ORIGINAL ARTICLE

Journal of Indonesia Vascular Access (*INAVA*) 2025, Volume 5, Number 1: 1-6
E-ISSN : 2798-6780 ; P- ISSN : 2807-7032

Published By : IVAA
the Indonesian Vascular Access Association

Comparing Short Outcomes of Robotic-Assisted vs. Video-Assisted Thoracoscopic Surgery for Lobectomy in Non-Small Cell Lung Cancer in Asia: A Systematic Review and Meta-Analysis

I Made Sathya Vijayananda[1*], Putu Raka Widhiarta[1], I Wayan Sudarma[2]

[1]Faculty of Medicine, Udayana University, Denpasar, Bali, Indonesia
[2]Cardiothoracic Vascular Surgeon and Thoracic Surgery Consultant, Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Bali, Indonesia

*Corresponding author:
I Made Sathya Vijayananda; Faculty of Medicine; Universitas Udayana, Denpasar, Bali, Indonesia;
esathya26@gmail.com

Received: 2024-12-15
Accepted: 2025-02-09
Published: 2025-03-05

ABSTRACT

Background: Open surgery remains a therapeutic option for early-stage non-small cell lung cancer (NSCLC), though it is commonly associated with higher complication rates and prolonged hospitalization. Minimally invasive techniques such as robotic-assisted thoracoscopic surgery (RATS) and video-assisted thoracoscopic surgery (VATS) have emerged as widely accepted alternatives for lobectomy. However, comparative analysis is needed to evaluate their relative clinical effectiveness.
Methods: This systematic review and meta-analysis included studies published between January 2014 and September 2024, retrieved from PubMed, ScienceDirect, and Cochrane databases. A total of 927 records were screened, and five studies met the inclusion criteria, focusing on short-term outcomes of RATS versus VATS for lobectomy in NSCLC patients across Asia. Study quality was assessed using the Cochrane Risk of Bias 2.0 tool, and all procedures followed PRISMA and Cochrane Handbook guidelines. Statistical analysis was performed using Review Manager (RevMan) version 5.4.1.
Results: Five studies comprising 1,091 patients (404 RATS; 687 VATS) were included. RATS showed a shorter hospital stay (SMD = -0.53; 95% CI: -0.93 to -0.14; $I^2 = 88\%$; $p = 0.008$) and chest tube duration (SMD = -0.35; 95% CI: -0.65 to -0.04; $I^2 = 80\%$; $p = 0.03$). No significant differences were observed in operative time or number of dissected lymph nodes.
Conclusion: RATS may offer clinical benefits in reducing hospitalization and chest tube duration, while maintaining comparable outcomes to VATS in operative time and lymphadenectomy.

Keywords: Robotic-Assisted Thoracoscopic Surgery, Video-Assisted Thoracoscopic Surgery, Lobectomy, Non-Small Cell Lung Cancer, Outcome.
Cite This Article: Vijayananda, I.M.S., Widhiarta, P.R., Sudarma, I.W. 2025. AComparing Short Outcomes of Robotic-Assisted vs. Video-Assisted Thoracoscopic Surgery for Lobectomy in Non-Small Cell Lung Cancer in Asia: A Systematic Review and Meta-Analysis. *Journal of Indonesia Vascular Access* 5(1): 1-6. DOI : 10.51559/jinava.v5i1.85

INTRODUCTION

Lung cancer is the second leading cause of death for women globally, particularly in Asia, and one of the malignancies with the highest mortality rate for males. In Asia, there were 1,033,881 instances of lung cancer recorded in 2012; 926,436 of those cases resulted in death. Communities are often burdened by lung cancer. The Southeast Asian nations have the most significant illness burden recorded.[1,2]

The majority of thoracic cancer centres use chemotherapy, radiation, surgery, and palliative care as part of their routine treatment. In the early stage, open surgery is performed. In the early stages, surgery is one treatment option, but it can cause many complications, both early and late complications. [1–3] Several post-operative complications after open thoracic surgery, including lung atelectasis, haemothorax, lobar torsion, pleural empyema, pneumonia, bronchopleural fistula, local tumour recurrence, parietal dehiscence, chest wall vascular fistula. Pneumonia is the most common post-operative complication. [4]

Minimally invasive surgery represents a rapidly advancing approach in modern medicine, integrating advanced imaging technology with smaller incisions to enhance surgical precision and visualization. Compared to conventional open procedures, this technique has been widely adopted for various clinical conditions, offering benefits such as reduced hospitalization time, lower complication rates, and faster postoperative recovery. Among the commonly utilized methods in thoracic surgery are Robotic-Assisted Thoracoscopic Surgery (RATS) and Video-Assisted Thoracoscopic Surgery (VATS). [1,3] With the development of the medical world using these two procedures, it is necessary to conduct research that discusses the comparison between these two alternative methods in assessing short-term outcomes in NSCLC patients who undergo lobectomy, especially in Asia. Therefore, the purpose of the study is to compare short-term outcomes of robotic-assisted with video-assisted thoracoscopic surgery for lobectomy in non-small cell lung cancer in Asia.

METHODS

Research Design

Research addressing the issue of comparing the short-term outcomes

between RATS and VATS in lobectomy in NSCLC patients was included in the systematic search, which was conducted in accordance with the PRISMA criteria and the research we considered for the systematic review and meta-analysis. Two authors (IMSV and PRW) conducted all of the literature research, data extraction, and bias assessment. Any disagreements about the study eligibility were methodically resolved by working together to reach a consensus with other participants. The papers were examined separately by two authors.

The following criteria were chosen: Studies that were conducted in the Asia-Pacific region had to explicitly compare RATS and VATS in lobectomies for NSCLC cases, describing patient outcomes like length of hospital stay, operative time, chest tube drainage, number of dissected lymph nodes, and post-operative complications. We also included the adult patient population and underwent procedures from 2014 to 2024. Excluded from the analysis were studies with performed surgical techniques without RATS and VATS, studies involving pediatric populations, and studies that lacked information about the patient's outcome and procedure or management undergone for the patients.

Comprehensive Literature Screening

A literature search was conducted in MEDLINE, PubMed, and ScienceDirect (January 2014–September 2024) using English-language MeSH terms and relevant keywords including (((((((((Robotic Assisted Thoracoscopic Surgery) OR (RATS)) AND (Video Assisted Thoracoscopic Surgery)) OR (VATS)) AND (Lobectomy)) AND (Non-Small Cell Lung Cancer)) OR (NSCLC)) AND (Efficacy)) OR (Effectiveness)) OR (Outcome). Nine hundred and seventy-two manuscripts were initially identified, and 5 were confirmed to meet the predetermined inclusion criteria, delineated in the PRISMA flowchart, and statistical analysis was conducted using RevMan.

Qualitative evaluation of the included studies

Using the seven essential components of the Cochrane Collaboration's Risk of Bias Assessment tools, a thorough assessment of possible bias was carried out. Important elements, including participant blinding, allocation concealment, and randomization processes, were thoroughly assessed to determine the possibility of bias in the trials.

Data synthesis and analysis

Binary outcomes were transformed into standardized mean differences (SMD) with corresponding 95% confidence intervals (CI) to assess short-term subgroup outcomes, while post-operative complications were reported as odds ratios (OR). Forest plots were generated to visually present effect sizes and CIs across studies. Heterogeneity was evaluated using the I^2 statistic; values above 50% indicated substantial heterogeneity, prompting the use of a random-effects model, whereas values below 50% warranted a fixed-effects model. All statistical analyses were conducted using Review Manager (RevMan) version 5.4.1. A p-value < 0.05 was considered statistically significant. This analytical approach ensured a rigorous and clinically meaningful synthesis of the evidence.

RESULTS

Selection of the Studies and Risk of Bias Analysis

The PRISMA flow diagram shows the study selection process in Fig. 1. The initial research obtained a total of 927 studies, and after the elimination of duplication, 809 studies underwent independent screening. Seven hundred and ninety-three were excluded due to the following reasons: irrelevant titles or abstracts, non-lobectomy procedures, and studies that were not conducted in the Asia region. After exclusion, 10 full-text studies were assessed for eligibility. At the end, 5 studies were included in our data synthesis. According to the inclusion study.

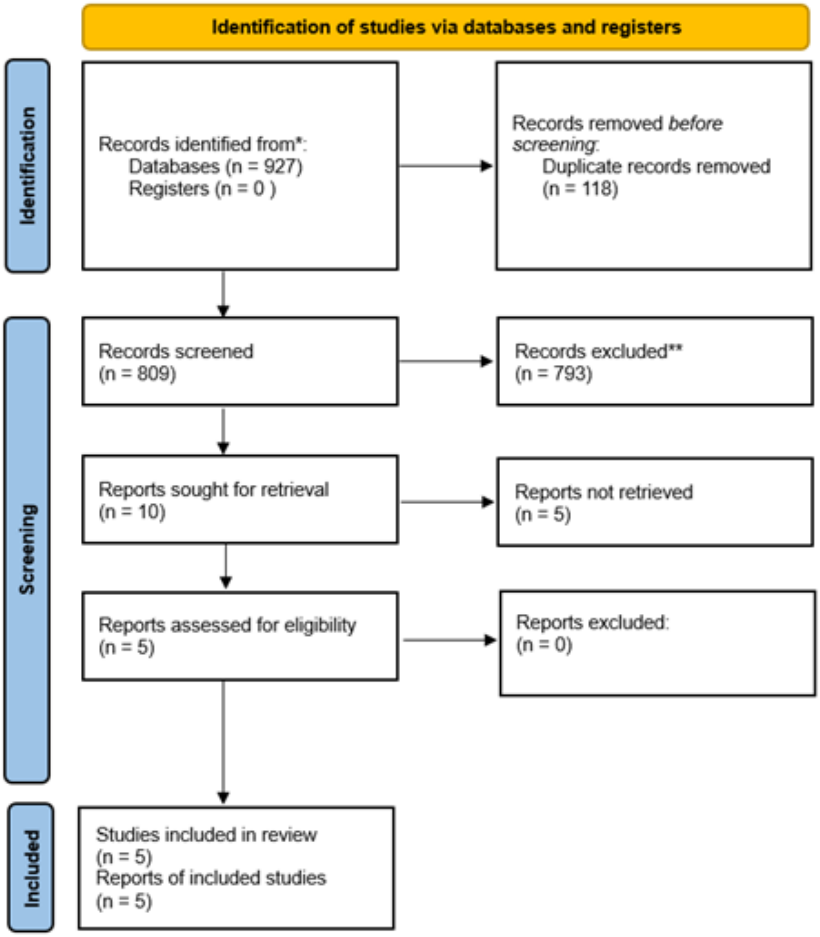

Figure 1. PRISMA Flowchart

Characteristics of the patient

Characteristics of the studies that we included are shown in **Table 1**. All our studies were conducted in the Asia region. Five studies discussed the comparison of RATS with VATS in lobectomy procedures in NSCLC cases. The intervention group consisted of 404 patients, while the control group consisted of 687 patients. The mean age of the population is shown in **Table 1**.

Comparison between RATS and VATS

The results of the data analysis showed that RATS was significantly better than VATS in the parameter of length of hospital stays for patients in cases (SMD -0.53, 95% CI [-0.93, -0.14], I^2 = 88%, p = 0.008). In addition, the parameter of the duration of chest tube drainage was also better in RATS compared to VATS (SMD -0.35, 95% CI [-0.065, -0.04], I^2 = 80%, p = 0.03). However, for the other 2 parameters, namely operative time (SMD -0.19, 95% CI [-0.48, 0.10] I^2 = 78%, p = 0.21) and number of dissected lymph nodes (SMD 0.11, 95% CI [-0.05, 0.27] I^2 = 80%, p = 0.03), these were not statistically significant.

Post-Operative Complications

Our findings show that 5 major groups of complications occur in patients undergoing this procedure. In prolonged air leak complications, it was significantly different (OR 0.46, 95% CI, [0.24, 0.90]). This was also like pleural effusion, which showed statistically different OR 0.84, 95% CI [0.14, 4,96]. However, the other three complications, namely pneumonia (OR 1.21, 95% CI [0.42, 3.48]), arrhythmia (OR 1.39, 95% CI [0.29, 6.73]), and pulmonary embolism (OR 1.40, 95% CI [0.14, 4.96]), are not significantly different.

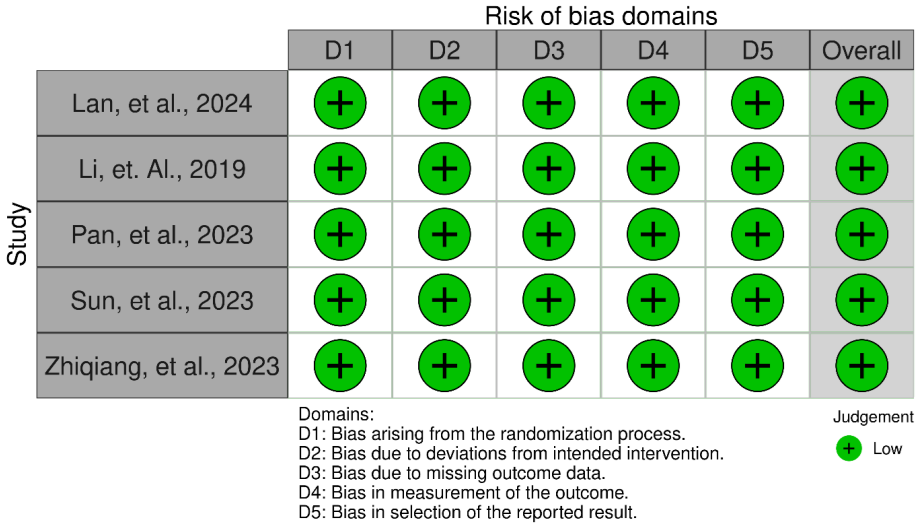

Figure 2. Risk of Bias Analysis

Table 1. Characteristics of the studies

Study	Country	Design	Study Period	Ages (Mean SD)		Intervention for patients		
				RATS	VATS	RATS	VATS	Total
Li et al., 2019[5]	China	Retrospective Cohort	January 2014–January 2017	57.2± 8.9	59.7± 8.8	36	85	121
Pan, et al., 2023[6]	China	Retrospective Cohort	November 2014-March 2021	32.2± 3	32.2± 2.9	105	315	420
Sun, et al., 2023[7]	China	Retrospective Cohort	January 2019-February 2022	57.5± 7.5	59± 7	173	163	336
Zhiqiang et al. 2023[8]	China	Retrospective Cohort	January 2021-April 2022	59.5± 7.5	60± 6	40	48	88
Lan, et al., 2024[9]	China	Retrospective Cohort	March 2021-May 2022	58.1± 9.4	58.1± 11.5	42	84	126

DISCUSSION

RATS and VATS are minimally invasive procedures for lung resection in NSCLC. RATS employs a more complicated robotic system, which has certain benefits but also has issues. The robotic device improves surgical accuracy and control, making it especially beneficial for complicated lymph node dissections.[10] However, this intricacy may lead to lengthier operational periods, potentially extending post-surgical recovery and hospital stays.[11] It has been proven by our findings in this study, with a total of 1091 patients, with each undergoing lobectomy with RATS, amounting to 404 patients, and VATS amounting to 687 patients, that RATS was better in terms of the length of hospital stay of patients. Our findings are consistent with those reported in previous meta-analyses by Tasoudis et al.,[12] Ma, et al.,[13] both of which demonstrated that patients undergoing lobectomy with RATS experienced shorter hospital stays compared to those treated with VATS. In contrast, Huang et al. reported no significant difference in hospital stay duration between the two surgical approaches.[14]

The present analysis indicates that RATS is associated with a shorter duration of chest tube drainage compared to VATS. This observation is in line with the findings reported by Ma et al.[13], who also demonstrated a favorable outcome for RATS in terms of reduced chest tube duration. This could be because RATS is a less invasive surgical technique with a wider field of view, which allows it to offer less invasive advantages by lessening tissue

irritation around the pleura, which lowers the risk of pleural effusion and shortens the recovery period following surgery. Nonetheless, a number of studies have produced conflicting results concerning the length of chest tubes: some meta-analyses show that patients undergoing RATS have much shorter drainage times than patients undergoing VATS, while other studies show that patients with lung neoplasms do not significantly differ in drainage times between the two procedures. [13,15]

The operative time that we found showed no significant difference; this is in line with the findings of a meta-analysis compiled by Huang et al.,[14] who stated that the data they had also did not show any significant difference. This is different from the findings of Ma et al.,[13] who showed in their data that RATS had a lower duration of chest tube drainage compared to VATS. One significant aspect is the technological difficulty of RATS. Although robotic systems provide more dexterity and visualization, these benefits may result in lengthier setup times than VATS. The requirement to position and calibrate robotic arms may increase the total operating time, particularly for surgeons who are still learning the robotic technology. [16,17] Research indicates that as surgical teams gain proficiency and experience with robotic systems, operative times tend to decrease significantly. Early surgical procedures often experience delays due to the learning curve associated with advanced robotic tools. [16]

In contrast, although VATS is often thought to be easier and faster because of its known procedures and decreased setup needs, additional aspects influencing operational time with this methodology should be addressed. For example, intrinsic inequalities in anatomical visibility and access may result in varying operation durations. In complicated instances, more time may be required to resolve anatomical problems provided by VATS, such as restricted access to particular lung segments and the necessity to resect neighboring tissues for optimal exposure. [18,19] Furthermore, the experience and surgical volume of the operating team are significant factors influencing operative times for both RATS and VATS procedures. Surgeons with high-

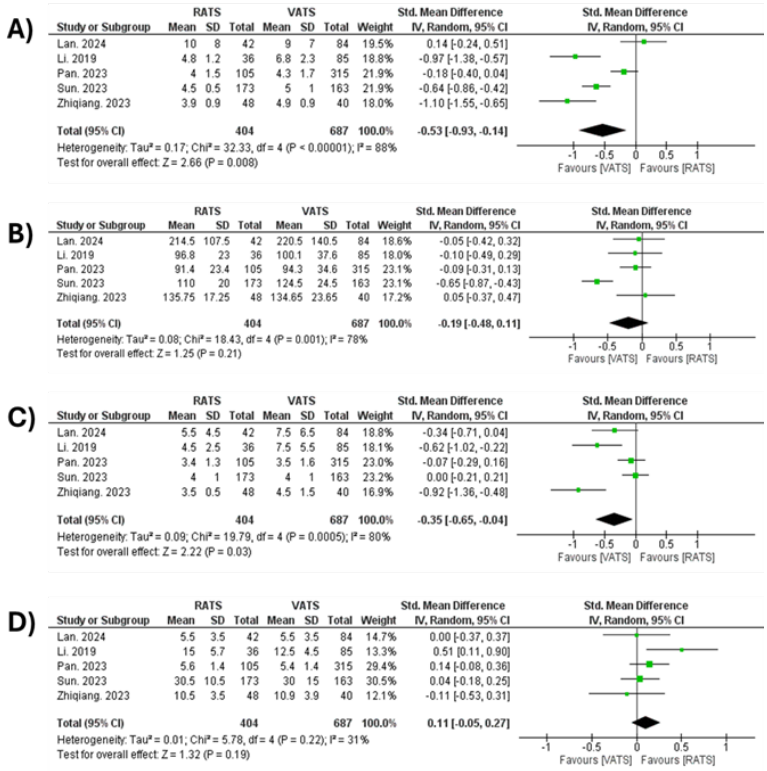

Figure 3. Comparison of RATS and VATS's short-term results on (A) hospital stay duration, (B) operating time, (E) chest tube drainage, and (D) number of lymph nodes removed

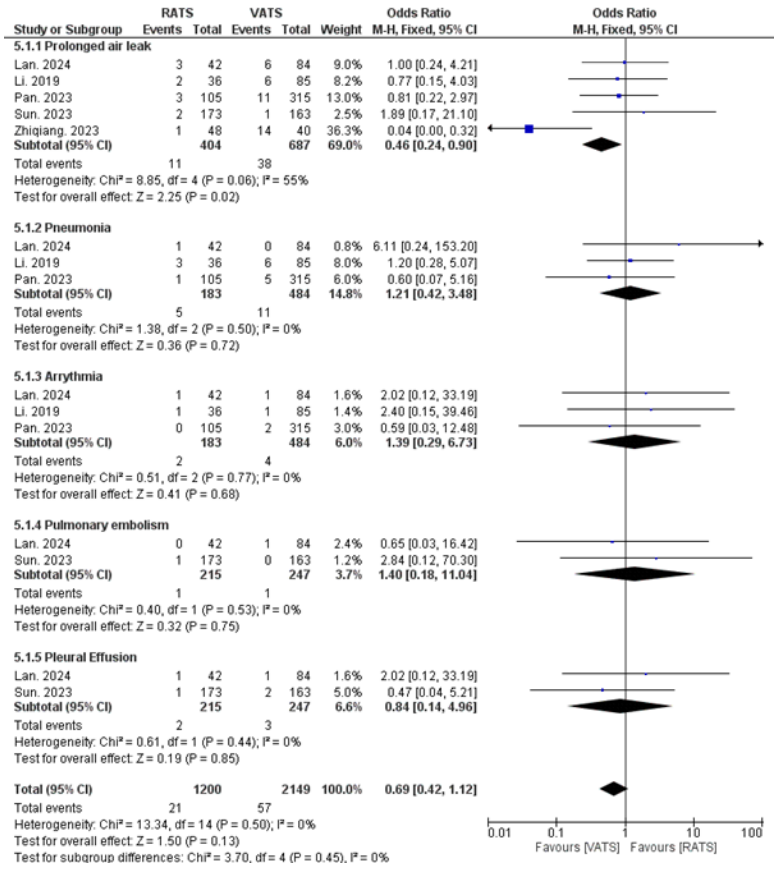

Figure 4. Post-operative complications plot

volume experience generally complete procedures more efficiently, regardless of the technique employed. [17]

The number of dissected lymph nodes is a key parameter in evaluating the short-term outcomes of lobectomy. Based on our analysis, no significant difference was observed between the RATS and VATS groups. This contrasts with findings from three previous meta-analyses by Tasoudis et al.,[12] Ma, et al.,[13]and Huang et al.,[14], which reported a higher number of lymph nodes dissected in the RATS group. Importantly, lymph node dissection plays a critical role in accurate cancer staging. A greater number of resected lymph nodes provides more detailed information regarding disease spread and contributes to determining the pathological N stage in accordance with the TNM classification system. [20,21] This detailed examination is necessary because appropriate staging influences future treatment choices and determines the necessity for adjuvant medicines. For example, the number of lymph nodes checked has a considerable impact on the survival of patients with NSCLC. Gallina et al. found that an acceptable surgical lymph node dissection should collect enough nodes to guarantee that no malignant lymph nodes are ignored throughout the staging procedure. [21]

Complications might develop, particularly during operational procedures. In our investigation, we discovered problems from this surgery, such as extended air leak, pneumonia, arrhythmia, pleural effusion, and pulmonary embolism. The most prevalent problem was a protracted air leak, which we found to be statistically distinct. This is different from the findings of Tasoudis et al.,[12] and Huang et al.[14] who said that RATS and VATS were equivalent or not statistically different. Other complications include pneumonia, arrhythmia, pleural effusion, and pulmonary embolism. Based on our findings, they are not statistically different, and this is in line with the meta-analysis by Tasoudis et al.,[12] and Huang et al.[14]

CONCLUSION

In conclusion, we found that RATS was better in short-outcome parameters such as length of hospital stay and duration of chest tube drainage compared to VATS. However, operative time and number of dissected lymph nodes were still comparable. For post-operative complications, prolonged air leak was less common than VATS, and there was no difference in the incidence of pneumonia, arrhythmia, pleural effusion, and pulmonary embolism.

DISCLOSURE

AUTHOR CONTRIBUTION

All authors contributed substantially to the conception, study design, data acquisition, and interpretation of the findings presented in this manuscript.

CONFLICT OF INTEREST

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

FUNDING

This research was conducted without any external financial support or funding sources.

REFERENCES

1. Khan JA, Albalkhi I, Garatli S, Migliore M. Recent Advancements in Minimally Invasive Surgery for Early Stage Non-Small Cell Lung Cancer: A Narrative Review. J Clin Med. 2024;13(11):3354. Available from: https://pubmed.ncbi.nlm.nih.gov/38893066
2. Pakzad R, Mohammadian-Hafshejani A, Ghoncheh M, Pakzad I, Salehiniya H. The incidence and mortality of lung cancer and their relationship to development in Asia. Transl Lung Cancer Res. 2015;4(6):763–74.
3. Berzenji L, Wen W, Verleden S, Claes E, Yogeswaran SK, Lauwers P, et al. Minimally Invasive Surgery in Non-Small Cell Lung Cancer: Where Do We Stand? Cancers (Basel). 2023;15(17):4281. Available from: https://pubmed.ncbi.nlm.nih.gov/37686557
4. Burel J, El Ayoubi M, Baste JM, Garnier M, Montagne F, Dacher JN, et al. Surgery for lung cancer: postoperative changes and complications—what the Radiologist needs to know. Vol. 12, Insights into Imaging. Springer Science and Business Media Deutschland GmbH; 2021.
5. Li C, Hu Y, Huang J, Li J, Jiang L, Lin H, et al. Comparison of robotic-assisted lobectomy with video-assisted thoracic surgery for stage IIB-IIIA non-small cell lung cancer. Transl Lung Cancer Res. 2019;8(6):820–8. Available from: https://pubmed.ncbi.nlm.nih.gov/32010560
6. Pan H, Zhang J, Tian Y, Zou N, Zhu H, Gu Z, et al. Short- and long-term outcomes of robotic-assisted versus video-assisted thoracoscopic lobectomy in non-small cell lung cancer patients aged 35 years or younger: a real-world study with propensity score-matched analysis. J Cancer Res Clin Oncol. 2023/05/30. 2023;149(12):9947–58. Available from: https://pubmed.ncbi.nlm.nih.gov/37253947
7. Sun T-Y, Xie C-L, Tan Z, Li J-B, Yang M-Z, Yang H-X. Short-term outcomes of robotic lobectomy versus video-assisted lobectomy in patients with pulmonary neoplasms. Thorac Cancer. 2023/05/01. 2023;14(16):1512–9. Available from: https://pubmed.ncbi.nlm.nih.gov/37128686
8. Zhiqiang W, Shaohua M. Perioperative outcomes of robotic-assisted versus video-assisted thoracoscopic lobectomy: A propensity score matched analysis. Thorac Cancer. 2023/05/18. 2023;14(20):1921–31. Available from: https://pubmed.ncbi.nlm.nih.gov/37201914
9. Lan Z, Zeng C, Li Z, Xia X, Mo A, Li X, et al. Early patient-reported outcomes after robotic-assisted versus video-assisted thoracoscopic lobectomy. Thorac Cancer. 2024/05/30. 2024;15(20):1563–71. Available from: https://pubmed.ncbi.nlm.nih.gov/38816940
10. Zhi-qiang WU, Ma S. Perioperative Outcomes of Robotic-assisted Versus Video-assisted Thoracoscopic Lobectomy: A Propensity Score Matched Analysis. Thorac Cancer. 2023;14(20):1921–31.
11. Wei S, Chen M, Chen N, Liu L. Feasibility and Safety of Robot-Assisted Thoracic Surgery for Lung Lobectomy in Patients With Non-Small Cell Lung Cancer: A Systematic Review and Meta-Analysis. World J Surg Oncol. 2017;15(1).
12. Tasoudis PT, Diehl JN, Merlo A, Long JM. Long-term outcomes of robotic versus video-assisted pulmonary lobectomy for non-small cell lung cancer: systematic review and meta-analysis of reconstructed patient data. J Thorac Dis. 2023/09/18. 2023;15(10):5700–13. Available from: https://pubmed.ncbi.nlm.nih.gov/37969301
13. Ma J, Li X, Zhao S, Wang J, Zhang W, Sun G. Robot-assisted thoracic surgery versus video-assisted thoracic surgery for lung lobectomy or segmentectomy in patients with non-small cell lung cancer: a meta-analysis. BMC Cancer. 2021;21(1):498. Available from: https://pubmed.ncbi.nlm.nih.gov/33941112
14. Huang S, Huang X, Huang Z, Luo R, Liang W. Comparison of robot-assisted thoracic surgery versus video-assisted thoracic surgery in the treatment of lung cancer: a systematic review and meta-analysis of prospective studies. Front Oncol. 2023;13:1271709. Available from: https://pubmed.ncbi.nlm.nih.gov/38023124
15. Katritama AA, Yasa KP, Tidja YEA. Comparing Robotic-Assisted Thoracoscopic Surgery (RATS) vs Video-Assisted Thoracoscopic Surgery (VATS) Approaches for Non-Small Cell Lung Cancer (NSCLC): A Systematic Review and Meta-Analysis. Journal of Social Research. 2023;2(10):3699–711.
16. Dang J, Sun S, Wu Z, Shan Y, Zhang H. Meta-

Analysis of Clinical Efficacy of Thoracoscopy and Robotic Surgery in the Treatment of Mediastinal Tumors. World J Surg Oncol. 2024;22(1).
17. Wang C, Wang J, Liu F, Wang W. Robot-Assisted Thoracoscopic Surgery vs. Sternotomy for Thymectomy: A Systematic Review and Meta-Analysis. Front Surg. 2023;9.
18. Xie B, Sun X, Qin Y, Liu A, Miao S, Jiao W. Short-term Outcomes of Typical Versus Atypical Lung Segmentectomy by Minimally Invasive Surgeries. Thorac Cancer. 2019;10(9):1812–8.
19. Yamashita Y, Mukaida H, Harada H, Tsubokawa N. Post-Thoracotomy Pain and Long-Term Survival Associated With Video-Assisted Thoracic Surgery Lobectomy Methods for Clinical T1N0 Lung Cancer: A Patient-Oriented, Prospective Cohort Study. European Journal of Cardio-Thoracic Surgery. 2013;44(1):e71–6.
20. Venkitaraman B, Jiang L, Wu L, Cai J. Uniportal Video-Assisted Thoracoscopy Surgery in Lung Cancer: Largest Experience. Asian Cardiovasc Thorac Ann. 2019;27(7):559–64.
21. Gallina FT, Melis E, Forcella D, Mercadante E, Marinelli D, Ceddia S, et al. Nodal Upstaging Evaluation After Robotic-Assisted Lobectomy for Early-Stage Non-Small Cell Lung Cancer Compared to Video-Assisted Thoracic Surgery and Thoracotomy: A Retrospective Single Center Analysis. Front Surg. 2021;8.