

Safety Analysis of Lung Cancer Surgery in Patients with Coronary Heart Disease and Coronary Stents

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Abstract

Objective

To evaluate the safety of lung resection surgery in patients with lung cancer and concomitant coronary heart disease with prior stent implantation, and to analyze the incidence and risk factors of postoperative complications and major adverse cardiovascular events (MACE).

Methods

A retrospective analysis was conducted on clinical data from 273 patients with lung cancer and concomitant coronary heart disease with prior stent implantation who underwent lung resection surgery at the Department of Thoracic Surgery, Peking Union Medical College Hospital, from January 2018 to December 2023. Data collected included demographic characteristics, comorbidities, coronary heart disease treatment (time of stent implantation, antiplatelet drugs, statins, beta-blockers), surgery-related factors, and postoperative complications. The Chi-square test or Fisher's exact test was used to compare categorical variables, and the Mann-Whitney U test was used for continuous variables. Factors associated with overall complications and MACE (including myocardial infarction and new-onset postoperative atrial fibrillation) were analyzed.

Results: Among the 273 patients, the overall postoperative complication rate was 17.6% (48 cases). The MACE rate was 5.9% (16 cases), including 9 cases (3.3%) of myocardial infarction and 7 cases (2.6%) of new-onset postoperative atrial fibrillation. Univariate analysis showed that pulmonary disease was significantly associated with overall complications ($P = 0.0174$). Statin use was significantly associated with overall complications ($P = 0.0115$). Factors such as antiplatelet drugs, beta-blockers, gender, smoking history, hypertension, diabetes, cerebrovascular disease, surgical procedure, operative duration, blood loss, and ICU admission showed no statistically significant association with complications or MACE ($P > 0.05$).

Conclusion: Lung resection surgery is generally safe for lung cancer patients with coronary heart disease and prior stent implantation. Statin use was associated with a lower overall complication rate against overall postoperative complications. Pulmonary disease is an independent risk factor for postoperative complications. The period from six months to one year after stent implantation may represent a risk window for cardiovascular events, requiring enhanced perioperative management.

Background

Lung cancer is one of the most common and deadliest malignancies worldwide. Surgical resection is the preferred treatment for early-stage non-small cell lung cancer. With the aging population, the proportion of lung cancer patients with concomitant coronary heart disease is increasing year by year. Literature reports indicate that approximately 22.3% of hospitalized patients with primary lung cancer also have coronary heart disease.[1] Patients with coronary heart disease often require percutaneous coronary intervention (PCI) with drug-eluting stent implantation and need long-term antiplatelet therapy after the procedure to prevent in-stent thrombosis.

For these patients, if subsequent surgical treatment for newly diagnosed lung cancer is required, they face multiple challenges. On one hand, surgical trauma and anesthesia stress can induce MACE. On the other hand, perioperative management of antiplatelet drugs requires a delicate balance between preventing stent thrombosis and controlling surgical bleeding risk. Lung resection surgery itself places high demands on cardiopulmonary function, with postoperative complication rates reported to be approximately 22%-45%. [2]For patients with coronary heart disease, surgical risk is further increased.

In recent years, with the popularization of minimally invasive surgical techniques and improvements in perioperative management, the proportion of elderly patients and those with comorbidities undergoing lung cancer surgery has been steadily increasing. Perioperative management of antiplatelet drugs is a core element of clinical decision-making for these patients. However, current guideline recommendations are largely based on the general cardiovascular disease population, and their applicability in lung cancer surgery patients remains to be validated. Furthermore, the impact of underlying pulmonary disease on prognosis deserves special attention.

This study aims to evaluate the incidence of postoperative complications and MACE by retrospectively analyzing clinical data from 273 such patients, and to explore the association of antiplatelet drugs, stent implantation time, secondary prevention medications, demographic characteristics, comorbidities, and surgery-related factors with prognosis, providing evidence-based guidance for clinical practice.

Methods

1. Study Design and Population

This study was a single-center retrospective cohort study. It consecutively enrolled lung cancer patients with coronary heart disease and prior coronary stent implantation who underwent lung resection surgery at the Department of Thoracic Surgery, Peking Union Medical College Hospital, from January 2018 to December 2023. This study was approved by the Ethics Committee of Peking Union Medical College Hospital. The requirement for informed consent was waived.

2. Study Population

Inclusion criteria were (1) Pathologically confirmed non-small cell lung cancer; (2) History of coronary heart disease treated with percutaneous coronary intervention (PCI) and drug-eluting stent implantation; (3) Underwent lung resection surgery (including wedge resection, segmentectomy, or lobectomy); (4) Complete clinical data. Exclusion criteria were (1) Emergency or palliative surgery; (2) Acute coronary syndrome or emergency PCI within 30 days before surgery; (3) Concurrent other malignancies; (4) Incomplete clinical data. A total of 273 eligible patients were included in the study. The patient screening and enrollment process is shown in Fig. 1.

2. Data Collection

Data were retrospectively collected from the hospital's electronic medical record system, including: (1) demographic characteristics (age, sex); (2) comorbidities and risk factors (smoking history, hypertension,

diabetes, chronic kidney disease, cerebrovascular disease, and pulmonary disease); (3) cardiac-related factors (time since stent implantation, perioperative antiplatelet use, statin use, and beta-blocker use); (4) surgery-related factors (procedure type, operative duration, blood loss, and ICU admission); and (5) postoperative outcome measures.

Postoperative outcome measures included: (1) clinical major adverse cardiovascular events (MACE), defined as postoperative myocardial infarction and new-onset postoperative atrial fibrillation; (2) subclinical myocardial injury, defined as isolated postoperative elevation of cardiac enzymes without clinical evidence of myocardial infarction; (3) other postoperative complications, such as prolonged air leak, chylothorax, bleeding, pulmonary infection, and pneumothorax; and (4) recovery indicators, including chest tube duration, postoperative hospital stay, and 30-day mortality.

3. Perioperative Antiplatelet Drug Management Strategy

All patients had their antiplatelet drug regimens adjusted preoperatively based on cardiology consultation recommendations. The standard strategy was: discontinue clopidogrel 5–7 days before surgery; aspirin was either continued or discontinued before surgery at the physician's discretion. Some high-risk patients received low molecular weight heparin bridging anticoagulation until 12–24 hours before surgery. Antiplatelet drugs were resumed as early as possible postoperatively once adequate hemostasis was confirmed.

4. Statistical Analysis

SPSS version 26.0 software was used for statistical analysis. Categorical data were presented as numbers (percentages). Group comparisons were performed using the Chi-square test or Fisher's exact test (when expected frequency was < 5). Continuous data with normal distribution were presented as mean $\pm$ standard deviation, and group comparisons were performed using the independent samples t-test. Continuous data without normal distribution were presented as median (interquartile range), and group comparisons were performed using the Mann-Whitney U test. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

Results

Table 1

Patient baseline characteristics and their relationship with complications and major adverse cardiovascular events (MACE)

Variable	Classification	Number of cases (%) / Mean ± SD	Number of complications (%)	Number of MACE cases (%)	Complication P-value	MACE P-value
demographic characteristic						
age		67.56 ± 6.57				
gender	Male	205 (75.1%)	39 (19.0%)	11 (5.4%)	0.3666	0.775
	Female	68 (24.9%)	9 (13.2%)	5 (7.4%)		
smoking history	Yes	181 (66.3%)	36 (19.9%)	10 (5.5%)	0.2163	0.789
	No	92 (33.7%)	12 (13.0%)	6 (6.5%)		
complication						
hypertension	Yes	159 (58.2%)	26 (16.4%)	9 (5.7%)	0.6388	0.615
	No	114 (41.8%)	22 (19.3%)	7 (6.1%)		
diabetes	Yes	92 (33.7%)	12 (13.0%)	5 (5.4%)	0.2163	0.789
	No	181 (66.3%)	36 (19.9%)	11 (6.1%)		
cerebrovascular disease	Yes	6 (2.2%)	2 (33.3%)	1 (16.7%)	0.6294	0.2999
	No	267 (97.8%)	46 (17.2%)	15 (5.6%)		

Variable	Classification	Number of cases (%) / Mean $\pm$ SD	Number of complications (%)	Number of MACE cases (%)	Complication P-value	MACE P-value
Lung diseases (4 cases were diagnosed as COPD)	Yes	4 (1.5%)	3 (75.0%)	1 (25.0%)	0.0174	0.206
	No	269 (98.5%)	45 (16.7%)	15 (5.6%)		
Cardiac-related						
The time of cardiac stent placement	<Half a year	16 (5.9%)	0 (0.0%)	0 (0.0%)	0.132	0.497
	Half a year to 1 year	38 (13.9%)	9 (23.7%)	3 (7.9%)		
	> 1 year	219 (80.2%)	39 (17.8%)	13 (5.9%)		
Antiplatelet drugs	No	26 (9.5%)	5 (19.2%)	2 (7.7%)	0.495	0.176
	Single	165 (60.4%)	32 (19.4%)	12 (7.3%)		
	Double	82 (30.0%)	11 (13.4%)	2 (2.4%)		
statins	Yes	171 (62.6%)	26 (15.5%)	8 (4.7%)	0.0115	0.305
	No	102 (37.0%)	22 (21.6%)	8 (7.8%)		
β -blocker	Yes	117 (42.9%)	31 (19.9%)	6 (5.1%)	0.3238	0.799
	No	156 (57.1%)	17 (14.5%)	10 (6.4%)		
Related to surgery						

Variable	Classification	Number of cases (%) / Mean $\pm$ SD	Number of complications (%)	Number of MACE cases (%)	Complication P-value	MACE P-value
surgical method	Wedge resection	61 (22.3%)	10 (16.4%)	4 (6.6%)	0.4357	0.811
	segmentectomy	50 (18.3%)	6 (12.0%)	3 (6.0%)		
	lobectomy	162 (59.3%)	32 (19.8%)	9 (5.6%)		
Duration of the surgery	< 1 hour	143 (52.4%)	24 (16.8%)	8 (5.6%)	0.5791	0.514
	1–3 hours	124 (45.4%)	22 (17.7%)	7 (5.6%)		
	> 3 hours	6 (2.2%)	2 (33.3%)	1 (16.7%)		
Return to the ICU	Yes	81 (29.7%)	17 (21.0%)	5 (6.2%)	0.4429	0.247
	No	191 (70.0%)	31 (16.2%)	11 (5.8%)		

Table 2
Complication occurrence rate

Complication type	Number of occurrences	Incidence rate (%)
Elevated myocardial enzymes	21	7.69
myocardial infarction	9	3.30
atrial fibrillation	7	2.57
air leakage	17	6.23
chylothorax	4	1.47
hemorrhage	2	0.73
pulmonary infection	1	0.37
pneumothorax	1	0.37

Table 3

The relationship between continuous variables (bleeding volume) and complications as well as major adverse cardiovascular events (MACE)

Variable	Group	Number of Cases	Mean $\pm$ Standard Deviation	Median [Interquartile Range]	P-value
Blood loss	Overall	273	50.2 $\pm$ 78.6	50.0 [0.0–50.0]	
Blood loss	Complication group	48	66.0 $\pm$ 106.9	50.0 [0.0-100.0]	0.3201
Blood loss	Complication-free group	225	46.8 $\pm$ 70.9	50.0 [0.0–50.0]	
Blood loss	No MACE	257	48.9 $\pm$ 75.2	50 [0–50]	0.52
Blood loss	MACE	16	60.0 $\pm$ 89.5	50 [20–100]	

A total of 273 eligible patients were included. The mean age was 67.56 ± 6.57 years, and 205 patients (75.1%) were male. Smoking history was present in 181 patients (66.3%). Hypertension was observed in 159 patients (58.2%), diabetes mellitus in 92 (33.7%), cerebrovascular disease in 6 (2.2%), and pulmonary disease in 4 (1.5%). Most patients had undergone coronary stent implantation more than 1 year before surgery (80.2%) and were receiving single antiplatelet therapy (60.4%). Statins and beta-blockers were used in 62.6% and 42.9% of patients, respectively. Lobectomy was the most common procedure (59.3%), and the mean intraoperative blood loss was 50.2 ± 78.6 mL. Detailed baseline characteristics are presented in (Table 1).

Overall, 48 patients (17.6%) experienced at least one postoperative complication. Elevated cardiac enzymes were the most frequent event (21/273, 7.69%), followed by air leak (17/273, 6.23%), myocardial infarction (9/273, 3.30%), new-onset atrial fibrillation (7/273, 2.57%), and chylothorax (4/273, 1.47%). Less common events included postoperative bleeding (2/273, 0.73%), pulmonary infection (1/273, 0.37%), and pneumothorax (1/273, 0.37%) (Table 2). No 30-day mortality or other severe perioperative events, including stroke, pulmonary embolism, respiratory failure, or reoperation, were recorded. (Table 2) Compared with patients without complications, those with complications had significantly longer chest tube duration (6.12 ± 5.79 vs. 2.72 ± 1.00 days, $P < 0.001$) and postoperative hospital stay (7.77 ± 6.06 vs. 3.80 ± 1.14 days, $P < 0.001$).

Regarding the clinical management and outcomes of these complications, patients with elevated cardiac enzymes all recovered after symptomatic treatment. The 9 patients with myocardial infarction improved after coronary vasodilator therapy. The 7 patients with new-onset postoperative atrial fibrillation converted back to sinus rhythm after pharmacological cardioversion. Patients with air leak required prolonged chest tube drainage, which extended the average postoperative hospital stay by 4.2 days. Patients with chylothorax were all successfully treated with conservative management. The occurrence of complications significantly impacted postoperative recovery. Patients in the complication group had significantly longer

chest tube duration (6.12 ± 5.79 days vs. 2.72 ± 1.00 days, $P < 0.001$) and longer postoperative hospital stay (7.77 ± 6.06 days vs. 3.80 ± 1.14 days, $P < 0.001$) (Table 1) compared to the no-complication group. However, there were no significant differences between the two groups in the rate of ICU readmission or 30-day mortality.

In this study, postoperative outcomes were analyzed among three groups based on antiplatelet therapy: 26 patients not on antiplatelet agents, 165 patients on single antiplatelet therapy (SAPT), and 82 patients on dual antiplatelet therapy (DAPT). Most patients discontinued antiplatelet agents approximately one week before surgery, with some receiving bridging heparin anticoagulation until 12 hours preoperatively. Results showed that in the no-antiplatelet group, the complication rate was 19.2% (5 cases) and the MACE rate was 7.7% (2 cases). In the SAPT group, the complication rate was 19.4% (32 cases) and the MACE rate was 7.9% (13 cases). In the DAPT group, the complication rate was 13.4% (11 cases) and the MACE rate was 2.4% (2 case). The MACE rate in the DAPT group (2.4%) was notably lower than in the SAPT group (7.9%) and the no-antiplatelet group (7.7%), but this difference was not statistically significant ($P = 0.176$). (Table 1)

Time since stent implantation reflects the stability of a patient's coronary revascularization and is an important reference index for assessing perioperative cardiovascular risk. The distribution across three groups was: 16 patients in the < 6 months group, 38 in the 6 months ~ 1 year group, and 219 in the > 1 year group. Results showed no complications or MACE (0%) in the < 6 months group. The complication rate was 23.7% (9 cases) and the MACE rate was 7.9% (3 cases) in the 6 months ~ 1 year group. The complication rate was 17.8% (39 cases) and the MACE rate was 5.9% (13 cases) in the > 1 year group. The Chi-square test showed no statistically significant difference among the three groups ($P = 0.497$). (Table 1)

This study showed that among the 102 patients not on statins, the complication rate was 21.6% (22 cases) and the MACE rate was 7.8% (8 cases). In contrast, among the 171 patients on statins, the complication rate was only 15.5% (26 cases) and the MACE rate was 4.7% (8 cases). The Chi-square test showed no statistically significant difference between the two groups ($P = 0.305$). In this study, among the 156 patients not on beta-blockers, the complication rate was 19.9% (31 cases) and the MACE rate was 6.4% (10 cases). Among the 117 patients on beta-blockers, the complication rate was 14.5% (17 cases) and the MACE rate was 5.1% (6 cases). (Table 1) Although the group using beta-blockers showed numerically lower complication and MACE rates, the differences were not statistically significant.

Regarding pulmonary complications, the incidence of air leak in this study was 6.23%, the incidence of chylothorax was 1.47%, and the incidence of pulmonary infection was 0.37%. Furthermore, severe complications such as heart failure, pulmonary embolism, stroke, respiratory failure, anastomotic leak, reoperation, and 30-day mortality did not occur in this study.

Among the remaining 11 factors analyzed, only the presence of pulmonary disease showed a statistically significant association with the overall complication rate ($P = 0.0174$). Specifically, among the 4 patients with pulmonary disease, all had a history of chronic obstructive pulmonary disease (COPD), and 3 developed postoperative complications (a complication rate of 75.0%). Other factors, such as gender, smoking history, hypertension, diabetes mellitus, cerebrovascular disease, surgical procedure, operative duration, blood loss, and ICU admission, did not show statistically significant associations with overall

complications or MACE ($P > 0.05$). Analyzed as a continuous variable, the mean blood loss was higher in the complication group (66.0 ml) compared to the no-complication group (46.8 ml), but this difference was not statistically significant ($P = 0.3201$). (Table 3) Regarding the choice of surgical procedure, the complication rate was slightly higher in the lobectomy group (19.8%) compared to the wedge resection group (16.4%) and the segmentectomy group (12.0%), but the difference was not statistically significant.

Discussion

This study conducted a retrospective analysis of clinical data from 273 lung cancer surgery patients with coronary heart disease and prior stent implantation. In this study, the overall postoperative complication rate of lung cancer patients with coronary heart disease and coronary stent implantation history was 17.6%. Compared with the reported complication rates of postoperative thoracic surgeries (27.7%),^[3] this rate was at a relatively low level. Moreover, no severe disabling events such as death within 30 days, stroke, respiratory failure, or the need for a second surgery occurred after the surgery, indicating that lung resection surgery is safe in this group of high-risk patients.

The incidence of elevated cardiac enzymes in this study was 7.69%. This indicator is rarely reported as an independent complication in the literature on general lung surgery populations. However, in lung cancer surgery patients with coronary heart disease and stents, elevated cardiac enzymes have important clinical significance. They are both a sensitive marker of perioperative myocardial injury and an independent risk factor for predicting patient prognosis.^[4] In this study, elevated cardiac enzymes had the highest incidence among postoperative complications (7.7%), approximately 2.3 times that of typical myocardial infarction (3.3%). This finding suggests that in high-risk patients with coronary heart disease, subclinical myocardial injury is much more common than clinically confirmed myocardial infarction. It can easily be missed without routine postoperative monitoring. Studies have confirmed that postoperative elevation of cardiac enzymes, even without electrocardiogram changes or clinical symptoms, is significantly associated with 30-day mortality.^[4] It results from the combined effect of surgical stress and underlying coronary artery disease and has independent prognostic value. This study showed that patients in the elevated cardiac enzymes group had significantly longer postoperative hospital stays (7.77 days vs. 3.80 days). This indicates that even transient, reversible myocardial injury can have a substantial impact on the postoperative recovery trajectory. It fills the transitional zone between asymptomatic myocardial injury and clinical myocardial infarction, providing a window of opportunity for early intervention. In clinical practice, routine postoperative monitoring of cardiac enzymes should be performed for lung cancer surgery patients with coronary heart disease. Risk stratification management should be implemented using biomarkers like high-sensitivity troponin. Its incidence varies depending on the frequency of testing and diagnostic criteria.

The incidence of myocardial infarction in this study was 3.30%, which is higher than the level reported in the general lung surgery population. A study based on the STS GTSD (Society of Thoracic Surgeons General Thoracic Database) perioperative lung resection risk model showed that acute myocardial infarction accounted for 0.36% of perioperative major adverse cardiovascular events in lung surgery patients.^[5] The higher incidence of myocardial infarction in our patients can be explained from multiple perspectives. First, our study population consists of high-risk patients with confirmed coronary heart disease and stents. They

have more severe underlying coronary lesions and decreased coronary flow reserve. Surgical stress can more easily induce myocardial injury and in-stent thrombosis. Second, lung cancer patients themselves have an increased risk of cardiovascular mortality. An analysis of over 270,000 patients from the SEER database showed that cardiovascular mortality in lung cancer patients is 74% higher than in the general population (IRR 1.74). The risk is highest in the first month after diagnosis (IRR 12.08). [6] Lung cancer diagnosis and surgery themselves are strong triggers for cardiovascular events. In this study, although the 3.30% incidence of myocardial infarction is higher than in the general population, this rate is expected considering the patients all have coronary heart disease with stents. More importantly, all events improved with treatment. There were no deaths, and severe complications were zero. The incidence of new-onset postoperative atrial fibrillation in this study was 2.57%. In contrast, the incidence of postoperative atrial fibrillation reported in STS GTSD studies is 12.6%. [7] The significantly lower incidence of atrial fibrillation in our study may be related to improvements in perioperative management in recent years, the popularization of minimally invasive techniques, and the fact that all patients in this group received specialized cardiac management.

The use of antiplatelet drugs is a core element of perioperative management for patients with coronary heart disease. This study analyzed postoperative outcomes in three groups: patients not using antiplatelet drugs, those on single antiplatelet therapy (SAPT), and those on dual antiplatelet therapy (DAPT). The DAPT group had the lowest MACE rate (2.4%), notably lower than the SAPT group (7.9%) and the no-antiplatelet group (7.7%). However, the Chi-square test showed that the difference among the three groups was not statistically significant ($P = 0.176$). This result may be influenced by multiple factors. First, there is inherent selection bias in the decision to use antiplatelet drugs. Clinically, medication plans are usually chosen based on the patient's cardiovascular risk stratification, with higher-risk patients more likely to receive DAPT. Second, the sample size distribution among the groups was uneven, with only 26 cases in the no-antiplatelet group, which may affect statistical power. Third, perioperative antiplatelet management strategies (such as whether to stop medication and the duration of withdrawal) were not included in the analysis, which may also have a confounding effect on the results. Nevertheless, the 2.4% MACE rate in the DAPT group still suggests that DAPT may have a protective effect for high-risk patients. As for the perioperative antiplatelet strategy, we routinely discontinued clopidogrel 5–7 days before surgery [8], continued aspirin in most cases, and used heparin bridging in selected high-risk patients until 12–24 hours preoperatively. This approach appeared to balance thrombotic and bleeding risks well: the overall MACE rate was 5.9%, and the postoperative bleeding rate was only 0.73%, with no cases of fatal bleeding or reoperation for hemostasis. These findings suggest that the "stop 5–7 days plus heparin bridging when needed" strategy is safe for lung cancer surgery patients with coronary stents, though larger studies are needed to confirm the optimal regimen.

Time since stent implantation reflects the stability of a patient's coronary revascularization. It is an important reference index for assessing perioperative cardiovascular risk. Research shows that the first year after stent implantation is a high-risk period for thrombotic events. The incremental risk of postoperative myocardial infarction decreases from 5% immediately after stenting to 2% at one year. After one year, the risk is no longer significantly elevated compared to a control group without stents. [9] This study observed a counterintuitive phenomenon: none of the 16 patients with stent implantation < 6 months

experienced MACE (0%). However, the MACE rate was 7.9% in the 6-month to 1-year group and 5.9% in the > 1 year group. This apparently paradoxical finding may be explained by several factors. First, the < 6-month subgroup was small, containing only 16 patients, which limits statistical reliability. Second, these patients were likely subject to stricter selection and more intensive perioperative cardiac management. Third, all patients in this subgroup received more cautious antiplatelet management, which may have mitigated perioperative thrombotic risk. Therefore, this finding should be interpreted cautiously and should not be taken as evidence that early surgery after stent implantation is universally safe.

Statins are not only the foundation of lipid-lowering therapy but also play an important role in cardiovascular protection due to their pleiotropic effects (anti-inflammatory, plaque stabilization, improving endothelial function).[10] This study showed that among 102 patients not using statins, the complication rate was 21.6% (22 cases) and the MACE rate was 7.8% (8 cases). In contrast, among 171 patients using statins, the complication rate was only 15.5% (26 cases) and the MACE rate was 4.7% (8 cases). The Chi-square test showed that the difference in complication rates between the two groups was statistically significant ($P = 0.0115$). However, the difference in MACE rates did not reach statistical significance ($P = 0.305$). This suggests that the potential benefit of statins in our cohort may have been more closely related to reducing minor myocardial injury or overall postoperative complications rather than preventing hard cardiovascular events. In addition, the possibility of a healthy-user effect should be considered. Patients receiving statins were more likely to receive other cardiovascular protective therapies, including antiplatelet agents and beta-blockers, which may have contributed to the observed association. Therefore, while our findings support the continuation of statins in eligible patients during the perioperative period[11], the independent protective effect of statins requires confirmation in prospective studies.

Beta-blockers are standard for coronary heart disease. In this study, patients on beta-blockers had slightly lower complication rates (14.5% vs. 19.9%) and MACE rates (5.1% vs. 6.4%), but the differences were not significant ($P > 0.05$). One possible explanation is that the benefit may be limited to certain subgroups—such as those with high heart rates, prior myocardial infarction, or left ventricular dysfunction—and gets diluted in the overall analysis.[12] Also, we lacked data on dosage, timing, and whether the drug was continued perioperatively, which could affect the results. In clinical practice, beta-blockers are still reasonable for patients with fast heart rates, angina, or poor heart function, but overuse should be avoided.

Pulmonary disease was associated with a higher complication rate (75.0% vs. 16.7%, $P = 0.0174$), but this finding should be interpreted with caution. Only 4 patients had a documented diagnosis of pulmonary disease (all COPD), which limits statistical power and makes the result unstable. In reality, the proportion of patients with poor pulmonary function is much higher in our cohort, but many were not formally coded with a COPD diagnosis in the medical records. Therefore, this analysis likely underestimates the true impact of pulmonary disease on postoperative outcomes.

Regarding pulmonary complications, the incidence of air leak in this study was 6.23%. A study on surgery for malignant lung tumors showed that the incidence of prolonged air leak in patients undergoing thoroscopic surgery is approximately 10.6%. [13] The incidence of air leak in our study is lower than this literature report. The incidence of chylothorax in our study was 1.47%. A large-sample retrospective

analysis published in 2013 showed that the overall incidence of postoperative chylothorax was 2.3%. [14]The incidence in our study is lower than this related report. The incidence of pulmonary infection in our study was 0.37%. Literature reports on the incidence of pneumonia after lung cancer surgery vary widely. A 2025 retrospective cohort study reported an incidence of 8.9%.[15] The pulmonary infection rate in our study is much lower than literature reports. This may be related to differences in the inclusion and exclusion criteria of the study population, differences in infection definitions, and the more meticulous preoperative cardiovascular disease management in our patient group.

Blood loss showed no significant difference between the complication and no-complication groups. Complication rates also did not differ significantly by procedure type. Lobectomy, longer operative time, and more blood loss all trended toward higher risk numerically, but the differences were not significant, likely due to the widespread use of minimally invasive techniques and precise intraoperative management. [16]Although surgeons often choose less extensive resections for high-risk patients to reduce risk, our data suggest that lobectomy did not increase risk more than wedge or segmental resection. Complications significantly prolonged chest tube duration and hospital stay (by about 4 days), highlighting that preventing complications matters not only for patient safety but also for resource utilization. This study retrospectively analyzed 273 lung cancer patients with coronary heart disease and stents. The results suggest that under standardized cardiac care and multidisciplinary collaboration, lung resection is acceptably safe in this population.

However, this study has several limitations. First, as a retrospective single-center study, there may be inherent selection bias, and it is impossible to completely control for the influence of unmeasured confounding factors. Second, some patients had distant stent implantation, and complete data on their coronary stents were lacking. This prevented a stratified assessment of in-stent thrombosis risk. Third, some subgroups (such as the pulmonary disease group with only 4 cases) had small sample sizes, resulting in insufficient statistical power and potentially leading to Type II errors. Fourth, details such as drug dosage, medication adherence, and perioperative medication adjustments were not included in the analysis, which may affect the precise interpretation of the results. Future large-scale, prospective, multi-center studies are needed to further verify the protective and risk factors identified in this study and to establish a specific risk prediction model applicable to lung cancer surgery patients with coronary heart disease.

Conclusion

This study conducted a retrospective analysis of 273 lung cancer patients with coronary heart disease and prior stent implantation who underwent lung resection surgery. The results showed that the overall postoperative complication rate was 17.6%, the major adverse cardiovascular event rate was 5.9%, and there were no perioperative deaths. These findings indicate that under standardized multidisciplinary management, lung resection surgery is safe for lung cancer patients with coronary heart disease and stents. Although elevated cardiac enzymes were common (7.7%), most cases represented subclinical myocardial injury, and all patients with cardiovascular events improved after treatment. Statins helped reduce the risk of overall complications, while patients with pulmonary disease required enhanced

perioperative management. In conclusion, with meticulous perioperative care, surgical safety can be effectively ensured in this high-risk population.

Declarations

Ethics approval and consent to participate

Human Ethics and Consent to Participate declarations: not applicable

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests

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Author Contribution

Weixin Chen and Hongsheng Liu conceived and designed the study. Weixin Chen, Zhewei Zhao, Yingzhi Qin, Yuan Xu, Qixuan Wang, and Dongjie Ma collected and curated the clinical data. Weixin Chen and Zhewei Zhao performed the statistical analysis and interpreted the results. Weixin Chen drafted the original manuscript. Yingzhi Qin, Yuan Xu, Qixuan Wang, and Dongjie Ma contributed to data validation and manuscript revision. Hongsheng Liu supervised the study, provided critical intellectual input, and approved the final version of the manuscript. All authors reviewed and approved the final manuscript, and agree to be accountable for all aspects of the work.

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Not applicable

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due [REASON WHY DATA ARE NOT PUBLIC] but are available from the corresponding author on reasonable request.

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Figures

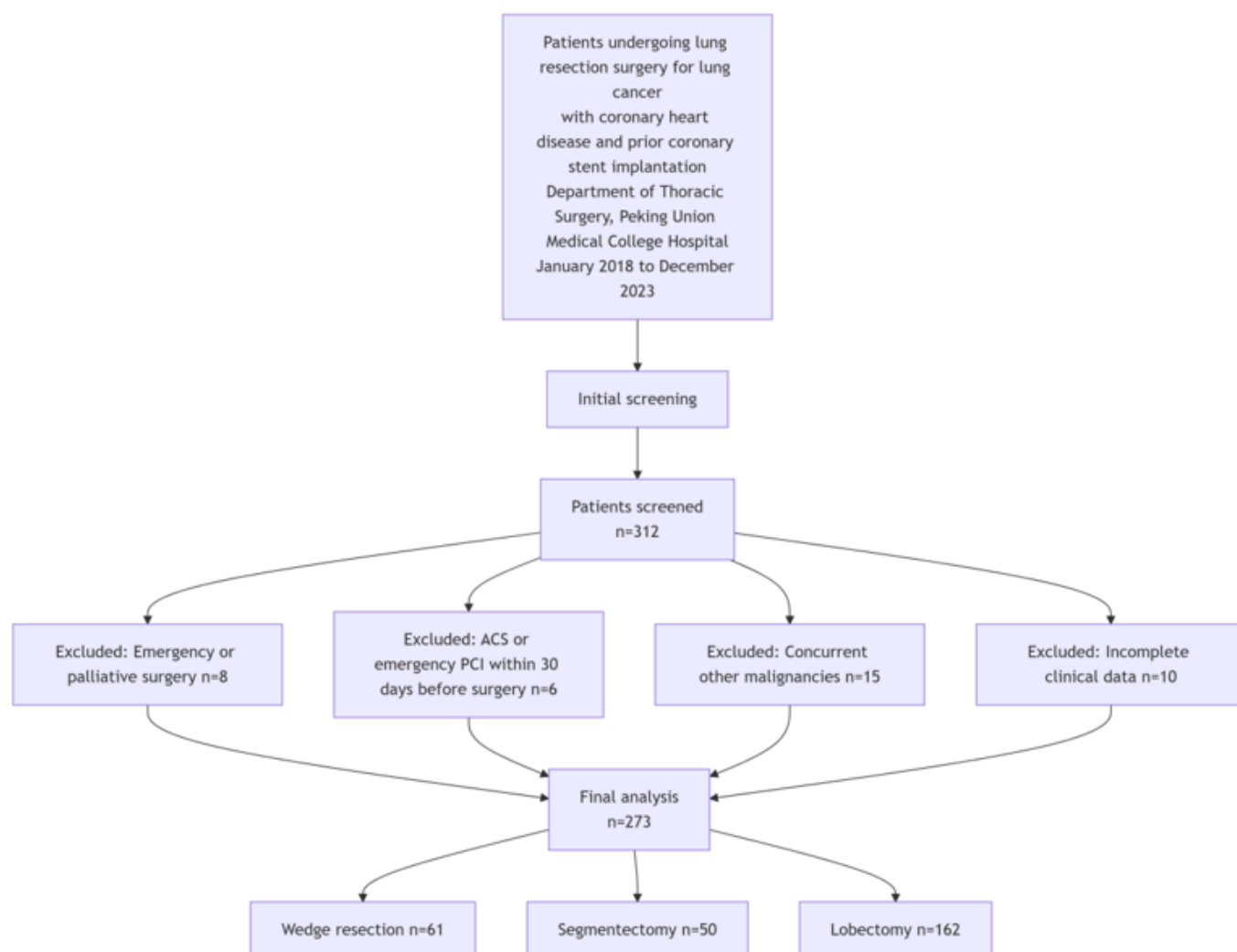


Figure 1

The patient screening and enrollment process