Supplementary

Table S1 Patient baseline characteristics

Author	VATS	RATS	Age VATS	Age RATS	Males VATS	Males RATS	Females VATS	Females RATS	Ever smoker VATS	Ever smoker RATS	CVS comorbidities VATS	CVS comorbidities RATS	Pulmonary comorbidities VATS	Pulmonary comorbidities RATS	FEV1 VATS	FEV1 RATS
Huang *et al.* 2019 (38)	105	61	66.3±10.1	62.5±11.6	58 (55.2%)	27 (44.3%)	47 (44.8%)	34 (55.7%)	81 (77.1%)	52 (85.2%)	41 (39%)	20 (32.8%)	31 (29.5%)	22 (36.1%)	N/A	N/A
Meritt *et al.* 2022(37)	100	100	63.3±9.4	66.5±9.9	44 (44%)	41 (41%)	56 (56%)	59 (59%)	88 (88%)	86 (86%)	23 (23%)	17 (17%)	25 (25%)	33 (33%)	84.7±18.3	85.4±20.1
Worell *et al.* 2018 (35)	73	25	N/A	N/A	35 (47.9%)	12 (48%)	38 (52.1%)	13 (52%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Yang *et al.* 2017 (34)	172	172	67.5±10	68±10.2	53 (30.8%)	74 (43%)	88 (51.2%)	98 (57%)	115 (66.9%)	139 (80.8%)	N/A	N/A	N/A	N/A	90.3±17.9	91.6±17.4
Lee *et al.* 2015 (40)	158	53	67.7±33.7	69.3±25.1	56 (35.4%)	30 (56.6%)	102 (64.6%)	23 (43.4%)	120 (75.9%)	44 (83%)	27 (17.1%)	11 (20.8%)	N/A	N/A	83.7±17.3	78.7±18.7
Casiraghi *et al.* 2022 (33)	36	72	66.5±6.6	66±5.5	16 (44.4%)	32 (44.4%)	20 (55.6%)	40 (55.6%)	29 (80.6%)	55 (76.4%)	20 (55.6%)	40 (55.6%)	8 (22.2%)	4 (5.6%)	N/A	N/A
Haruki *et al.* 2020 (41)	49	49	66±7.2	64.8±9.2	24 (49%)	21 (42.9%)	25 (51%)	28 (57.1%)	24 (49%)	21 (42.9%)	10 (20.4%)	6 (12.2%)	7 (14.3%)	5 (10.2%)	74.5±11.5	71.2±10.3
Montagne *et al.* 2022 (32)	436	234	65.24±9.4	64±10.5	297 (68.1%)	147 (62.8%)	139 (31.9%)	87 (37.2%)	323 (74.1%)	163 (69.7%)	42 (9.6%)	14 (6%)	99 (22.7%)	48 (20.5%)	85.2±18.4	85.3±19.9
Park *et al.* 2017 (36)	17	12	61.2±10.9	62.6±7.2	7 (41.2%)	7 (58.3%)	10 (58.8%)	5 (41.7%)	N/A	N/A	N/A	N/A	N/A	N/A	106.9±17.9	106.8±15.4
Li *et al.* 2019 (39)	85	36	59.7±8.8	57.2±8.9	38 (44.7%)	17 (47.2%)	47 (55.3%)	19 (52.8%)	32 (37.6%)	14 (38.9%)	N/A	N/A	3 (3.5%)	1 (2.8%)	95.8±16.7	89.8±15.8

All values are reported as frequencies (corresponding %) or means ± standard deviation. VATS, video assisted thoracoscopic surgery; RATS, robotic assisted thoracoscopic surgery; CVS, cardiovascular; FEV1, forced expiratory volume in the 1st second; N/A, not applicable.

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Table S2 Tumor characteristics

Author	VATS	RATS	Adenocarcinoma VATS	Adenocarcinoma RATS	SCC VATS	SCC RATS	Left side VATS	Left side RATS	Right side VATS	Right side RATS	Upper or middle lobe VATS	Upper or middle lobe RATS	Lower lobe VATS	Lower lobe RATS
Huang *et al.* 2019 (38)	105	61	46 (43.8%)	28 (45.9%)	28 (26.7%)	14 (23%)	56 (53.3%)	27 (44.3%)	49 (46.7%)	34 (55.7%)	–	–	–	–
Meritt *et al.* 2022 (37)	100	100	77 (77%)	72 (72%)	18 (18%)	26 (26%)	42 (42%)	40 (40%)	58 (58%)	60 (60%)	65 (65%)	61 (61%)	35 (35%)	39 (39%)
Worell *et al.* 2018 (35)	73	25	–	–	–	–	37 (50.7%)	11 (44%)	36 (49.3%)	14 (56%)	62 (84.9%)	21 (84%)	11 (15.1%)	4 (16%)
Yang *et al.* 2017 (34)	172	172	23 (13.4%)	19 (11%)	69 (40.1%)	91 (52.9%)	53 (30.8%)	62 (36%)	88 (51.2%)	110 (64%)	104 (60.5%)	120 (69.8%)	37 (21.5%)	52 (30.2%)
Lee *et al.* 2015 (40)	158	53	115 (72.8%)	39 (73.6%)	27 (17.1%)	6 (11.3%)	59 (37.3%)	19 (35.8%)	99 (62.7%)	34 (64.2%)	103 (65.2%)	31 (58.5%)	55 (34.8%)	22 (41.5%)
Casiraghi *et al.* 2022 (33)	36	72	30 (83.3%)	58 (80.6%)	4 (11.1%)	7 (9.7%)	16 (44.4%)	31 (43.1%)	20 (55.6%)	41 (56.9%)	20 (55.6%)	51 (70.8%)	16 (44.4%)	21 (29.2%)
Haruki *et al.* 2020 (41)	49	49	45 (91.8%)	45 (91.8%)	3 (6.1%)	4 (8.2%)	23 (46.9%)	17 (34.7%)	26 (53.1%)	32 (65.3%)	33 (67.3%)	35 (71.4%)	16 (32.7%)	14 (28.6%)
Montagne *et al.* 2022 (32)	436	234	296 (67.9%)	163 (69.7%)	97 (22.2%)	44 (18.8%)	188 (43.1%)	110 (47%)	240 (55%)	107 (45.7%)	197 (45.2%)	90 (38.5%)	231 (53%)	127 (54.3%)
Park *et al.* 2017 (36)	17	12	17 (100%)	10 (83.3%)	0 (0%)	2 (16.7%)	4 (23.5%)	6 (50%)	13 (76.5%)	6 (50%)	12 (70.6%)	5 (41.7%)	5 (29.4%)	7 (58.3%)
Li *et al.* 2019 (39)	85	36	78 (91.8%)	33 (91.7%)	4 (4.7%)	2 (5.6%)	34 (40%)	13 (36.1%)	51 (60%)	23 (63.9%)	57 (67.1%)	14 (38.9%)	28 (32.9%)	22 (61.1%)

All values are reported as frequencies (corresponding %). VATS, video assisted thoracoscopic surgery; RATS, robotic assisted thoracoscopic surgery; SCC, squamous cell carcinoma.

Table S3 Tumor staging

Author	Stage I VATS	Stage I RATS	Stage II VATS	Stage II RATS	Stage III VATS	Stage III RATS	Lymph nodes dissected VATS	Lymph nodes dissected RATS	N0 VATS	N0 RATS	N1 VATS	N1 RATS	N2 VATS	N2 RATS
Huang *et al.*, 2019 (38)	–	–	–	–	–	–	–	–	52 (49.5%)	37 (60.7%)	7 (6.7%)	5 (8.2%)	4 (3.8%)	3 (4.9%)
Meritt *et al.*, 2022 (37)	72 (72%)	72 (72%)	19 (19%)	18 (18%)	9 (9%)	10 (10%)	6.3±3.8	15±6	83 (83%)	79 (79%)	11 (11%)	14 (14%)	6 (6%)	7 (7%)
Worell *et al.*, 2018 (35)	42 (75%)	18 (82%)	14 (25%)	4 (18%)	0 (0%)	0 (0%)	11.3±12.9	10.7±13.3	–	–	–	–	–	–
Yang *et al.*, 2017 (34)	114 (66.3%)	133 (77.3%)	21 (12.2%)	29 (16.9%)	6 (3.5%)	10 (5.8%)	3.3±0.6	4.5±1.5	121 (70.3%)	145 (84.3%)	14 (8.1%)	20 (11.6%)	6 (3.5%)	7 (4.1%)
Lee *et al.*, 2015 (40)	134 (84.8%)	46 (86.8%)	13 (8.2%)	5 (9.4%)	11 (7%)	2 (3.8%)	16.8±8.1	19.5±7.9	134 (84.8%)	46 (86.8%)	13 (8.2%)	5 (9.4%)	11 (7%)	2 (3.8%)
Casiraghi *et al.*, 2022 (33)	26 (72.2%)	65 (90.3%)	8 (22.2%)	3 (4.2%)	2 (5.6%)	4 (5.6%)	14.8±5	19.3±6.5	29 (80.6%)	66 (91.7%)	5 (13.9%)	2 (2.8%)	2 (5.6%)	4 (5.6%)
Haruki *et al.*, 2020 (41)	32 (65.3%)	43 (87.8%)	17 (34.7%)	6 (12.2%)	0 (0%)	0 (0%)	–	–	43 (87.8%)	46 (93.9%)	5 (10.2%)	2 (4.1%)	1 (2%)	1 (2%)
Montagne *et al.*, 2022 (32)	279 (64%)	139 (59.4%)	90 (20.6%)	51 (21.8%)	45 (10.3%)	36 (15.4%)	–	–	383 (87.8%)	205 (87.6%)	37 (8.5%)	18 (7.7%)	16 (3.7%)	11 (4.7%)
Park *et al.*, 2017 (36)	85 (100%)	36 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	22.9±13	21.6±13.8	–	–	–	–	–	–
Li *et al.*, 2019 (39)	6 (7.1%)	3 (8.3%)	24 (28.2%)	16 (44.4%)	55 (64.7%)	17 (47.2%)	12.5±4.5	15±5.7	0 (0%)	0 (0%)	40 (47.1%)	17 (47.2%)	45 (52.9%)	19 (52.8%)

All values are reported as frequencies (corresponding %) or means ± standard deviation. VATS, video assisted thoracoscopic surgery; RATS, robotic assisted thoracoscopic surgery; SCC, squamous cell carcinoma.

https://dx.doi.org/10.21037/jtd-23-582

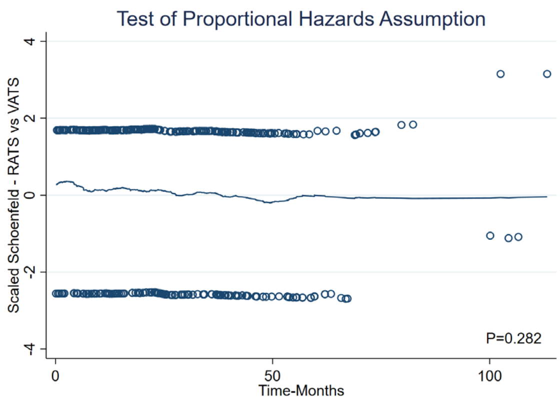

Figure S1 Evaluation of proportional hazards assumption using scaled Schoenfeld residuals versus time regarding OS. OS, overall survival; VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

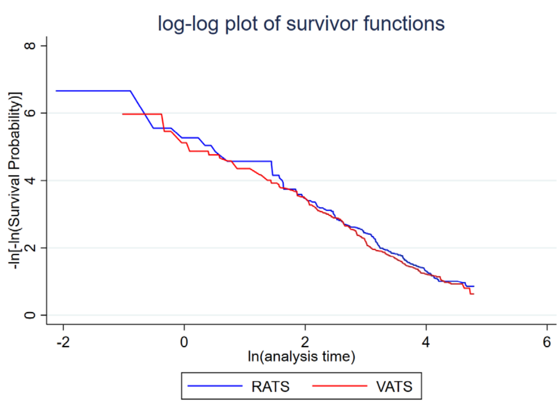

Figure S2 Assessment of proportional hazards assumption using log-log plot of survivor functions regarding OS. OS, overall survival; VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

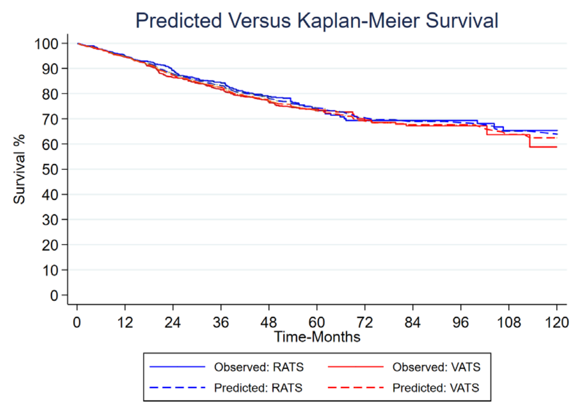

Figure S3 Assessment of proportional hazards assumption using fitted versus predicted survival functions regarding overall survival. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

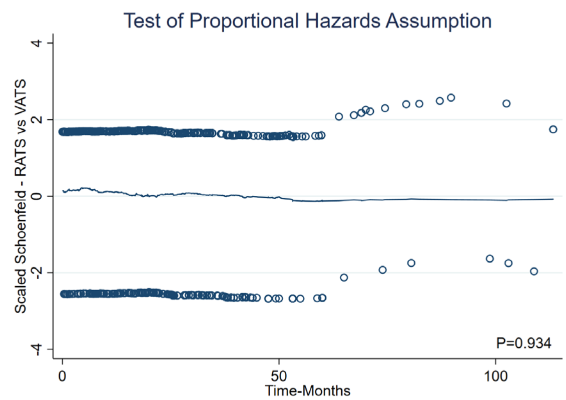

Figure S4 Evaluation of proportional hazards assumption using scaled Schoenfeld residuals versus time regarding disease-free survival. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

https://dx.doi.org/10.21037/jtd-23-582

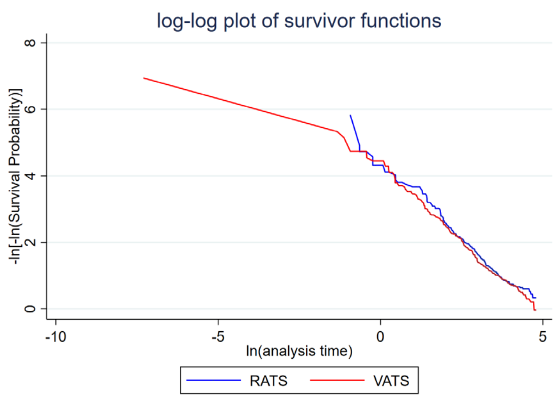

Figure S5 Assessment of proportional hazards assumption using log-log plot of survivor functions regarding disease-free survival. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

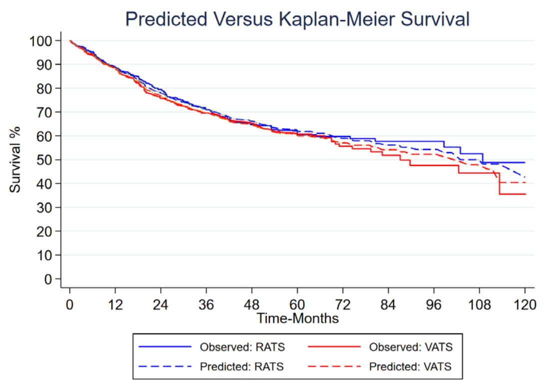

Figure S6 Assessment of proportional hazards assumption using fitted versus predicted survival functions regarding disease-free survival. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

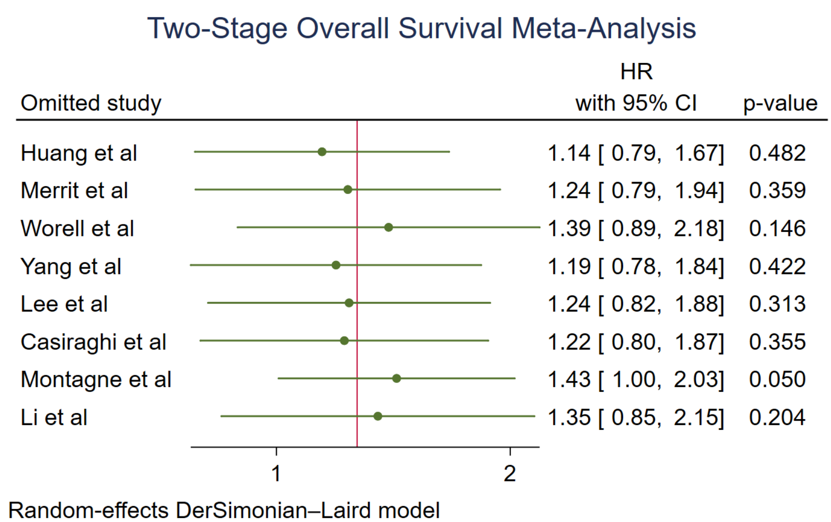

Figure S7 Leave-one-out meta-analysis regarding overall survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

 https://dx.doi.org/10.21037/jtd-23-582

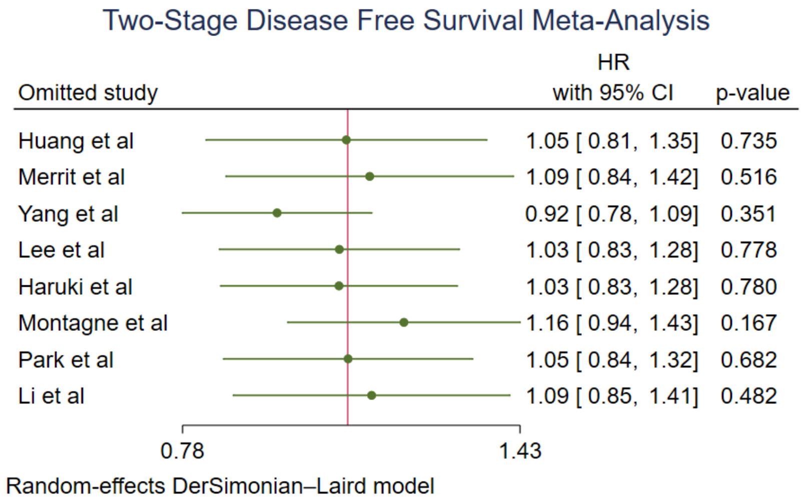

Figure S8 Leave-one-out meta-analysis regarding disease-free survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

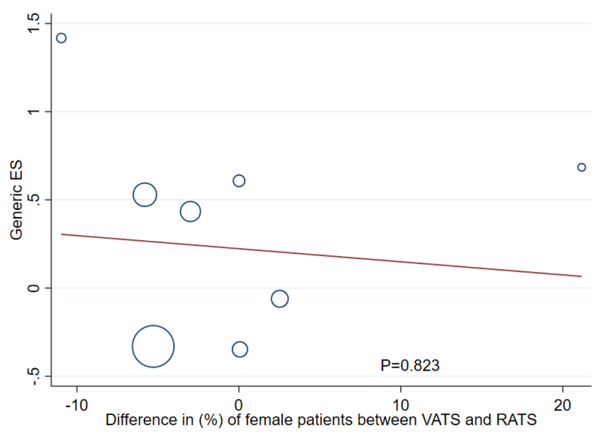

Figure S9 Meta-regression analysis examining the impact of female gender in overall survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

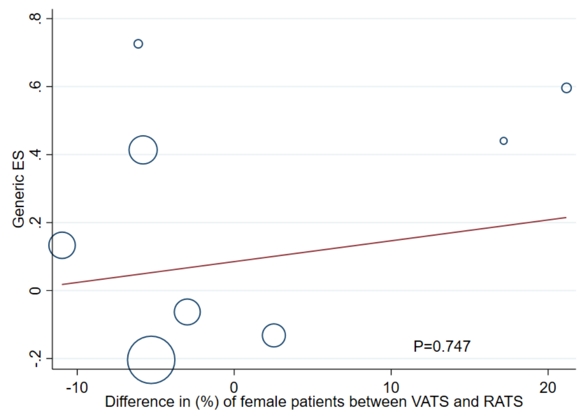

Figure 10 Meta-regression analysis examining the impact of female gender in disease-free survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

https://dx.doi.org/10.21037/jtd-23-582

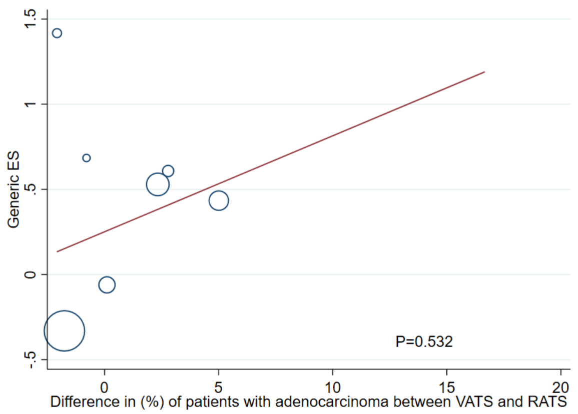

Figure S11 Meta-regression analysis examining the impact of the presence of adenocarcinoma in the overall survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

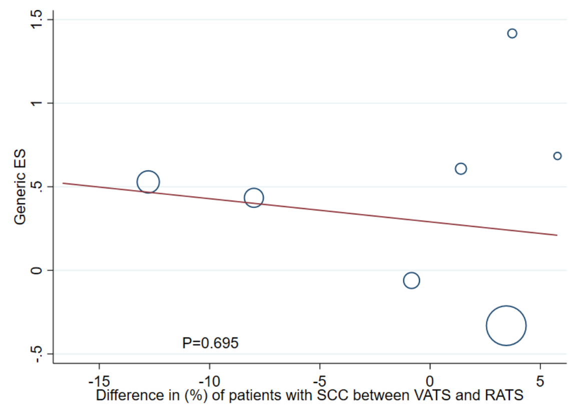

Figure S13 Meta-regression analysis examining the impact of the presence of squamous cell carcinoma in the overall survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

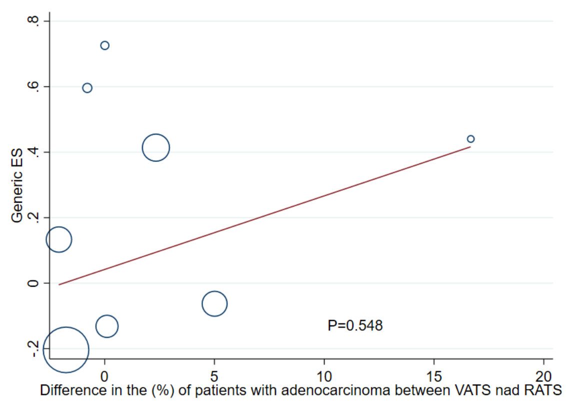

Figure S12 Meta-regression analysis examining the impact of the presence of adenocarcinoma in the disease-free survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

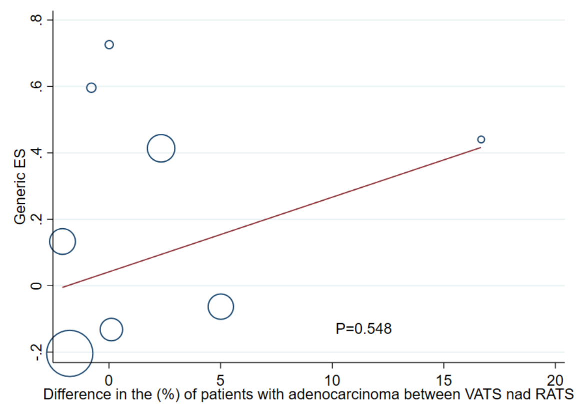

Figure S14 Meta-regression analysis examining the impact of the presence of squamous cell carcinoma in the disease-free survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

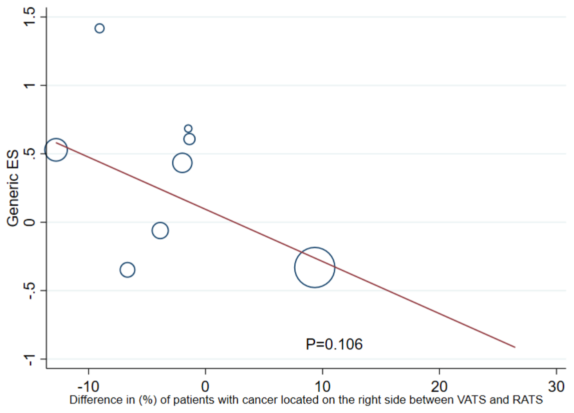

Figure S15 Meta-regression analysis examining the impact of the tumor laterality in the overall survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

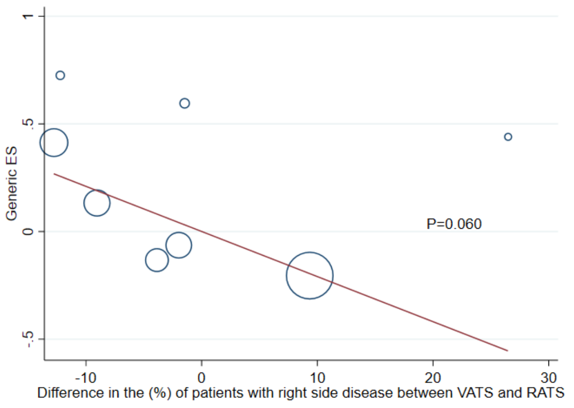

Figure S16 Meta-regression analysis examining the impact of the tumor laterality in the disease-free survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

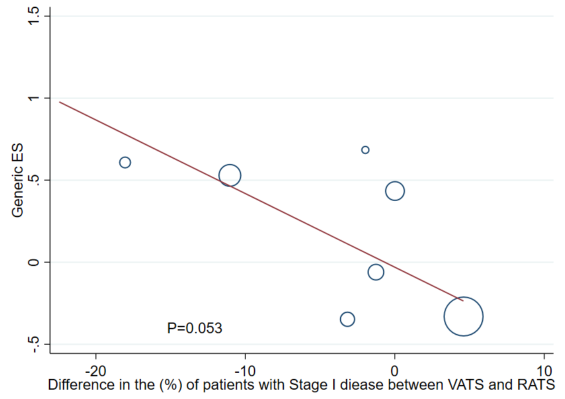

Figure S17 Meta-regression analysis examining the impact of the disease's stage the overall survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

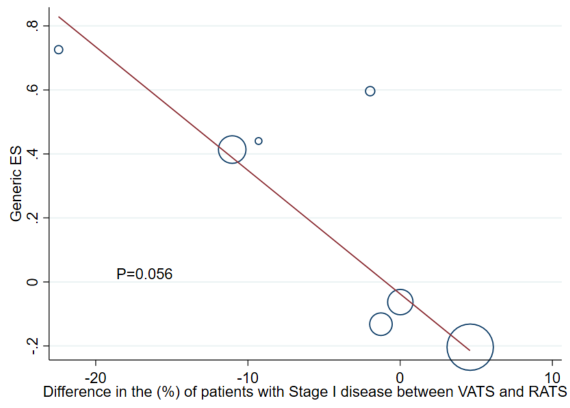

Figure S18 Meta-regression analysis examining the impact of the disease's stage the disease-free survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

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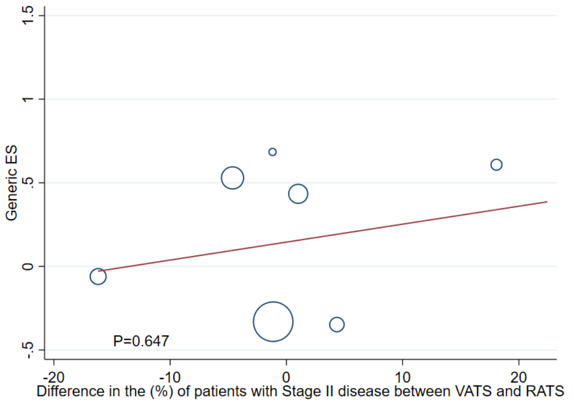

Figure S19 Meta-regression analysis examining the impact of the disease's stage the overall survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

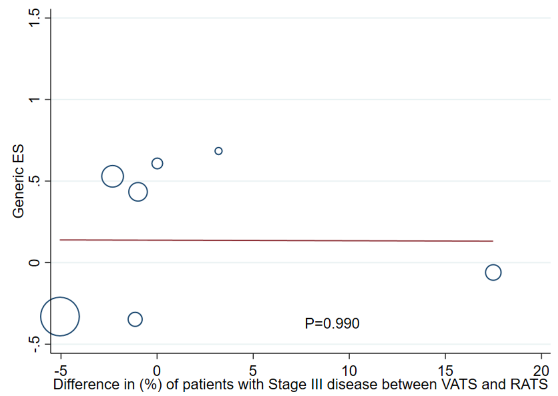

Figure S21 Meta-regression analysis examining the impact of the disease's stage the overall survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

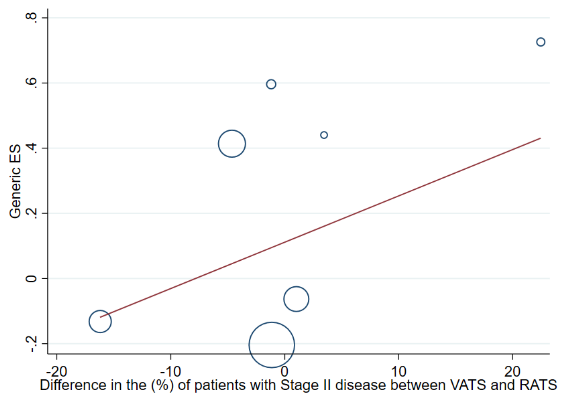

Figure S20 Meta-regression analysis examining the impact of the disease's stage the disease-free survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

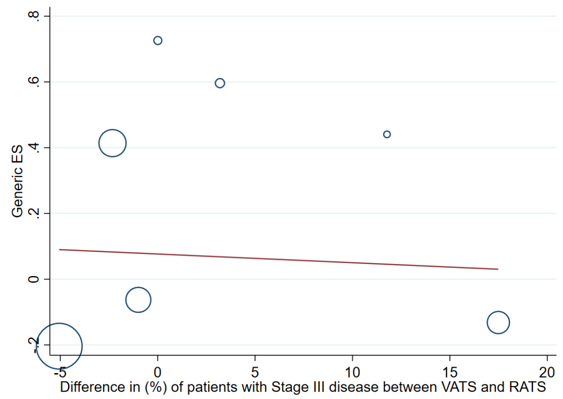

Figure S22 Meta-regression analysis examining the impact of the disease's stage the disease-free survival difference between VATS and RATS. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

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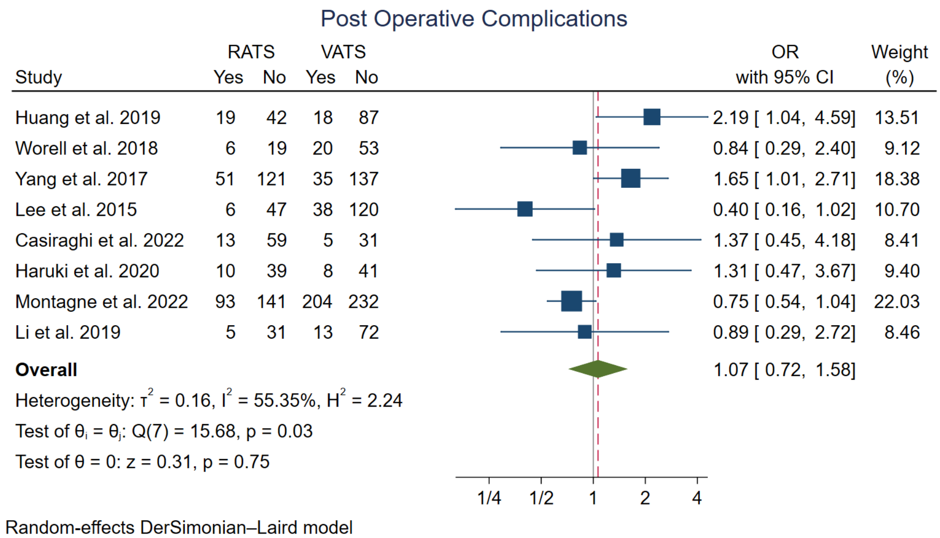

Figure S23 Forest plot describing the comparison between VATS and RATS regarding postoperative complications. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

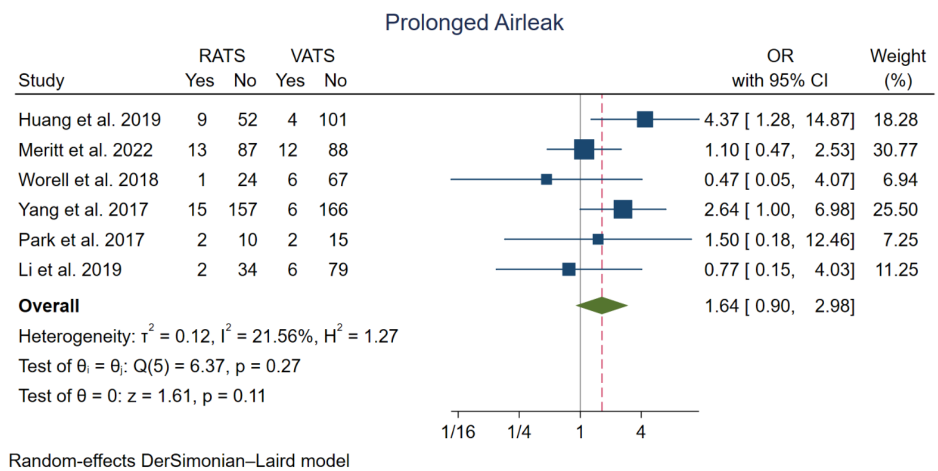

Figure S24 Forest plot describing the comparison between VATS and RATS regarding prolonged airleak rates. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

 https://dx.doi.org/10.21037/jtd-23-582

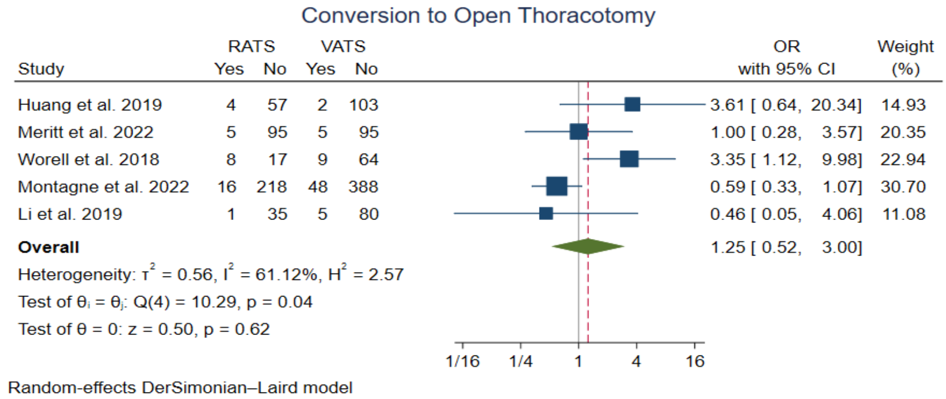

Figure S25 Forest plot describing the comparison between VATS and RATS regarding conversion to open thoracotomy rates. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery.

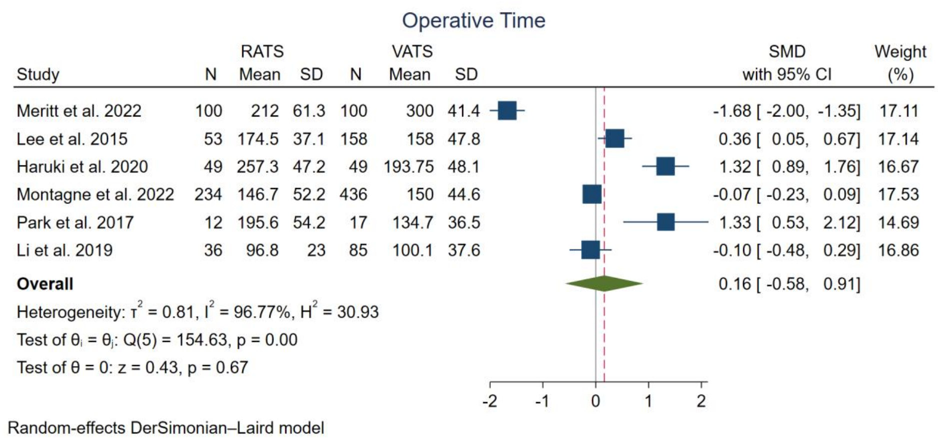

Figure S26 Forest plot describing the comparison between VATS and RATS regarding operative time. VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery; N, number; SD, standard deviation; SMD, standard mean difference.

https://dx.doi.org/10.21037/jtd-23-582

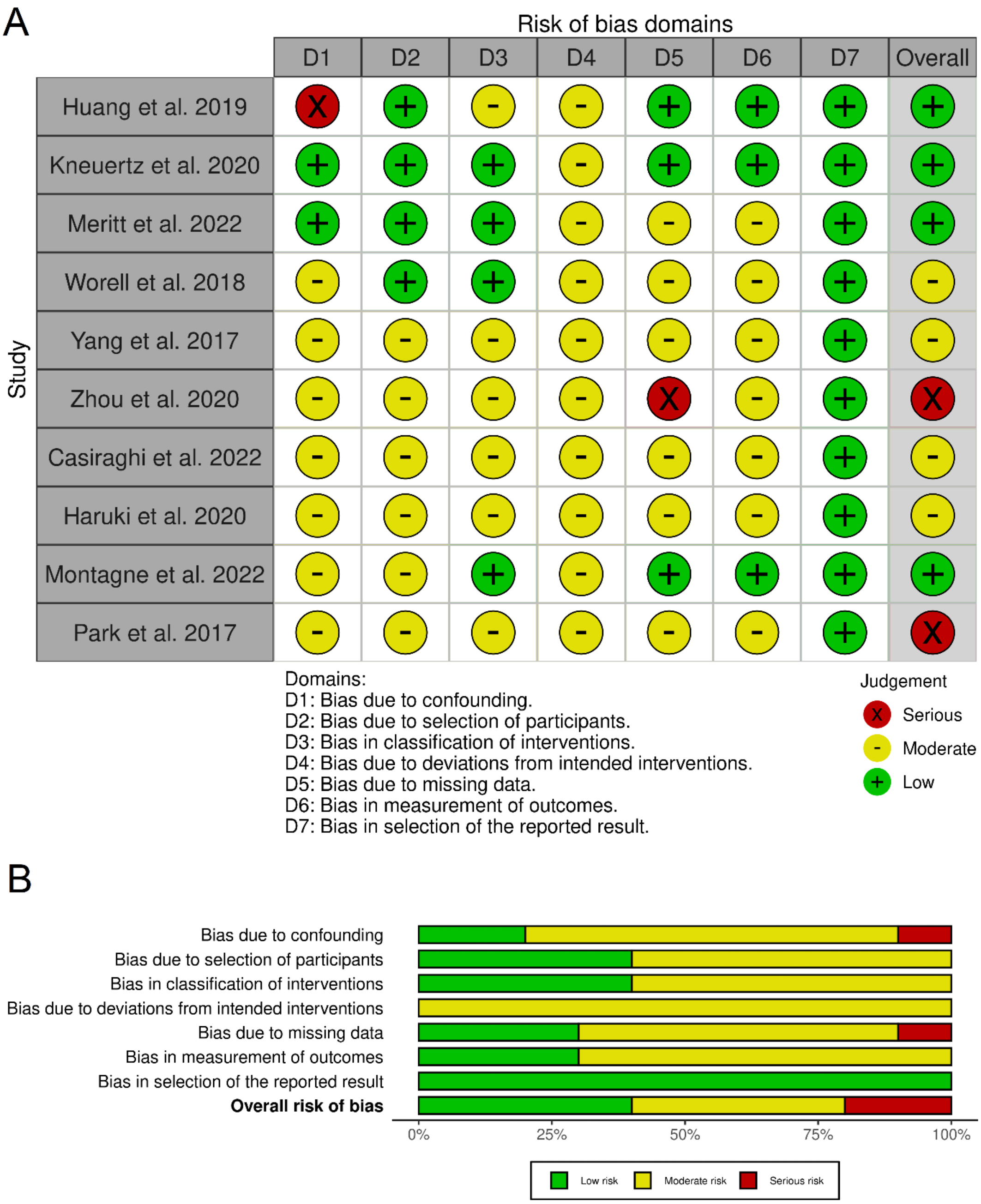

Figure S27 ROBINS 1 tool for risk of bias assessment (A) traffic light plot and (B) summary plot.

https://dx.doi.org/10.21037/jtd-23-582

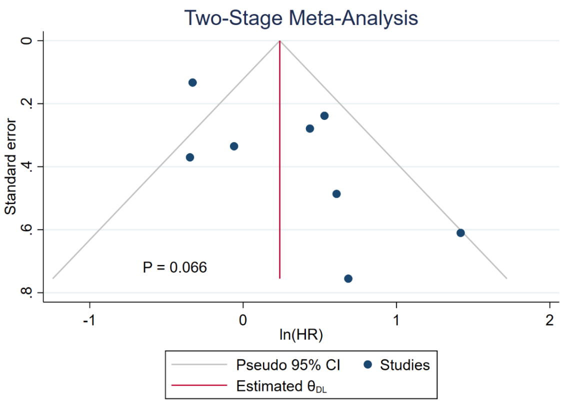

Figure S28 Funnel plot and Egger's test P value for two-stage OS meta-analysis. OS, overall survival.

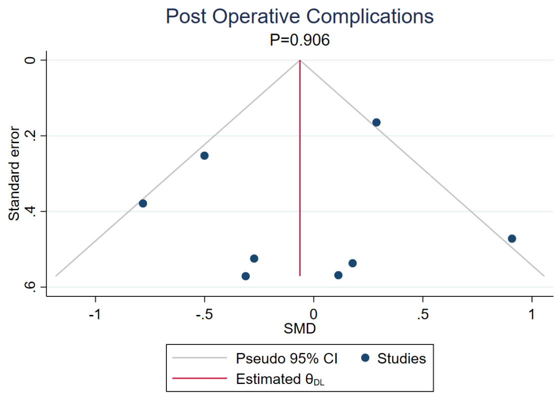

Figure S30 Funnel plot and Egger's test P value for postoperative complications meta-analysis. SMD, Standard mean difference.

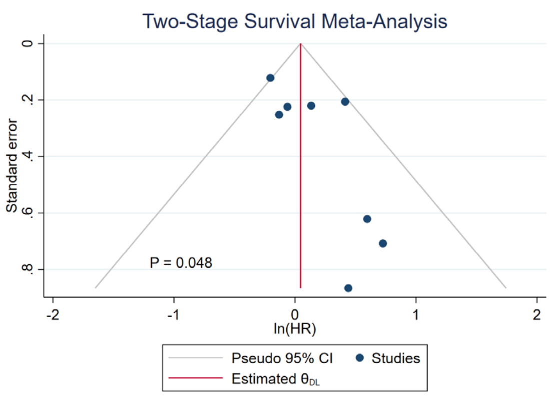

Figure S29 Funnel plot and Egger's test P value for two-stage DFS meta-analysis. DFS, disease-free survival.

 https://dx.doi.org/10.21037/jtd-23-582

Table S4 Summary of the previous meta-analyses comparing VATS versus RATS

Author	Year	Journal	Number of studies	Findings
Ye *et al.*, (61)	2015	*Interactive Cardiovascular and Thoracic Surgery*	8	No differences in: • Morbidity • Mortality
Wei *et al.*, (62)	2017	*World Journal of Surgical Oncology*	12	RATS better in: • Mortality No difference in: • Morbidity
Emmert *et al.*, (63)	2017	*Medicine (Baltimore)*	10	RATS better in: • Mortality No difference in: • Operative time • Chest tube drainage duration • LOS
Yu *et al.*, (64)	2017	*Oncotarget*	15	VATS better in: • Operative time No difference in: • Number of dissected lymph nodes • LOS • Conversion to open thoracotomy • Morbidity • Mortality
Liang *et al.*, (42)	2018	*Annals of Surgery*	14	RATS better in: • 30-day mortality • Conversion to open thoracotomy No difference in: • Postoperative complications • Operative time • LOS • Days to tube removal • Lymph node dissection • Retrieved lymph node stations
Guo *et al.*, (65)	2019	*Medicine (Baltimore)*	14	No differences in: • Conversion to open thoracotomy • Number of dissected lymph nodes • LOS • Operative time • Chest tube drainage • Prolonged air leak • Morbidity
O'Sullivan *et al.*, (66)	2019	*Interactive Cardiovascular and Thoracic Surgery*	N/A	RATS better in: • Post-operative complications • LOS • 30-day mortality VATS better in: • Duration of operation
Hu *et al.*, (67)	2019	*Combinatorial Chemistry & High Throughput Screening*	20	RATS better in: • Mortality VATS better in: • Operative duration No difference in: • LOS • Number of dissected lymph nodes • Lymph node stations retrieved • Chest tube drainage • Prolonged airleak • Arrythmia • Pneumonia • Conversion to open thoracotomy • Morbidity
Hu *et al.*, (68)	2020	*International Journal of Medical Robotics and Computer Assisted Surgery*	32	RATS better in: • 30-day mortality No difference in: • Operative time • Conversion rate to thoracotomy • Number of dissected lymph nodes • Postoperative morbidity • LOS
Ma *et al.*, (44)	2021	*BMC Cancer*	18	RATS better in: • Amount of blood loss • Conversion to open thoracotomy • Number of dissected lymph nodes • Lymph node stations retrieved • Chest tube drainage • LOS • Complications • Cancer recurrence VATS better in: • Costs No difference in: • Operative time • Mortality • Overall survival • Disease-free survival
Mao *et al.*, (69)	2021	*Translational Cancer Research*	18	RATS better in: • Number of lymph node dissected VATS better in: • Operative time No differences in: • Conversion to open thoracotomy • Lymph node stations retrieved • Chest tube duration • In-hospital mortality • LOS
Chen *et al.*, (70)	2021	*Lung Cancer*	N/A	VATS better in: • Costs
Wu *et al.*, (43)	2021	*European Journal of Cardiothoracic Surgery*	25	RATS better in: • Disease free survival No difference in: • Overall Survival • 30-day mortality • Post-operative complications • Conversion to open thoracotomy • Lymph node upstaging
Zhang *et al.*, (45)	2022	*Frontiers in Oncology*	26	RATS better in: • Blood loss • Conversion to open thoracotomy • LOS • Number of dissected lymph nodes • 5-year disease-free survival No difference in: • Operative time • Complications • Tumor size • Chest tube drainage duration • R0 resection rate • Number of lymph stations retrieved • 5-year overall survival • Cancer recurrence

VATS, video-assisted thoracoscopic surgery; RATS, robotic-assisted thoracoscopic surgery; LOS, length of hospital stay.

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References

61. Ye X, Xie L, Chen G, et al. Robotic thoracic surgery versus video-assisted thoracic surgery for lung cancer: a meta-analysis. Interact Cardiovasc Thorac Surg 2015;21:409-14.
62. Wei S, Chen M, Chen N, et al. 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;15:98.
63. Emmert A, Straube C, Buentzel J, et al. Robotic versus thoracoscopic lung resection: A systematic review and meta-analysis. Medicine (Baltimore) 2017;96:e7633.
64. Yu Z, Xie Q, Guo L, et al. Perioperative outcomes of robotic surgery for the treatment of lung cancer compared to a conventional video-assisted thoracoscopic surgery (VATS) technique. Oncotarget 2017;8:91076-84.
65. Guo F, Ma D, Li S. Compare the prognosis of Da Vinci robot-assisted thoracic surgery (RATS) with video-assisted thoracic surgery (VATS) for non-small cell lung cancer: A Meta-analysis. Medicine (Baltimore) 2019;98:e17089.
66. O'Sullivan KE, Kreaden US, Hebert AE, et al. A systematic review and meta-analysis of robotic versus open and video-assisted thoracoscopic surgery approaches for lobectomy. Interact Cardiovasc Thorac Surg 2019;28:526-34.
67. Hu X, Wang M. Efficacy and Safety of Robot-assisted Thoracic Surgery (RATS) Compare with Video-assisted Thoracoscopic Surgery (VATS) for Lung Lobectomy in Patients with Non-small Cell Lung Cancer. Comb Chem High Throughput Screen 2019;22:169-78.
68. Hu J, Chen Y, Dai J, et al. Perioperative outcomes of robot-assisted vs video-assisted and traditional open thoracic surgery for lung cancer: A systematic review and network meta-analysis. Int J Med Robot 2020;16:1-14.
69. Mao J, Tang Z, Mi Y, et al. Robotic and video-assisted lobectomy/segmentectomy for non-small cell lung cancer have similar perioperative outcomes: a systematic review and meta-analysis. Transl Cancer Res 2021;10:3883-93.
70. Chen D, Kang P, Tao S, et al. Cost-effectiveness evaluation of robotic-assisted thoracoscopic surgery versus open thoracotomy and video-assisted thoracoscopic surgery for operable non-small cell lung cancer. Lung Cancer 2021;153:99-107.