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Evaluating the Outcomes of Simultaneous Lung Resection and Cardiac Surgery: A Retrospective Cohort Study

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Abstract

Objective: The management of patients requiring both cardiac and pulmonary surgeries presents a unique challenge, given the rarity of coexisting conditions necessitating simultaneous interventions. This study aimed to evaluate the surgical outcomes of performing lung resection and cardiac surgery in a single operative session. The primary objective of this study was to assess the early and midterm outcomes of a combined surgical strategy for treating coexistent heart and lung diseases. Specifically, it seeks to understand the feasibility, safety, and efficacy of simultaneous operations compared with traditional staged approaches.

Methods: This retrospective analysis included 25 patients who underwent concurrent thoracic and cardiac surgery between 2012 and 2021. We examined the types of cardiac and pulmonary surgeries performed, the necessity of additional thoracotomy beyond median sternotomy, early postoperative outcomes, including operative mortality, the incidence of re-exploration due to complications, and pulmonary complications. Long-term outcomes were evaluated through direct outpatient visits or telephonic interviews.

Results: The average age was 62.6±9.4 years, with six females among the participants. Median sternotomy was the primary surgical approach for all patients, with one case requiring additional thoracotomy. Surgical interventions included 13 isolated coronary artery bypass grafting (CABG) procedures, 5 valve surgeries, 6 combined CABG and valve surgeries, and 1 Bentall procedure. Pulmonary interventions included 15 wedge resections and 10 lobectomies with lymph node dissection. There were no cases of operative mortality. Re-exploration was necessary in one patient because of bleeding ($p>0.05$). Post-extubation hypoxemia was not observed, and pulmonary complications occurred in two patients ($p>0.05$).

Conclusion: Simultaneous execution of thoracic and cardiac surgeries is feasible, demonstrating low rates of postoperative mortality and complications, thereby offering a viable alternative for patients with coexisting cardiac and pulmonary conditions. This study underscores the potential benefits of a simultaneous surgical approach in selected patients, suggesting that with appropriate preoperative planning and surgical expertise, combined operations can be safely conducted, minimizing the need for multiple hospitalizations and surgeries.

Keywords: Cardiac surgical procedures, pulmonary surgical procedures, wedge resection

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INTRODUCTION

Coexisting cardiac and pulmonary conditions that require surgical intervention are uncommon, yet they present significant clinical challenges (1). Incidental findings of lung masses during computed tomography (CT) scans for preoperative cardiac surgery evaluation are not unusual (2). The dual presence complicates surgical management because of the absence of a universally accepted protocol for simultaneously addressing both conditions (3). Historically, the preference was for a staged surgical approach, conducting cardiac surgery first and delaying pulmonary surgery by several weeks (4). However, emerging evidence, supported by findings from our research, suggests a shift toward simultaneous cardiac and pulmonary surgeries as a viable option, demonstrating promising surgical results (5-8).

The rationale behind this study stems from the complexity and intricacy of managing patients with concurrent cardiac and pulmonary surgical needs. Although the staged approach has its merits, it also prolongs the patient's recovery time and exposes them to the risks associated with multiple operations. The potential benefits of simultaneous surgery include reduced overall hospital stay, cost savings, and possibly a quicker return to normal activities for the patient. Despite these advantages, the decision to adopt a one-stage procedure must be carefully weighed against the increased complexity of performing two major surgeries simultaneously. The literature provides limited guidance on this matter, with studies offering varying outcomes and recommendations. This ambiguity underscores the necessity for further research to establish clearer guidelines and to explore the potential advantages of a one-stage surgical approach in this patient population. In addition, the evolution of surgical techniques and postoperative care has enabled more complex surgical procedures to be performed with improved safety profiles, suggesting that simultaneous surgeries could be more feasible than previously thought.

Therefore, this study was designed to evaluate the early and midterm outcomes of patients undergoing combined pulmonary resection and cardiac surgery at our specialized thoracic and cardiovascular surgery center. Our aim was to contribute to the body of evidence supporting the feasibility and safety of this approach, potentially offering a new perspective on optimal patient management. By comparing our results with those available in the literature, we sought to identify areas of convergence and divergence, thus providing insights into the relative benefits and challenges of simultaneous surgeries. The hypothesis of this study was that simultaneous pulmonary resection and cardiac surgery could achieve comparable, if not superior, outcomes to the traditional staged approach, thereby offering an effective alternative for patients with coexisting conditions.

METHODS

Study Setup and Data Collection

The scope of this study included patients who underwent simultaneous pulmonary resection and cardiac surgery at our institution from 2012 to 2021. The exclusion criteria were patients under 18 years of age and those who underwent emergency surgery. Preoperative demographic, echocardiographic, and laboratory data were systematically collected. Operation notes detailed the cardiac procedure type, use of cardiopulmonary bypass (CPB), durations of CPB and aortic cross-clamp, specifics of the pulmonary resection type, and need for thoracotomy alongside median sternotomy. Postoperative data encompassed operative mortality, cases requiring re-exploration because of bleeding or cardiac tamponade, pulmonary complications, and lengths of stays in the intensive care unit and hospital. Preoperative, operative, and postoperative outcomes were evaluated in two groups: patients undergoing wedge resection only and those undergoing lobectomy with lymph node dissection.

Definitions

Operative mortality was defined as death occurring either before discharge or within 30 days after surgery. Pulmonary complications included hypoxemia, air leakage necessitating drainage tubes for more than 3 days, pneumothorax, persistent pulmonary infiltrates on chest X-ray, pulmonary thromboembolism, pneumonia, reintubation, and tracheostomy.

Surgical Preparation and Technique

Pulmonary function tests and chest X-ray imaging were routinely performed before each cardiac surgery. All cardiac surgery patients were assessed by a pulmonologist during the preoperative period. Following the pulmonologist's recommendations, individuals with known lung masses or abnormalities on chest X-ray underwent further evaluation using tomography. In the context of concurrent pulmonary resection and cardiac surgery, procedures were performed with a low incidence of postoperative mortality and complications. The surgical approach for patients was determined collectively by a multidisciplinary team consisting of cardiovascular surgeons, thoracic surgeons, cardiologists, pulmonologist and radiologists. Conventional coronary angiography and transthoracic echocardiography were performed on all patients. The fine

needle aspiration procedure (FNAP) was not routinely performed preoperatively. Whole-body positron emission tomography/CT was used to evaluate preoperative cancer spread in cases focused on lung masses, while omitted for surgeries related to bullous lung disease. For off-pump surgeries, 80 U/kg heparin was administered, whereas on-pump surgeries received 400 U/kg heparin. CPB initiation was reserved for on-pump surgeries. Cold blood cardioplegia was employed in surgeries with arrested hearts. Following the completion of cardiac surgery, protamine was administered to counteract heparin. The choice between wedge resection or lobectomy, along with lymph node dissection, was made according to the pre-established surgical plan post-cardiac surgery. Direct lobectomy and lymph node dissection were performed in patients with a preoperative diagnosis of pulmonary malignancy using FNAP. In cases without a preoperative FNAP diagnosis, a frozen section in the form of wedge resection was obtained for mass lesions. If the frozen section revealed malignancy, the procedure was expanded to include lobectomy and lymph node dissection. All removed pulmonary masses were subjected to pathological examination.

Postoperative Follow-up

The patients were transferred to the intensive care unit (ICU) with mechanical ventilator support. The invasive arterial pressure and central venous pressure were monitored. After extubation, the patients were mobilized. Arterial catheters were removed, and patients with stable hemodynamics were transferred to the cardiovascular service. Long-term treatment plans were developed on the basis of the pathology results. Patient follow-up was conducted long term either through in-person outpatient visits or telephone interviews.

This study was conducted in compliance with the Declaration of Helsinki. In this retrospective observational cohort study, patient data were collected following approval (approval number: 2022.02-13, date: 22.02.2022) from the İstanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital Clinical Research Ethics Committee. A written informed consent was obtained from each patient.

Statistical Analysis

Statistical analyses were performed using R version 4.0.3 (R Foundation for Statistical Computing). The distributions of continuous variables were assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Non-normally distributed continuous data were presented as medians and interquartile ranges and compared using the Mann-Whitney U test. Categorical data were presented as the number of patients with ratios and compared using Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS

The average age of the study participants was 62.6 years, with a standard deviation of 9.4 years. Of these, six participants (24%) were female. A total of nine patients (36%) had been diagnosed with diabetes mellitus, all of whom were on insulin or oral antidiabetic drugs. Most cohort, 21 individuals (84%), reported a history of smoking, whereas only four (16%) reported never having smoked. Chronic renal failure was not reported in any participant's history. The median value for preoperative serum creatinine was recorded at 0.89 mg/dL, with an interquartile range of 0.73-0.96 mg/dL. Comprehensive preoperative demographic and clinical details are provided in Table 1.

Table 1. Comparison of preoperative demographic and clinical data

	All patients (n=25)	Only wedge resection (n=15)	Lobectomy and lymph node dissection (n=10)	p-value*
Age (years)	65 (54-72)	65 (54-72)	64 (54-67)	0.70
Male	76	73	80	1.00
Hypertension	76	80	70	0.65
NYHA stage 3-4	20	33	0	-
Diabetes mellitus	36	27	50	0.40
COPD	32	33	30	1.00
Smoker	84	80	90	0.63
Serum creatinine (mg/dL)	0.89 (0.73-0.96)	0.89 (0.83-0.93)	0.85 (0.73-0.96)	0.89
Ejection fraction (%)	50 (35-60)	50 (35-55)	55 (45-60)	0.38

Data are given as percentage or median (interquartile range) as appropriate.
COPD: Chronic obstructive pulmonary disease, NYHA: New York Heart Association
*Comparison of wedge resection, lobectomy, and lymph node dissection

Operative Details

Median sternotomy was used for all surgical procedures, with an additional thoracotomy required for one patient because of a malignant mass in the left lower lobe of the lung. Surgical procedures varied among the patients; isolated coronary artery bypass grafting (CABG) was performed on 13 patients, two of whom employed the beating heart technique. Isolated aortic valve replacements were performed in three patients, whereas single instances of mitral valve replacement, tricuspid valve repair, combined aortic and mitral valve replacement, and the Bentall procedure were performed. Six patients underwent combined CABG and valve surgeries. The median times for CPB and aortic cross-clamp were 95 and 53 min, respectively.

Isolated wedge resections were performed on 15 patients, with six of these proceeding to lobectomy based on the frozen section results. Lobectomy and lymph node dissection were performed in 10 patients (40%) following heart surgery, predominantly in the right upper lobe, as observed in nine patients (36%). The operative details are summarized in Table 2.

Operative mortality was not reported in the cohort. Re-exploration because of hemorrhagic complications was necessary for only one patient (4%), and none experienced cardiac tamponade. Post-extubation, hypoxemia was not observed in any patient, eliminating the need for non-invasive mechanical ventilation or reintubation.

Pulmonary complications were noted in two patients (8%), with pneumonic infiltration detected on X-ray within four days post-surgery, leading to the initiation of antibiotic treatment, which resolved the condition within five days. In these cases, *Klebsiella pneumoniae* was identified in sputum cultures before antibiotic administration. One patient experienced persistent air leakage, which resolved spontaneously within eight days post-operation without the need for further invasive procedures. No significant statistical differences were noted in intubation duration, ICU stay length, and total hospital stay between patients undergoing wedge resection only and those receiving lobectomy with lymph node dissection ($p>0.05$). The postoperative outcomes are detailed in Table 3.

Pathological examinations revealed non-small-cell lung cancer in nine patients, including adenocarcinoma in four, squamous cell carcinoma in two, large cell carcinoma in one, atypical carcinoid in one, and undifferentiated round cell carcinoma in another. One patient was diagnosed with small cell lung cancer. In addition, benign lung tumors were diagnosed in 12 patients, including six hamartomas, three adenomas, and three papillomas. Pathology reports for three patients operated on for high-risk bullous lung disease showed emphysematous changes.

Table 2. Comparison of operational data

	All patients (n=25)	Only wedge resection (n=15)	Lobectomy and lymph node dissection (n=10)	p-value*
Cardiac surgery data				
On pump CABG	44	40	50	0.70
Off-pump CABG	8	7	10	1.00
Aortic valve surgery	12	13	10	1.00
Mitral and tricuspid valve surgeries	4	7	0	-
Aortic and mitral valve surgery	4	7	0	-
Combined CABG and valve surgery	24	20	30	0.65
Bentall procedure	4	7	0	-
CPB time (min)	95 (63-137)	95 (83-132)	91 (77-138)	0.82
ACC time (min)	53 (36-94)	52 (35-92)	56 (40-95)	0.89
Pulmonary surgery data				
Right upper lobe	36	33	40	1.00
Right middle lobe	4	7	0	-
Right lower lobe	28	27	30	1.00
Left upper lobe	28	33	20	0.70
Left lower lobe	4	0	10	-

Data are given as percent or median (interquartile range) as appropriate. ACC: Aortic cross clamp, CABG: Coronary artery bypass grafting, CPB: Cardiopulmonary bypass, min: Minutes

*Comparison of only wedge resection, lobectomy, and lymph node dissection

Table 3. Comparison of postoperative data				
	All patients (n=25)	**Only wedge resection (n=15)**	**Lobectomy and lymph node dissection (n=10)**	**p-value***
Need for re-exploration	4	0	10	-
Pulmonary complications	8	7	10	1.00
Intubation time (hours)	19 (12-39)	13 (12-30)	19 (13-43)	0.33
ICU stay (hours)	37 (25-78)	27 (24-61)	37 (27-86)	0.27
Hospital stay (days)	7 (5-12)	6 (5-10)	7 (5-13)	0.31
Data are given as percentage or median (interquartile range) as appropriate. ICU: Intensive care unit *Comparison of only wedge resection, lobectomy, and lymph node dissection				

Long-term follow-up ranged from 1 to 9 years, during which nine patients died; three from lung cancer and six from cardiac causes. No reoperations for cardiac or thoracic conditions were reported. Among those who died of lung cancer, recurrence and metastasis were identified, with all three succumbing to the disease within one year of recurrence diagnosis. Coronary angiography was performed in two patients with recurrent chest pain, although no coronary stents were placed. Permanent pacemakers were implanted in two patients who had undergone combined CABG and valve surgery.

DISCUSSION

Chest X-ray is instrumental in the preoperative assessment of cardiac surgeries, often leading to additional imaging to closely examine areas of concern. Occasionally, these evaluations reveal unexpected pathologies that necessitate pulmonary resection; however, a standardized surgical approach for such scenarios remains undefined (3). The literature describes two principal strategies: a staged approach in which lung surgery follows cardiac surgery according to the original plan (4,9) and a simultaneous procedure that combines pulmonary resection and cardiac surgery (5-8,10). The choice between a staged and simultaneous approach lacks direction from prospective studies. Simultaneous operations provide the benefits of prompt lung cancer resection, decreased overall costs, and reduced length of hospital stays but introduce challenges such as managing two critical organs at once, increased risk of postoperative bleeding, and the intricacies involved in extensive lymph node dissection (11-13). Extra incisions alongside median sternotomy increase surgical risks (14). In our practice, the simultaneous approach has been the standard for the last decade, primarily through median sternotomy to diminish surgical risks. Among 24 patients treated, only one required an additional thoracotomy for extensive lymph node dissection.

Despite the majority of cardiac surgeries being performed on-pump (92%), the need for re-exploration due to bleeding was rare, occurring in just one patient, and pulmonary complications were observed in only two patients during the initial postoperative phase. While off-pump CABG is linked to fewer bleeding and pulmonary complications, our outcomes indicate that on-pump procedures can be safely integrated into simultaneous operations (15-17). Preferring to complete cardiac surgery before pulmonary resection typically reduces cardiac-related risks during concurrent surgeries (1). We believe that addressing the cardiac condition first not only decreases the potential for cardiac issues during combined surgeries but also paves the way for a smoother recovery. Moreover, starting with pulmonary surgery could result in increased bleeding and edema at the lung incision sites because of the administration of heparin during cardiac procedures. For these reasons, lung surgeries were conducted after cardiac interventions in all cases.

A comprehensive meta-analysis of 29 retrospective observational studies encompassing 536 patients revealed an operative mortality rate of 0.01 and a postoperative complication rate of 0.40 for individuals undergoing combined cardiothoracic surgeries (18). Our study's initial postoperative results are consistent with these findings, demonstrating that combined pulmonary resection and cardiac surgeries can be performed with a relatively minimal surgical risk. Pathology outcomes from our cohort revealed malignancies in 10 patients. Not pursuing simultaneous surgeries might delay scheduling lung operations due to the need for antiplatelet or anticoagulant therapy and extended recuperation after cardiac procedures, potentially worsening malignant growths. Despite the need for longer anesthesia times during combined surgeries, these can be performed with low rates of postoperative mortality and complications.

In summary, our findings suggest that simultaneous pulmonary resection and cardiac surgery are feasible with low rates of postoperative mortality and complications.

Study Limitations

This investigation is not without its limitations, including a small cohort size, the inclusion of varied surgical pathologies, and differences in surgical approaches, especially regarding on-pump versus off-pump CABG.

CONCLUSION

In conclusion, our study demonstrates that simultaneous pulmonary resection and cardiac surgery can be performed with minimal postoperative mortality and complication rates. To validate these results, further randomized controlled trials are necessary.

Ethics

Ethics Committee Approval: In this retrospective observational cohort study, patient data were collected following approval (approval number: 2022.02-13, date: 22.02.2022) from the İstanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital Clinical Research Ethics Committee.

Informed Consent: A written informed consent was obtained from each patient.

Authorship Contributions

Surgical and Medical Practices: T.A., Ç.T.Ü., Z.M.D., Z.A., Concept: T.A., Ç.T.Ü., Z.M.D., Z.A., Design: T.A., Ç.T.Ü., Z.M.D., Data Collection or Processing: T.A., Ç.T.Ü., Z.A., Analysis or Interpretation: T.A., Ç.T.Ü., Z.A., Literature Search: T.A., Ç.T.Ü., Z.M.D., Writing: T.A.

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