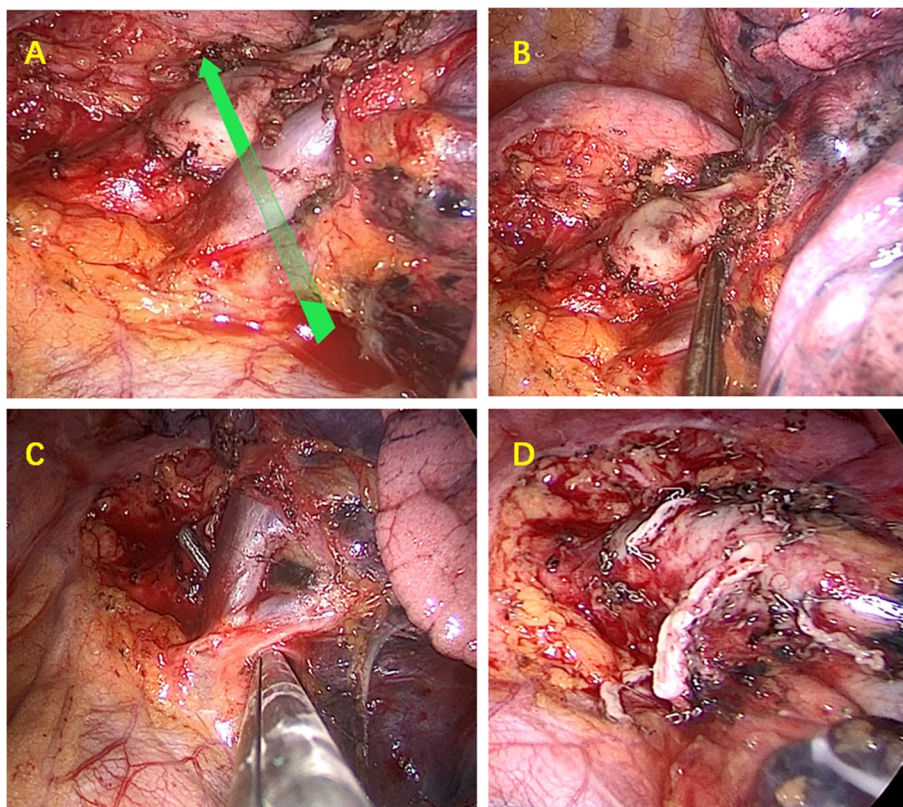


Fig. 2 Application of export priority technology in Uni-portal thoracoscopic left upper lobectomy + lymph node dissection. **A** When dealing with veins first, arteries LA^{1+2a+b} and LA^3 block the posterior Export of the left upper pulmonary vein. Forcefully passing through the linear cutting occluder may damage the blood vessels and cause bleeding. **B** Fully free the left upper pulmonary artery and venous space, expose LA^{1+2a+b} and LA^3 . **C** By utilizing export priority technology, LA^{1+2a+b} and LA^3 can be first incised to fully expose the left upper pulmonary vein Export. Cutting off the left upper pulmonary vein under Uni port conditions is easier and safer. **D** After the surgery, the condition of blood vessel and tracheal stumps

oritize handling $L(A^{1+2}a+b)$ and (LA^3) , open the Export, and subsequently disconnect the left upper pulmonary vein. The specific surgical sequence is as follows: $L(A^{1+2}a+b) \rightarrow (LA^3) \rightarrow L(A^{1+2}c) \rightarrow L(A^4+A^5) \rightarrow L(V^{1+5}) \rightarrow L(B^{1+5})$ + systematic hilar and mediastinal lymph node dissection, Fig. 2C, D).

Statistics

The statistical analysis data was processed using SPSS 26.0, and the quantitative data was represented by $(\bar{x} \pm s)$. Comparison between two groups of data with normal distribution is conducted using t-test, while count data is conducted using t-test χ^2 Inspection. Inspection level $\alpha=0.05$.

Results

Thirty-two patients who underwent Uni-portal thoracoscopy for radical surgery of left upper lung cancer were successfully treated, and all surgeries were performed following the principle of Export priority. Among them, there were 12 males and 20 females, with an average age of (52.53 ± 12.66) years. The total number of lymph node dissections was (13.96 ± 2.69) pieces, and the surgical time was (98.93 ± 14.98) minutes. The postoperative chest catheterization time averaged (3.1 ± 1.84) days, while the overall length of hospital stay was (5.62 ± 1.81) days. The average surgical bleeding volume was (79.53 ± 37.96) ml. The Day 1, chest tube drainage was (101.87 ± 49.46) ml. The postoperative pathological staging was predominantly distributed from stage I to stage IIIA, with 18 cases in stage I, 11 cases in stage II, and 3 cases in stage III. One patient developed chylothorax after surgery, and successful recovery was achieved through a fat-free diet, nutritional support, and one week of fluid replacement before discharge. There were no deaths during or within one month after surgery, and no transition to three-hole or traditional open chest surgery, Table 1.

Discussion

UVATS left upper lobectomy is widely acknowledged as the most challenging procedure among all lobectomy surgeries, presenting the highest risk and likelihood of bleeding. This is primarily attributed to the intricate branching pattern of the left upper pulmonary artery, which is prone to variations, and the absence of a direct route for the left upper pulmonary vein and artery, both of which encircle the left upper pulmonary bronchus. Consequently, the complexity of Uni-portal thoracoscopic left upper lobectomy resection is significantly heightened. In the early stages, the absence of angled linear cutting staplers led many surgeons to believe that a Uni-portal approach was unsuitable for left upper

lobectomy [5, 12]. Since Gonzalez Rivas first reported a case of UVATS left upper lobectomy in 2011 [13], Many thoracic surgeons have incorporated the Uni-portal approach into their surgical techniques [14, 15]. Over the past two decades, advancements in Uni-portal thoracoscopic technology, coupled with continuous innovation and instrument development, have contributed to the maturation of Uni-portal thoracoscopic surgery [16–18]. As a result, left upper lobectomy is no longer deemed a restricted procedure for Uni-portal applications [19–21]. In our study, we introduced a novel concept known as the "principle of Export priority." This principle emphasizes the strategic sequencing of procedures, particularly prioritizing the dissection of A^3 and $A^{1+2}a+b$ before addressing the left upper pulmonary vein. This intentional sequencing, aimed at minimizing Export obstruction, streamlines the subsequent processing of the left upper pulmonary vein, effectively mitigating the risk of significant bleeding. After conducting propensity score matching for 544 cases of non-small cell lung cancer, Sun [22] concluded that Uni-portal UVATS and three-port VATS are equally safe and feasible. UVATS exhibited a median surgical time of 114 min. Studies by MU [23] revealed that the efficacy of UVATS lobectomy is comparable to that of three-port thoracoscopic lobectomy, with an average operating time of (138.83 ± 63.63) minutes. Wang et al. [24]'s research emphasized the influence of factors such as anesthesia, patient position, and instruments in UVATS left upper lung cancer radical surgery, reporting an average surgical time of (164.70 ± 12.50) minutes. Our study employs Export Priority technology to optimize vascular treatment, resulting in a significantly reduced surgical time of (98.93 ± 14.98) minutes, which is notably lower than reported in the literature [25]. HU's analysis [8] of 204 cases of UVATS revealed a median lymph node dissection of 12 (10,13) and a median postoperative hospitalization time of 5 (4,6) days, aligning closely with our research findings. Throughout the surgery, meticulous efforts were made to liberate both the anterior and posterior mediastinal pleura, ensuring clear exposure of the left upper pulmonary artery trunk. In instances of challenging left upper lobectomy or arterial bleeding, a proactive measure was taken by pre-blocking the left upper pulmonary artery trunk. Wang et al.'s research [26] indicates that a comprehensive dissection of the mediastinal pleura and the incorporation of the concept of broad exposure can enhance the efficiency of Uni-portal thoracoscopy lymph node dissection, providing better protection for crucial surrounding tissues and organs. This aligns with our perspective. When managing other pulmonary artery branches, we advocate for the applicability

of the Export priority approach, especially within the limited field of view of a Uni-portal thoracoscope. Vascular inlet anatomy is more comprehensively visualized in our field of view, while Export anatomy often remains insufficiently exposed. This imbalance elevates the risk of unplanned bleeding during the passage of the cutting closure device. Ensuring parity between the visibility of the Export and entrance anatomy significantly enhances surgical safety. When investigating lymph node fusion in the chest cavity, it is essential to pre-block the pulmonary artery trunk while fully dissecting the pulmonary artery, both the inlet and outlet. This precautionary measure helps mitigate the risk of bleeding and ensures confidence for subsequent sleeve lung resection. A thorough incorporation of the Export priority concept holds the potential to diminish the risk of unplanned bleeding, reduce surgical duration, and equip surgeons to handle challenging procedures with greater composure.

Due to the improvement of modern living standards, most patients suffer from obesity [27, 28]. Excessive and thick subcutaneous adipose tissue accumulation on the surface of the ribs undoubtedly increases the difficulty for the surgeon to locate the ribs. We propose a new concept for precise rib positioning, which utilizes the principle of parallel correspondence between the lower corner of the shoulder armor and the 5th rib to quickly locate the rib gap. Accurate and perfect incision selection can effectively improve the comfort of surgeons and is also an important foundation for ensuring surgical safety. Triple port thoracoscopy often uses a 4th/7th/9th or 3th/7th/9th intercostal incision mode [22, 29], and the surgeon's right hand holding an electrocoagulation hook requires a longer path to dissect the blood vessels in the 9th intercostal space through the posterior axillary line, making the surgery itself difficult. The Uni-portal surgical approach may reduce the complexity and learning curve of left upper lobectomy, which requires further research to confirm, especially beneficial for right-handed dominant surgeons [30].

Our study introduces an innovative intercostal localization method designed specifically for patients facing challenges in localization due to obesity. Simultaneously, a retrospective analysis was conducted on data from 32 cases of Uni-portal thoracoscopic left upper lobectomy utilizing the export priority concept. The findings affirm the safety and reproducibility of our proposed Export priority concept. Nevertheless, our research does have limitations. Firstly, being a single-center study, it lacks the benefit of data feedback from multiple centers. Secondly, the study's sample size is relatively small, necessitating further research with an expanded sample size in the future.

In summary, Export priority technology has shortened surgical time, reduced unplanned bleeding, and may become an effective method for treating left upper lung lobectomy with UVATS.

Abbreviations

UVATS	Uni-portal video-assisted thoracoscopic surgery
L(A ¹⁺² a + b)	Left upper apical posterior segment artery (a + b) branch
LV ¹⁻⁵	Left upper pulmonary vein
LB ¹⁻⁵	Left upper pulmonary bronchus ¹⁻⁵
LA ³	Left upper anterior pulmonary artery
BMI	Body Mass Index
COPD	Chronic obstructive pulmonary disease
FEV1	Forced expiratory volume in 1 s,
PO2	Partial pressure of oxygen
PET/CT	Positron emission tomography / Computed tomography

Acknowledgements

The authors thank all their team members for their dedication

Authors' contributions

Y.Y and J.L conceived the method. X.X designed the method. S.C conducted the experiments and prepared figures 1-2. Xin Cheng prepared figures. All authors reviewed the manuscript.

Funding

This study was supported in part by Grants from the Neijiang science and technology project (Z2022025).

Availability of data and materials

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Informed consent for publication was obtained.

Competing interests

The authors declare no competing interests.

Received: 1 December 2023 Accepted: 29 March 2024

Published online: 03 May 2024

References

- Xiang Z, Wu B, Zhang X, et al. Uniportal versus multiportal video-assisted thoracoscopic segmentectomy for non-small cell lung cancer: a systematic review and meta-analysis. *Surg Today*. 2023;53(3):293–305.
- Tulinsky L, Kepičová M, Ilnát P, et al. Radicality and safety of mediastinal lymphadenectomy in lung resection: a comparative analysis of uniportal thoracoscopic, multiportal thoracoscopic, and thoracotomy approaches. *Surg Endosc*. 2023;37(12):9208–16.
- Qi K, Lin G, Liu H, et al. Safety and feasibility of preferential manual bronchoplasty in 2–3 cm single-port video-assisted thoracoscopic lobectomy. *Thorac Cancer*. 2023;14(24):2484–92.
- Wang Y, Wang Z, Yao F. The safety and feasibility of three-dimension single-port video-assisted thoracoscopic surgery for the treatment of early-stage lung cancer. *J Thorac Dis*. 2020;12(12):7257–65.
- Zhang M, Sihoe AD, Du M. A "reverse direction" technique of single-port left upper pulmonary resection. *J Thorac Dis*. 2016;8(8):2252–5.
- Chen Y, Lin JT, Dong S, et al. Uniportal video-assisted thoracoscopic surgery left upper lobectomy and systematic lymph node dissection with fused fissure. *J Thorac Dis*. 2017;9(5):1375–81.

7. Vieira A, Bourdages-Pageau E, Kennedy K, et al. The learning curve on uniportal video-assisted thoracic surgery: An analysis of proficiency. *J Thorac Cardiovasc Surg.* 2020;159(6):2487–2495.e2.
8. Hu CG, Zheng K, Liu GH, et al. Effectiveness and postoperative pain level of single-port versus two-port thoracoscopic lobectomy for lung cancer: a retrospective cohort study. *Gen Thorac Cardiovasc Surg.* 2021;69(2):318–25.
9. Wang L, Liu D, Lu J, et al. The feasibility and advantage of uniportal video-assisted thoracoscopic surgery (VATS) in pulmonary lobectomy. *BMC Cancer.* 2017;17(1):75.
10. Liu C, Ran R, Luo L, et al. The three steps method for uniportal video-assisted thoracoscopic right upper lobectomy. *J Cardiothorac Surg.* 2023;18(1):12.
11. Bourdages-Pageau E, Vieira A, Lacasse Y, et al. Outcomes of Uniportal vs Multiportal Video-Assisted Thoracoscopic Lobectomy. *Semin Thorac Cardiovasc Surg.* 2020;32(1):145–51.
12. Shen Y, Wang H, Feng M, et al. Single- versus multiple-port thoracoscopic lobectomy for lung cancer: a propensity-matched study†. *Eur J Cardiothorac Surg.* 2016;49(Suppl 1):i48–53.
13. Gonzalez-Rivas D, de la Torre M, Fernandez R, et al. Single-port video-assisted thoracoscopic left upper lobectomy. *Interact Cardiovasc Thorac Surg.* 2011;13(5):539–41.
14. Magouliotis DE, Fergadi MP, Spiliopoulos K, et al. Uniportal Versus Multiportal Video-Assisted Thoracoscopic Lobectomy for Lung Cancer: An Updated Meta-analysis. *Lung.* 2021;199(1):43–53.
15. Sihoe ADL. Transition from multiportal video-assisted thoracic surgery to uniportal video-assisted thoracic surgery... and evolution to uniportal robotic-assisted thoracic surgery? *Ann Cardiothorac Surg.* 2023;12(2):82–90.
16. Paradelo M, Garcia-Perez A, Fernandez-Prado R, et al. Uniportal robotic versus thoracoscopic assisted surgery: a propensity score-matched analysis of the initial 100 cases. *Ann Cardiothorac Surg.* 2023;12(1):23–33.
17. Tamura M, Shimizu Y, Hashizume Y. Pain following thoracoscopic surgery: retrospective analysis between single-incision and three-port video-assisted thoracoscopic surgery. *J Cardiothorac Surg.* 2013;8:153.
18. Drevet G, Ugalde Figueroa P. Uniportal video-assisted thoracoscopic surgery: safety, efficacy and learning curve during the first 250 cases in Quebec. *Canada Ann Cardiothorac Surg.* 2016;5(2):100–6.
19. Han KN, Kim HK, Lee HJ, et al. Single-port video-assisted thoracoscopic pulmonary segmentectomy: a report on 30 cases†. *Eur J Cardiothorac Surg.* 2016;49(Suppl 1):i42–7.
20. Wang BY, Tu CC, Liu CY, et al. Single-incision thoracoscopic lobectomy and segmentectomy with radical lymph node dissection. *Ann Thorac Surg.* 2013;96(3):977–82.
21. Hanaoka J, Yoden M, Okamoto K, et al. Mediastinal lymph node evaluation, especially at station 4L, in left upper lobe lung cancer. *J Thorac Dis.* 2022;14(9):3321–34.
22. Sun K, Wu Z, Wang Q, et al. Three-port single-intercostal versus uniportal thoracoscopic segmentectomy for the treatment of lung cancer: a propensity score matching analysis. *World J Surg Oncol.* 2022;20(1):181.
23. Mu JW, Gao SG, Xue Q, et al. A Matched Comparison Study of Uniportal Versus Triportal Thoracoscopic Lobectomy and Sublobectomy for Early-stage Nonsmall Cell Lung Cancer. *Chin Med J (Engl).* 2015;128(20):2731–5.
24. Wang Q, Cai YX, Deng Y, et al. Modular 3-cm uniportal video-assisted thoracoscopic left upper lobectomy with systemic lymphadenectomy. *J Thorac Dis.* 2016;8(8):2264–8.
25. Bin Yameen TA, Gupta V, Behzadi A. Uniportal versus multiportal video-assisted thoracoscopic surgery in the treatment of lung cancer: a Canadian single-centre retrospective study. *Can J Surg.* 2019;62(6):468–74.
26. Wang W, Rao S, Ma M, et al. The concept of broad exposure facilitates uniportal video-assisted thoracoscopic mediastinal lymph nodes dissection. *J Cardiothorac Surg.* 2021;16(1):138.
27. Neeland IJ, Poirier P, Després JP. Cardiovascular and Metabolic Heterogeneity of Obesity: Clinical Challenges and Implications for Management. *Circulation.* 2018;137(13):1391–406.
28. Piché ME, Tchernof A, Després JP. Obesity Phenotypes, Diabetes, and Cardiovascular Diseases. *Circ Res.* 2020;126(11):1477–500.
29. Wu Z, Wang Q, Wu C, et al. Three-port single-intercostal versus multiple-intercostal thoracoscopic lobectomy for the treatment of lung cancer: a propensity-matched analysis. *BMC Cancer.* 2019;19(1):8.
30. Lee JY, Mucksavage P, McDougall EM. Surgical skills acquisition among left-handed trainees—true inferiority or unfair assessment: a preliminary study. *J Surg Educ.* 2013;70(2):237–42.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.