Comparison Between Video-Assisted Thoracoscopic Surgery versus Thoracotomy for Non Small Cell Lung Cancer : A Systematic Review and Meta-Analysis

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Abstract

Video-assisted thoracic surgery (VATS) lobectomy provides a minimally invasive approach for the management of early-stage lung cancer. This systematic review and meta-analysis is aim to provide the outcomes between VATS and thoracotomy lobectomy**.** The research is aim to compare between video-assisted thoracoscopis surgery and thoracotomy in non small cell lung cancer patient. Five articles databases were searched via PubMed. Primary outcomes were operative time, postoperative hospital stay, chest drainage volume, chest drainage time, and number of lymph node dissesction. Review Manager (RevMan) [computer program] version 5.4 was used to pool the data. There were significant results VATS has shorter postoperative length of stay (95% CI 1.08 to 4.83) and chest drainage volume (CI 25.83 to 344.98). There were not significant results in terms of operative time (95%CI -30.88 to 40.10), chest drainage time (95%CI -0.95 to 2.50), and number of lymph node rdissection (95%CI -0.67 to 1.740)**.** VATS lobectomy is superior to thoracotomy lobectomy in terms of shorter postoperative length of stay (95% CI 1.08 to 4.83) and chest drainage volume (CI 25.83 to 344.98). The results also showed no significant differences between the two treatment modalities regarding the operative time, chest drainage time, and number of lymph nodes dissected.

Keywords : Lobectomy, non-small cell lung cancer (NSCLC), thoracotomy, video-assisted thoracoscopic surgery

Perbedaan antara *Video Asissted Thoracoscopy Surgery* (VATS) dengan Torakotomi pada *Non Small Cell Lung Cancer* (NSCLC) : Sebuah Tinjauan Sistematik dan Meta Analisis

Abstrak

Lobektomi *Video-Assisted Thoracic Surgery* (VATS) memberikan pendekatan minimal invasif untuk penatalaksanaan kanker paru stadium awal. Tinjauan sistematis dan meta-analisis ini bertujuan untuk memberikan hasil antara VATS dan lobektomi torakotomi. Penelitian ini bertujuan untuk membandingkan antara VATS dan torakotomi pada pasien kanker paru *Non Small Cel Lung Cancer* (NSCLC). Lima artikel didapat melalui PubMed. Hasil utama adalah waktu operasi, rawat inap pasca operasi, volume drainase dada, waktu pemasangan drainase dada, dan jumlah diseksi kelenjar getah bening. Review Manager (RevMan) [program komputer] versi 5.4 digunakan untuk mengumpulkan data. Terdapat hasil yang signifikan VATS memiliki lama rawat inap pasca operasi yang lebih pendek (95% CI 1.08 hingga 4.83) dan volume drainase dada (CI 25.83 hingga 344.98). Tidak terdapat hasil yang signifikan pada waktu operasi (95%CI -30.88 hingga 40.10), waktu drainase dada (95%CI -0.95 hingga 2.50), dan jumlah pembedahan kelenjar getah bening (95%CI -0.67 hingga 1.740). Kesimpulan : Lobektomi VATS lebih unggul dibandingkan lobektomi torakotomi dalam hal lama rawat inap pasca operasi yang lebih pendek (95% CI 1,08 hingga 4,83) dan volume drainase dada (CI 25,83 hingga 344,98). Hasil penelitian juga menunjukkan tidak ada perbedaan yang signifikan antara kedua modalitas pengobatan mengenai waktu operasi, waktu drainase dada, dan jumlah kelenjar getah bening yang dibedah.

Kata kunci : Lobektomi, *non small cell lung cancer* (NSCLC), torakotomi, *video asissted thoracoscopy surgery* (VATS)

Introduction

Lung resection is currently the most widely accepted treatment method for early-stage lung cancer. As technology advances and surgical techniques adapt, traditional surgical methods have evolved into minimally invasive surgery. Video-assisted thoracoscopic surgery (VATS) lobectomy was introduced as a safe and feasible treatment option for early-stage non-small cell lung cancer (NSCLC) in the early 1990s. With increasing experience, VATS has become a routine procedure for these patients.[1] However, the use of VATS lobectomy

for patients with advanced lung cancer is still a topic of debate due to its disadvantages in en bloc resection and lymph node dissection, which can impact the oncological outcome.[2]

According to an analysis of The Society of Thoracic Surgery (STS) database, one-fifth of all lobectomies were carried out using a VATS method. The study also revealed that the use of VATS lobectomy as a treatment for lung cancer has been increasing over the past three years. In 2004, it was 21.6%, which rose to 28.6% in 2005 and reached 32% in 2006.[3]

Furthermore, video-assisted thoracoscopic surgery (VATS) is still superior to open thoracotomy for the resection of early-stage NSCLC with the advantages of less complication, less pain, faster recovery and long-term survival. This systematic review aims to compare VATS and Thoracotomy and evaluate the intraoperative blood loss, duration of operation time, drainage tube volume, duration of drainage, and length of stay.

Methods

This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Figure 1). The literature review search strategy was born from the database PubMed and restricted to the English language with publication in the last ten years. The Medical Subject Headings (MeSH) terms were used: “Primary lung cancer OR primary lung nodule OR Non-small cell lung cancer AND thoracoscopic OR Thoracoscopic lobectomy OR Thoracotomy lobectomy”. Study description and quality assesment stated in figure 3.

The PICO approach was used to describe this investigation's inclusion and exclusion criteria. All English language articles on early-stage non-small cell lung cancer were included in this analysis. The clinical outcomes were assessed, such as intraoperative blood loss, durante operation time, drainage tube volume, duration of drainage, length of stay and complications between video-assisted thoracoscopic surgery and thoracotomy in treatment for non-small cell lung cancer (NSCLC).

Results

In operating time, five studies included the operative time of the VATS group and the Thoracotomy group. The meta-analysis indicated that compared to thoracotomy, the operative time was similar between VATS and Thoracotomy lobectomy (WMD = 4.61, 95%CI -30.88 to 40.10, P = <0.0001), with specific heterogeneity (P = 0.80, I2 = 87%) (Figure 2)

In Postoperative Hospital stay**,** five studies included postoperative hospital stays, the meta-analysis revealed that the VATS lobectomy group had shorter postoperative hospital stays than thoracotomy lobectomy group lobectomy with significant results (WMD = 2.95, 95%CI 1.08 to 4.83, P = 0.01), with specific heterogeneity (P =0.002, I2 = 69%) (Figure 2)

In Chest Drainage Volume**,** three studies reported data on chest drainage volume, and our meta-analysis revealed that compared to thoracotomy, VATS lobectomy has lower chest drainage volume than the Thoracotomy lobectomy group (WMD = 185.40, 95%CI 25.83 to 344.98, P = 0.91), with no evidence heterogeneity (P = 0.02, I2 = 0%) (Figure 2)**.**

In Chest Drainage Time (days), five articles reported data on chest drainage time; in our meta-analysis, there were similar results in chest drainage time (days) between the VATS lobectomy and Thoracotomy lobectomy group; the results were not significant (WMD = 0.78, 95%CI -0.95 to 2.50, P <0.0001), with specific heterogeneity (P = 0.38, I2 = 85%) (Figure 2).

In Number of Resected lymph nodes, three articles reported the number of resected lymph nodes in our meta-analysis showed there were similiar results in the number of resected lymph nodes between VATS lobectomy and thoracotomy group (WMD = 0.53, 95%CI -0.67 to 1.740, P 0.03), with specific heterogeneity (P = 0.39, I2 = 73%) (Figure 2).

Table 1. Study description and quality assesment

No	Reference	Study Design	Treatment	Conversion rate	Number of patients	Mean Age, year	M vs F	Pathological Stage		
								I	II	III
1.	Batihan et.al., 2020	Retrospective study	Thoracoscopy	1 (4%)	24	62.17±1.61	22/2		9	14
			Thoracotomy		36	63.19±2.09	35/1		15	22
2.	Nakano et.al., 2015	Retrospective study	Thoracoscopy	4 (exclude)	35	75.0±6.2	31/4		24	11
			Thoracotomy		33	69.2±8.5	30/3		26	7
3.	Li et.al.2017	Retrospective study	Thoracoscopy	2 (10.5%)	19	42.5±11.3	4/15	NG	NG	NG
			Thoracotomy		11	40.9±17.5	5/6	NG	NG	NG
4.	Zhou et.al.,2015	Retrospective study	Thoracoscopy		10	60.5±16.9	9/1	6	2	2
			Thoracotomy		41	62.5±7.2	35/6	18	10	13
5.	Zhang et.al., 2022	Retrospective study	Thoracoscopy	42 of 78 patients	53	59.6±6.21	52/1	IB-IIB = 18		35
			Thoracotomy		78	59.1±7.8	75/3	IB-IIB = 13		65

NG : not given

Discussion

Several clinical studies have demonstrated that VATS lobectomy offers several perioperative advantages over thoracotomy lobectomy, such as shorter hospitalization, less blood loss, lower drainage volume, shorter drainage time, and less postoperative pain. Due to these benefits, the National Comprehensive Cancer Network (NCCN) guidelines recommend VATS lobectomy as the preferred early-stage NSCLC approach. However, there are still doubts about the safety and efficacy of VATS lobectomy in advanced lung cancer, as there are few published reports about its use in these cases.[1] It is worth noting that there is no absolute maximum size of the tumor for thoracoscopic sleeve lobectomy, and some case reports have shown the successful resection of tumors up to 6cm.[4]

The technique of thoracoscopic lobectomy has evolved over the years to become less invasive. Since the first VATS lobectomy was performed in the early 1990s, several studies have confirmed its safety and advantages. In 2002, Santambrogio et al. reported the first thoracoscopic sleeve bronchoplasty. VATS lobectomy continues to gain popularity among thoracic surgeons due to its multiple benefits.[5]

Case reports of VATS lobectomy with three or four ports have been published, demonstrating its safety and benefits.[6] In 2013, Gonzalez-Rivas et al. reported the first single-port VATS sleeve lobectomy, proving that sleeve lobectomy could be performed with fewer incisions.[7,8]

Uniportal VATS is generally considered more challenging than multiportal VATS. This is because the entire operation is carried out through a single incision, through which 2 or 3 surgical instruments and the thoracoscope are inserted. As a result, it has been assumed that a surgeon needs to have a thorough understanding of multiportal VATS before attempting uniportal VATS.

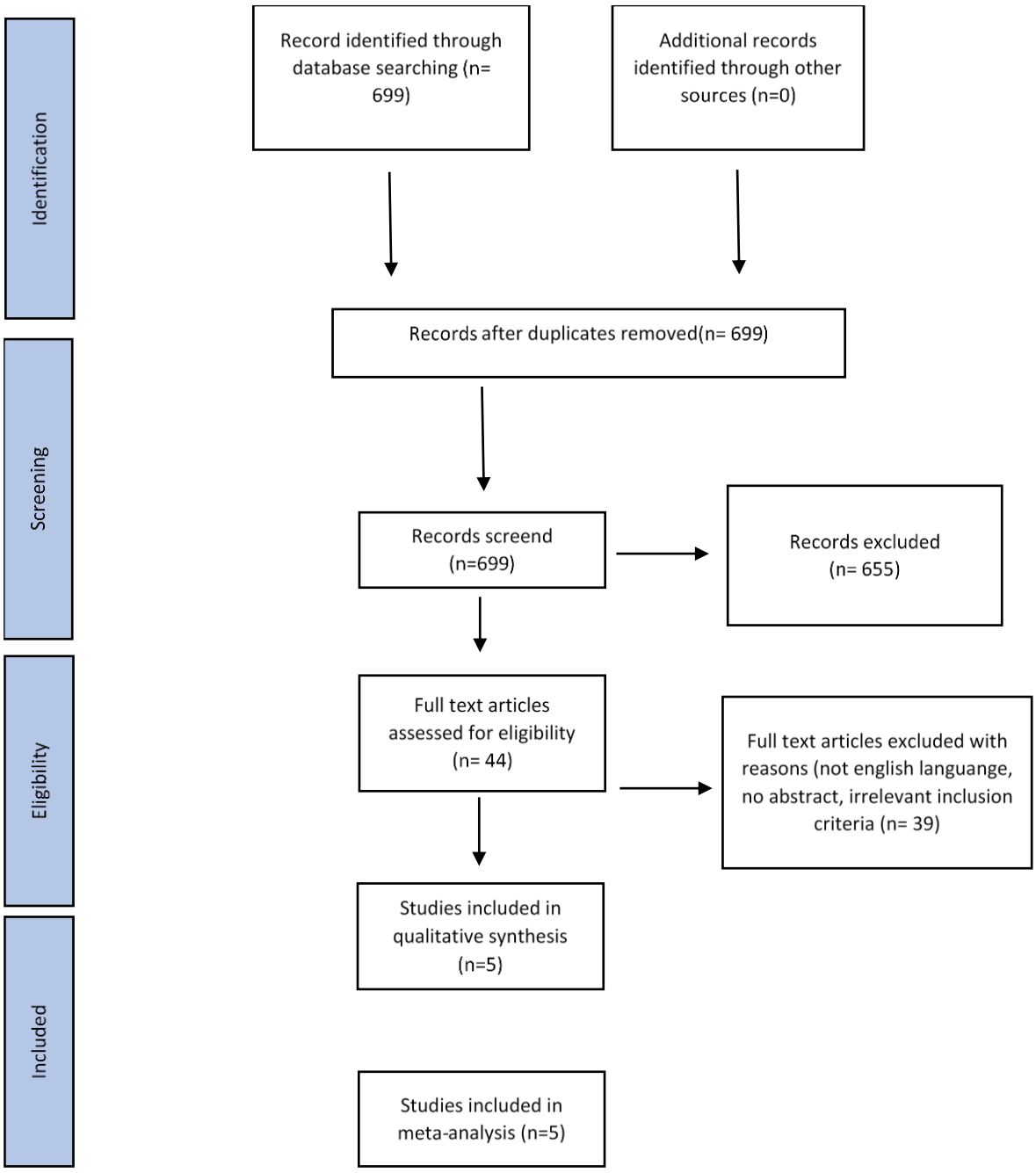
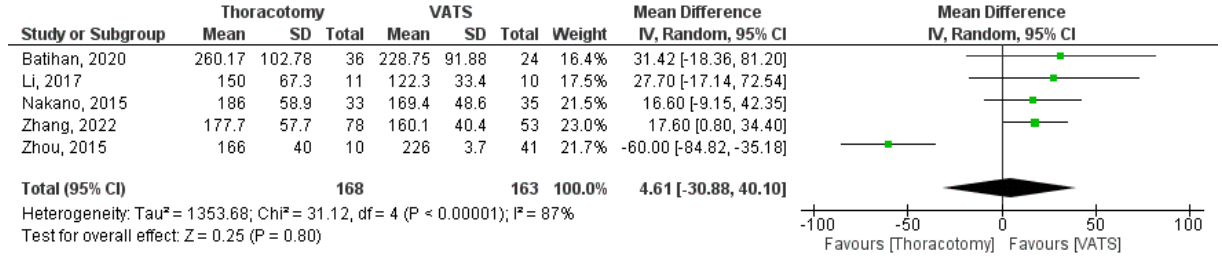
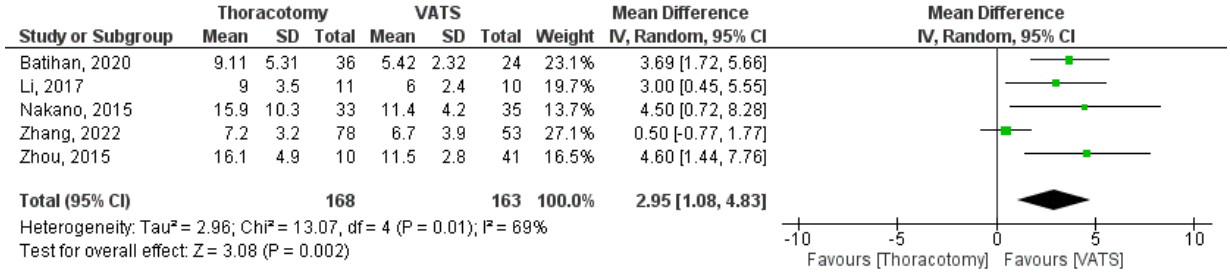


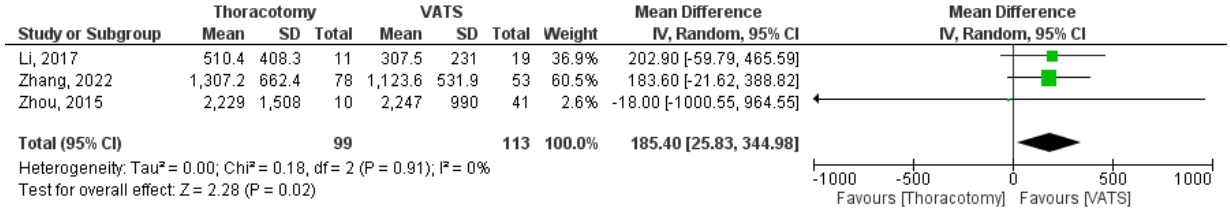
Figure 1. Searching procedure of meta-analysis on video-assisted thoracoscopic surgery lobectomy versus open thoracotomy lobectomy for NSCLC



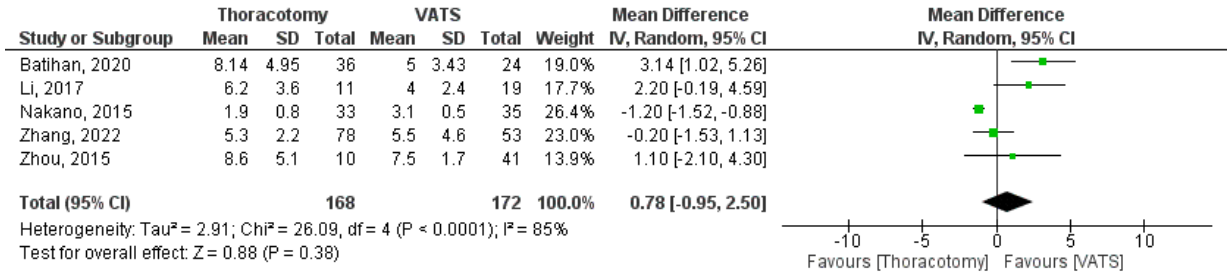
Operative Time



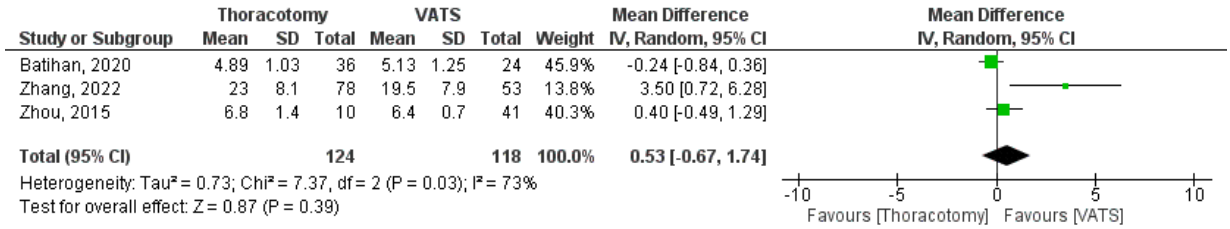
Postoperative Time



Chest Drainage Volume



Chest Drainage Time (days)



Number of Resected lymph nodes

Figure 2. Forest plot (a) operative time, (b) postoperative time, (c) chest drainage volume, (d) chest drainage time (days), (e) number of resected lymph nodes

Different researchers have used various techniques for V researchers have used various techniques for VATS resection. Batihan et al. used a two/three port non-rib spreading practice[1] while Li et al. used the classic three-portal procedure.[9] Nakano et al. performed VATS pulmonary resection using a five-port non-rib-spreading method[10], whereas Zhou et al. used a two-port approach with a 10mm incision in the midaxillary line at the 8th intercostalis (ICS) and a 10mm incision in the fourth or fifth ICS.[11] Finally, Zhang et al. employed a two-port technique for the VATS procedure.[12]

However, thoracotomy remains the preferred surgical approach for sleeve lobectomy due to the high technical demands of the procedure and limitations of VATS in terms of depth perception and maneuverability. In this meta-analysis, it was found that there was no significant difference in the duration of surgery between VATS and Thoracotomy (CI -30.88 to 40.10). This is consistent with the findings of a previous meta-analysis by Songlin Liu which also concluded that there was no significant difference in the duration of VATS surgery compared to thoracotomy. With the growing surgical experience, the duration of thoracotomy and VATS can be further shortened.[13]

In our study there was no significant differences between two approaches in operative time, but in another study found that VATS lobectomy has longer duration of operative time than thoracotomy lobectomy. In Wu et.al study the median operation of uniportal VATS 4hour and thoracotomy 3hour, similiar with Gao et.al study have shown that VATS group has longer operative time than thoracotomy group (300.3 ± 71.7 vs 221.0 ± 48.7, P<0.001).[14,15]

The study found no significant difference between VATS and Thoracotomy regarding the number of lymph node dissections. In the Eastern Cooperative Oncology Group 3590 study, lymphadenectomy was defined as removing more than ten lymph nodes from at least two or more mediastinal lymph node stations.[16](Tahara, Lackner, and Graver 2000). Some experts are concerned that VATS lobectomy provides insufficient lymph node dissection. However, studies have shown that a standard lobectomy with lymph node dissection can be performed via VATS[17,18]. This study was similiar with Watanabe et al. found no differences in total lymph node count, lymph node station count, mediastinal lymph nodes, or mediastinal station count between VATS and open thoracotomy.[19]

Denlinger et al. reported that fewer lymph nodes were sampled with VATS lobectomy than open lobectomy, but there was no survival difference. The authors believe fewer nodes were sampled with VATS lobectomy because the subcarinal space did not have to be exposed in upper lobe lobectomies, making the dissection of the subcarinal lymph nodes more challenging than that of other stations.[18,20]

Systematic lymph node removal is a crucial component of surgical treatment for non-small-cell lung cancer (NSCLC) and is associated with long-term survival. There have been concerns about the adequacy of video-assisted thoracoscopic surgery (VATS) in lymph node dissection during the early stages of the procedure. Still, numerous studies have demonstrated that systematic lymphadenectomy performed via thoracoscopy is just as effective as that done via thoracotomy[1,11,12]. Conducted a study comparing the number of lymph nodes dissected during lobectomy for patients undergoing VATS versus open surgery. They found no significant difference between the two groups, with a p-value of 0.20.[11] Similar results were obtained by Batihan et al. with a p-value of 0.352.[1] However, Zhang et al. found a significant difference in the number of lymph nodes dissected between VATS and Thoracotomy, with a p-value of 0.013.[12]

Survival is the most crucial factor in cancer treatment, but there is a lack of studies that report the long-term outcomes of VATS sleeve lobectomy. A survey did not show significant results for the overall survival rate at 1 year and five years (p-value 0.48), and the recurrence-free survival rate also showed no significant effects (p-value 0.65).[10] Similarly, study revealed no

significant difference in the overall median survival rates between VATS and thoracotomy groups at 1-,2-,3- and 4-year intervals (p-value = 0.58).[11] Zhang's study also found no significant survival difference between the surgical approaches, with a one-year recurrence-free survival rate of 87.2%.[12] However, Batihan et al. found that the VATS group had longer overall and recurrence-free survival rates, and the results were statistically significant.[1]

Our five article studies showed that there were no significant differences in complications between the VATS and Thoracotomy groups. Although there were no differences in difficulties, our systematic review of five studies involving 331 patients (163 VATS and 168 Thoracotomy) found that there were a total of 46 complications in the VATS group and 75 complications in the Thoracotomy group.

It's important to note that our meta-analysis has certain limitations that must be taken into account when interpreting the findings presented herein. One of the primary limitations is the variation in the number of portals used in VATS. While some studies have a high number of conversions from VATS to thoracotomy, other studies have no conversion at all. We also recognize that differences in factors that were not reported, such as institutional VATS reliability and potential avoidance of central tumor location, may have influenced the outcomes described in our meta-analysis. To account for these potential biases, large-scale, multicenter, prospective studies are necessary.

Conclusion

Based on current evidence, Video-Assisted Thoracoscopic Surgery (VATS) is a safe and efficient surgical procedure for Non-Small Cell Lung Cancer (NSCLS). VATS lobectomy has several advantages over thoracotomy, such as a shorter postoperative length of stay and less chest drainage volume. However, this conclusion needs validation through further high-quality research involving a larger population. The suggestions for this research are to use search data sources with larger samples and a larger number of articles

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