

# The impact of previous COVID-19 pneumonia on postoperative outcomes and complications in coronary artery bypass grafting

*Koroner arter baypas greftlemede geçirilmiş COVID-19 pnömonisinin ameliyat sonrası sonuçlar ve komplikasyonlar üzerindeki etkisi*

Özlem Erçen Diken<sup>1</sup>, İzzet Hafez<sup>2</sup>, Hüseyin Ali Tünel<sup>2</sup>, Muhammed Onur Hanedan<sup>3</sup>,  
Utku Alemardoğlu<sup>2</sup>, Adem İlkey Diken<sup>2</sup>

*Institution where the research was done:*  
Başkent University Faculty of Medicine, Adana, Türkiye

*Author Affiliations:*

<sup>1</sup>Department of Chest Diseases, University of Health Sciences, Adana City Training & Research Hospital, Health Sciences University, Adana, Türkiye  
<sup>2</sup>Department of Cardiovascular Surgery, Başkent University Faculty of Medicine, Adana Dr. Turgut Noyan Application and Research Center, Adana, Türkiye  
<sup>3</sup>Department of Cardiovascular Surgery, University of Health Sciences, Adana City Training & Research Hospital, Health Sciences University, Trabzon, Türkiye

## ABSTRACT

**Background:** This study aimed to provide nuanced insights in managing patients with a history of coronavirus disease 2019 (COVID-19) pneumonia undergoing coronary artery bypass grafting.

**Methods:** This retrospective cohort study involved 168 patients (131 males, 37 females; mean age: 61.2±9.7 years; range, 51 to 72 years) undergoing isolated coronary artery bypass grafting surgery between December 2021 and December 2023. The study examined factors such as age, sex, comorbidities, blood test results, vaccination status, operative parameters, and postoperative complications. Patients' health records were reviewed to confirm the presence of previous COVID-19 pneumonia and vaccination status. Patients were divided into two groups based on their history of COVID-19 pneumonia: Group 1 included 140 who had not been diagnosed with COVID-19 pneumonia, and Group 2 included 28 patients who had a documented history of COVID-19 pneumonia. Postoperative pulmonary complications, including atelectasis, pleural effusion, acute respiratory distress syndrome, and pneumonia, were noted.

**Results:** Patients with a history of COVID-19 pneumonia (Group 2, n=28) demonstrated significantly higher seropositivity for COVID-19 (89.3% vs. 29.3%, p=0.001) compared to those without a history (Group 1, n=140). Although pulmonary complications were higher in Group 2 (17.9% vs. 3.6%, p=0.013), postoperative mortality rates did not differ significantly between the groups. Pleural effusion was markedly higher in Group 2 (14.3% vs. 2.1%, p=0.015). Vaccination did not significantly affect perioperative and postoperative outcomes, except for a minor difference in postoperative drainage volume.

**Conclusion:** This study highlights the impact of prior COVID-19 pneumonia on postoperative outcomes in coronary artery bypass grafting patients. Although there was a rise in pulmonary complications, the mortality rates stayed similar among individuals with and without a prior history of COVID-19 pneumonia. Vaccination did not significantly influence outcomes, emphasizing the need for further research with larger cohorts to validate and expand upon these findings.

**Keywords:** CABG, COVID-19, outcomes, pneumonia.

## ÖZ

**Amaç:** Bu çalışmada koronavirüs hastalığı (COVID-19) pnömonisi öyküsü olan ve koroner arter bypass grefti uygulanan hastaların yönetimi üzerine ayrıntılı anlayışların sağlanması amaçlandı.

**Çalışma planı:** Bu retrospektif kohort çalışması, Aralık 2021 - Aralık 2023 tarihleri arasında izole koroner arter bypass grefti ameliyatı geçiren 168 hastayı (131 erkek, 37 kadın; ort. yaş: 61.2±9.7 yıl; dağılım, 51-72 yıl) içermektedir. Çalışmada, yaş, cinsiyet, eşlik eden hastalıklar, kan testi sonuçları, aşı durumu, operatif parametreler ve ameliyat sonrası komplikasyonlar gibi faktörler incelendi. Hastaların sağlık kayıtları, önceki COVID-19 pnömonisi varlığını ve aşılama durumunu doğrulamak için değerlendirildi. Hastalar, COVID-19 pnömonisi geçmişlerine göre iki gruba ayrıldı: Grup 1'de COVID-19 pnömonisi tanısı konmamış 140 hasta yer aldı ve Grup 2'de belgelenmiş COVID-19 pnömonisi öyküsü olan 28 hasta yer aldı. Atelektazi, plevral efüzyon, akut solunum sıkıntısı sendromu ve pnömoni dahil olmak üzere ameliyat sonrası pulmoner komplikasyonlar kaydedildi.

**Bulgular:** COVID-19 pnömoni öyküsü olan hastalar (Grup 2, n=28), pnömoni öyküsü olmayanlara (Grup 1, n=140) kıyasla anlamlı olarak daha yüksek COVID-19 seropozitivitesi sergiledi (%89.3'e karşın %29.3, p=0.001). Pulmoner komplikasyonlar Grup 2'de daha yüksek olmasına rağmen (%17.9'a karşın %3.6, p=0.013), ameliyat sonrası mortalite oranları gruplar arasında anlamlı bir fark göstermedi. Plevral efüzyon Grup 2'de anlamlı olarak yüksek bulundu (%14.3'e karşın %2.1, p=0.015). Aşı, ameliyat sonrası ve perioperatif sonuçları anlamlı bir şekilde etkilememekle beraber, sadece ameliyat sonrası drenaj hacminde küçük bir fark saptandı.

**Sonuç:** Bu çalışma, geçirilmiş COVID-19 pnömonisinin koroner arter bypass grefti hastalarının ameliyat sonrası sonuçları üzerindeki etkisini vurgulamaktadır. Pulmoner komplikasyonlarda artışa rağmen, daha önce COVID-19 pnömoni öyküsü olan ve olmayan hastalar arasında mortalite oranları benzer saptanmıştır. Aşılama, sonuçları anlamlı derecede etkilemeyerek bu bulguları doğrulamak ve daha kapsamlı hale getirmek için daha büyük kohortlarla daha fazla araştırmaya ihtiyaç olduğunu vurgulamıştır.

**Anahtar sözcükler:** KABG, COVID-19, sonuçlar, pnömoni.

**Corresponding author:** Özlem Erçen Diken.

E-mail: ozlemercen@gmail.com

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The coronavirus disease 2019 (COVID-19) pandemic has left an indelible mark on global health, challenging healthcare systems and reshaping our understanding of disease management.<sup>[1]</sup> The ongoing COVID-19 pandemic has profoundly influenced medical practices, necessitating a reevaluation of postoperative outcomes in patients with a history of COVID-19 pneumonia undergoing coronary artery bypass grafting (CABG). Despite gaining insights into the systemic effects of COVID-19, there is still a noticeable gap in understanding the postoperative outcomes and complications for patients undergoing cardiac surgery after recovering from COVID-19 pneumonia.

After experiencing COVID-19, various opinions exist regarding the presence of a long-term persistent sequelae in the lungs. While Tuncer et al.<sup>[2]</sup> asserted in their prospective randomized study that there was no significant difference in lung functions observed during post-COVID-19 pneumonia follow-ups, a meta-analysis by Lee et al.<sup>[3]</sup> indicated a noticeable lung function impairment that only improved towards the end of the first year after severe pneumonia. Pulmonary complications can pose a considerable challenge for surgeons, anesthesiologists, and pulmonologists following a successful CABG procedure.<sup>[4]</sup> No study has been found to investigate the potential long-term effects of COVID-19 on lung parenchyma and their impact on the course of patients after CABG, which could be beneficial in elucidating this issue. It is important to note that this exploration could offer valuable insights into understanding the matter.

Hence, this study sought to meticulously examine a cohort of patients who underwent isolated CABG surgery and assess pulmonary complications, mortality rates, and the influence of vaccination. By focusing on this specific subset, we aim to provide nuanced insights that contribute to a more informed approach to managing patients with a history of COVID-19 pneumonia undergoing CABG.

## PATIENTS AND METHODS

This retrospective cohort study enrolled 168 patients (131 males, 37 females; mean age: 61.2±9.7 years; range, 51 to 72 years) who underwent isolated CABG surgery at the Başkent University Faculty of Medicine, Adana Dr. Turgut Noyan Application and Research Center between December 2021 and December 2023. Patient records were meticulously reviewed, and comprehensive data were collected, including age, sex, comorbidities, blood test results,

vaccination status, operative parameters, length of hospital stay, postoperative complications, and mortality. Nasopharyngeal and oropharyngeal swab samples were obtained for reverse transcription polymerase chain reaction testing to evaluate COVID-19 positivity during the initial hospital admission. Exclusion criteria comprised individuals undergoing concomitant cardiac surgery procedures, emergency surgeries, and those currently experiencing active COVID-19 infection. This rigorous methodology ensured a focused analysis of patients undergoing isolated CABG surgery, allowing for a detailed exploration of factors influencing outcomes and complications within the specified timeframe.

During the initial patient assessments, the medical histories were examined to determine whether the patients had experienced pneumonia during the pandemic and if they had been hospitalized as a result. The electronic health records of all patients were reviewed to assess their COVID-19 positivity during the pandemic, along with detailed evaluations of chest radiographs and, if available, thoracic computed tomography scans. Similarly, past discharge summaries accessed through electronic health records were reviewed to document whether they had been diagnosed with COVID-19 pneumonia. Among the 168 patients included in the study, 140 patients (Group 1) did not exhibit diagnosed COVID-19 pneumonia, while the remaining 28 patients (Group 2) had documented a history of COVID-19 pneumonia.

Postoperative pulmonary complications investigated in the study were atelectasis (detected during the in-hospital period), pleural effusion (during the first follow-up visit), pneumonia (detected during the in-hospital period), prolonged mechanical ventilation (>48 h), and acute respiratory distress syndrome (detected during the in-hospital period). The examination for these complications involved a thorough review of postoperative follow-up sheets, daily patient progress notes, and routine chest X-rays. The electronic health records pertaining to hospital admissions were scrutinized to identify cases of readmissions and any associated complications.

### Statistical analysis

Statistical analysis was performed using IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics, mean ± standard deviation (SD) in continuous variables, and median (min-max) values were given using nonparametric tests for data that did not show normal distribution. Descriptive statistics of categorical data were presented as numbers and

percentages (%). The Mann-Whitney U test was used according to the normality assumption for continuous variables. The Pearson chi-square test and Fisher exact test were used for categorical variables. The Mann-Whitney U test was used to test the significance of the difference between the two means when the parametric assumptions were not met. In determining the significance of the difference, the Pearson chi-square or Fisher exact was used. Univariate logistic regression analysis was performed to determine the risk factors of patients who did or did not survive. Hosmer–Lemeshow goodness-of-fit statistics were used to assess model fit. A *p*-value <0.05 was considered statistically significant.

## RESULTS

Seropositivity for COVID-19 was significantly higher in patients with a history of COVID-19 pneumonia (29.3% vs. 89.3%, *p*=0.001). Vaccination

rates were similar between the two groups (93.6% vs. 82.1%, *p*=0.060). The median duration until the operation for patients who had COVID-19 pneumonia was three months (2-6 months).

Upon the examination of preoperative demographic and clinical variables, there were no significant differences between the two groups in terms of previous myocardial infarction, family history, hyperlipidemia, hypertension, diabetes mellitus, smoking, chronic obstructive pulmonary disease, neutrophil-to-lymphocyte ratio, vaccination status, peripheral arterial disease, atrial fibrillation, and EuroSCORE II (European System for Cardiac Operative Risk Evaluation II) parameters. Patients in Group 2 had a larger body surface area (1.87±0.19 vs. 2.02±0.27, *p*=0.009) and a higher body mass index (27.23±4.55 vs. 30.47±4.95, *p*=0.001).

When both groups were analyzed for perioperative and postoperative variables, the results were similar

**Table 1. Preoperative and demographic variables**

	COVID-19 Pneumonia history						<i>p</i>
	No (n=140)			Yes (n=28)			
	n	%	Mean±SD	n	%	Mean±SD	
Age (year)			61.8±10.0			59.5±9.8	0.267
Sex							0.279
Male	107	76.4		24	85.7		
Female	33	23.6		4	14.3		
Previous myocardial infarction	90	64.3		20	71.4		0.468
Family history for coronary artery disease	24	17.1		2	7.1		0.256
Hyperlipidemia	95	67.9		22	78.6		0.260
Hypertension	121	86.4		24	85.7		1.000
Diabetes mellitus	86	61.4		18	64.3		0.776
Smoker	37	26.4		6	21.4		0.580
Chronic obstructive pulmonary disease	34	24.3		5	17.9		0.462
COVID-19 sero-positivity	41	29.3		25	89.3		<b>0.001</b>
Neutrophil to lymphocyte ratio			65.91±10.32			67.11±10.62	0.577
Vaccination	131	93.6		23	82.1		0.060
Peripheral arterial disease	5	3.6		2	7.1		0.330
Atrial fibrillation	4	2.9		0	0		1.000
EuroSCORE II			5.17±2.64			5.07±2.71	0.855
Body mass index (kg/m <sup>2</sup> )			27.23±4.55			30.47±4.95	<b>0.001</b>
Body surface area (m <sup>2</sup> )			1.87±0.19			2.02±0.27	<b>0.009</b>

COVID-19: Coronavirus disease 2019; SD: Standard deviation; EuroSCORE II: European System for Cardiac Operative Risk Evaluation II.

in terms of erythrocyte suspension usage, fresh frozen plasma usage, drainage volume, intubation period, cardiopulmonary bypass duration, cross-clamping duration, off-pump CABG, number of distal anastomoses, need for inotropic drugs, arrhythmia, stroke, intra-aortic balloon pump usage, intensive care unit stay, and hospital stay parameters.

In the study group, a total of four (2.38%) in-hospital mortalities were observed, and a total of nine (5.35%) mortalities were observed within the first 30 days. There was no difference in mortality rates between the groups ( $p=0.130$  for in-hospital mortality and  $p=0.646$  for 30-day mortality). Among patients with in-hospital mortality, two were lost due to acute kidney failure, one due to major intracranial bleeding, and the last one due to gastrointestinal system complications. Both groups exhibited similar rates of postoperative atrial fibrillation, postoperative wound infection, renal complications (acute renal failure), gastrointestinal complications, and unplanned readmission to the hospital (emergency and outpatient services). Although a higher number of neurological complications were observed in Group 2, the difference did not reach a statistical significance [one (0.7%) in Group 1 vs. two (7.1%) in Group 2,  $p=0.072$ ; Table 3].

When pulmonary complications were examined, the overall pulmonary complication rate was higher

in Group 2 ( $n=5$ , 17.9%) compared to Group 1 ( $n=5$ , 3.6%), with a statistically significant difference ( $p=0.013$ ). Upon further analysis of subcategories of pulmonary complications, no cases of prolonged intubation or acute respiratory distress syndrome were observed in any patient. In Group 1, early-stage pneumonia was observed in one (0.7%) patient, while it was not observed in Group 2 ( $p=1.000$ ). Atelectasis detected in routine chest X-rays was observed in one patient in each group (0.7% in Group 1 vs. 3.6% in Group 2), with no statistically significant difference ( $p=0.306$ ). The only parameter showing a significant difference among pulmonary complications was pleural effusion. The frequency of pleural effusion was markedly higher in patients in Group 2 ( $n=4$ , 14.3%) compared to Group 1 ( $n=3$ , 2.1%), with a statistically significant difference ( $p=0.015$ , Table 3).

In addition to the primary findings of the study, a secondary analysis was conducted to investigate the impact of vaccination on current clinical outcomes between the two groups. Within the scope of the study, no significant differences were found in perioperative and postoperative parameters examined, except for drainage volume. In Group 2, a significant difference in drainage volume was observed between vaccinated and

**Table 2. Perioperative and postoperative variables among groups**

	Previous COVID-19 pneumonia						<i>p</i>
	No (n=140)		Yes (n=28)				
	n	%	n	%			
Erythrocyte suspension (unit)						0.800	
Fresh frozen plasma (unit)						0.438	
Drainage/blood loss (mL)						0.205	
Intubation period (h)						0.845	
Cardiopulmonary bypass duration (min)						0.296	
Cross-clamping duration (min)						0.595	
Off pump coronary artery bypass grafting	2	1.4	2	7.1		0.130	
Number of distal anastomosis						0.662	
Need for inotropic drugs	20	14.3	1	3.6		0.206	
Arrhythmia	12	8.6	3	10.7		0.718	
Stroke*	5	3.6	2	7.1		0.330	
Intraaortic balloon pump	1	0.7	0	0		1.000	
Intensive care unit stay (day)						0.805	
Hospital stay (day)						1.000	

COVID-19: Coronavirus disease 2019; SD: Standard deviation; \* In early postoperative period.

**Table 3. Postoperative complications resulting mortality and morbidity**

	Previous COVID-19 pneumonia				<i>p</i>
	No (n=140)		Yes (n=28)		
	n	%	n	%	
Postoperative atrial fibrillation	17	12.1	2	7.1	0.743
Pulmonary complications (total)	5	3.6	5	17.9	0.013
Atelectasis	1	0.7	1	3.6	0.306
Pleural effusion	3	2.1	4	14.3	0.015
Pneumonia	1	0.7	0	0	1.000
Prolonged intubation	0	0	0	0	N/A
Acute respiratory distress syndrome	0	0	0	0	N/A
Neurological complications	1	0.7	2	7.1	0.072
Postoperative wound infection	4	2.9	1	3.6	1.000
Renal complications	4	2.9	1	3.6	1.000
Gastrointestinal complications	0	0	1	3.6	0.167
Readmission to the hospital	46	32.9	6	21.4	0.232
In hospital mortality	2	1.4	22	7.1	0.130
30-Day mortality	7	5.0	2	7.1	0.646

COVID-19: Coronavirus disease 2019.

unvaccinated individuals (620.00±90.83 mL vs. 426.09±197.06 mL, *p*=0.041), while such a difference was not identified in Group 1.

## DISCUSSION

A higher seropositivity for COVID-19 was detected in patients with a recent medical history of COVID-19 pneumonia. During preoperative assessments of this patient group, it should be kept in mind that individuals with high seropositivity may have a higher likelihood of having experienced COVID-19 pneumonia. Although significant differences in pulmonary complications were observed in patients with a recent medical history of COVID-19 pneumonia, this did not alter the postoperative mortality rate among the study groups. Another noteworthy finding of our study is that vaccination did not have a significant impact on perioperative and postoperative parameters. Both vaccinated and unvaccinated individuals underwent a similar postoperative course, with only a minor difference in postoperative drainage volume.

During the pandemic, a decline in cardiac surgeries, such as coronary bypass surgery, has been observed, aiming to mitigate the increasing mortality impact of COVID and protect healthcare personnel. In a study,

a 25% reduction in bypass cases during the pandemic period was reported.<sup>[5]</sup> Worldwide decrease in elective surgeries is encouraged by various societies.<sup>[6,7]</sup> Various recommendations were established during the early stages of the pandemic about the management of patients needing cardiac surgery.<sup>[8,9]</sup> In most of these studies, different cardiac surgery types were stratified based on urgency, and algorithms were devised to guide decisions according to the patient's COVID-19 positivity during admission. Generally, in high-risk cases such as aortic dissection, COVID-19 positivity was not considered a deterrent for surgery, but it was recommended to postpone cases whenever possible, particularly in situations where vital risks decreased and waiting was feasible. While these initial recommendations largely maintained their validity, over time, a group of cases were encouraged not to be delayed whenever conditions permitted.<sup>[10]</sup> Furthermore, a multicenter Italian study proposed a roadmap to restart elective cardiac surgery after the COVID-19 peak and offered a stepwise algorithm to start elective cases in each phase of the pandemic.<sup>[11]</sup> A study that could be considered close to our work has been published by Girgin et al.<sup>[12]</sup> They reported that surgeries in patients undergoing cardiac surgery after COVID-19 could be performed with similar outcomes, but they observed increased rates of pneumothorax

**Table 4. Subgroup analysis of patients regarding the vaccination status**

	Previous COVID-19 pneumonia						Previous COVID-19 pneumonia						
	No (n=140)			Yes (n=28)			No (n=140)			Yes (n=28)			
	Vaccinated (n=9)		Unvaccinated (n=131)		Vaccinated (n=5)		Unvaccinated (n=23)		Vaccinated (n=5)		Unvaccinated (n=23)		
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	p
Erythrocyte suspension (unit)	0	0	1.56±1.01	2	1.5	1.09±0.94	0	0	0.80±0.84	1	4.3	1.13±1.01	1.000
Fresh frozen plasma (unit)	1	11.1	3.44±2.13	19	14.5	3.34±1.84	1	20	3.80±4.03	5	21.7	2.87±1.63	1.000
Drainage (mL)	0	0	455.56±168.53	1	0.8	534.35±276.11	0	0	620.00±90.83	1	4.3	426.09±197.06	<b>0.041</b>
Intubation duration (h)	0	0	13.89±10.76	4	3.1	12.05±4.75	0	0	16.00±14.63	0	0	11.04±5.94	1.000
CPB duration (min)	0	0	80.86±19.95	3	2.3	77.28±23.21	1	20	64.60±14.47	0	0	90.95±43.26	0.326
Cross-clamping duration (min)	0	0	64.83±18.10	2	1.5	56.05±19.27	1	20	43.00±14.58	1	4.3	64.11±35.48	0.590
Off pump CABG	0	0		7	5.3		0	0		1	4.3	2 (8.7%)	1.000
Number of distal anastomosis	1	11.1	3.78±0.97	19	14.5	3.84±1.01	1	20	3.40±1.14	5	21.7	3.78±1.45	0.626
Need for inotropic drugs	0	0		1	0.8		0	0		0	0		1.000
IABP	0	0		1	0.8		0	0		0	0		N/A
ICU stay	1	11.1	2.00±1.32	16	12.2	1.62±1.32	1	20	2.80±3.03	1	4.3	1.48±1.31	0.574
Hospital stay	1	11.1	6.00±2.91	16	12.2	5.69±3.33	1	20	6.80±5.89	1	4.3	5.48±2.89	1.000
Postoperative atrial fibrillation	0	0		5	3.8		0	0		1	4.3		0.331
Pulmonary complications	0	0		1	0.8		0	0		5	21.7		0.550
Neurological complications	0	0		4	3.1		1	20		1	4.3		0.331
Postoperative wound infection	0	0		3	2.3		1	20		0	0		0.179
Renal complications	1	11.1		0	0		1	20		0	0		0.179
GIS complications	0	0		0	0		1	20		0	0		0.179
Unplanned readmissions	3	33.3		43	32.8		1	20		5	21.7		1.000
In-hospital mortality	0	0		2	1.5		1	20		1	4.3		0.331
30-Day mortality	0	0		7	5.3		1	20		1	4.3		0.331

COVID-19: Coronavirus disease 2019; SD: Standard deviation; CPB: Cardiopulmonary bypass; CABG: Coronary artery bypass grafting; IABP: Intra-aortic balloon pump; ICU: Intensive care unit; GIS: Gastrointestinal system.

and increased hospital stays. The patients' COVID-19 pneumonia histories were not examined. Despite detailed examinations on the systemic inflammation caused by post-COVID-19 early-stage infection's impact on cardiac surgery, there are very few studies on cardiac surgery after recovery from COVID-19.

There are no large-scale studies apart from a few case reports and small-sample research articles on the relationship between surgical procedures and lung complications after recovery from COVID-19 pneumonia. Sakai et al.<sup>[13]</sup> presented a case where a patient underwent a lobectomy for lung cancer three months after experiencing severe bilateral COVID-19 pneumonia, and no adverse outcomes were documented. In a study conducted by Gabryel et al.<sup>[14]</sup> on 444 lung cancer cases, 72 patients with a history of COVID-19 were compared with 372 patients without infection in terms of postoperative complications, and no significant differences were found. The research article methodologically closest to our study was reported by Shah et al.<sup>[15]</sup> In this study, 20 patients with a history of COVID-19 infection and 20 patients without COVID-19 infection history were randomized, and pulmonary complications after cardiac surgery were compared. The study reported a higher incidence of pulmonary complications in the group with a history of COVID-19, longer intensive care unit stay, and a higher frequency of noninvasive mechanical ventilation in patients with a medical history of COVID-19. However, none of these studies explored whether patients had a prior history of COVID-19 pneumonia; instead, the sole criterion considered was the presence of a previous COVID-19 infection. In our study, we specifically explored the impact of documented COVID-19 pneumonia on postoperative outcomes rather than COVID-19 seropositivity. In this regard, our study presents different findings compared to the studies published to date.

During cardiac surgery, factors such as deep neuromuscular anesthesia, mechanical ventilation, the systemic effects of cardiopulmonary bypass, the opening of pleural cavities and the mediastinum, blood product transfusions, postoperative mechanical ventilation, postoperative pain, and muscle weakness, as well as mechanical instability in the chest wall in the early period, increase patients' susceptibility to pulmonary system complications.<sup>[16-18]</sup> Following cardiac surgery, the overall rate of pulmonary complications is reported to be around 7.5%.<sup>[19,20]</sup> Atelectasis, pleural effusion, pneumonia, acute respiratory distress syndrome, and prolonged intubation due to deep hypoxemia are the most

commonly observed pulmonary system complications following CABG. It was previously reported that a positive medical history for pneumonia is a risk factor for postoperative pulmonary complications following surgery.<sup>[21,22]</sup> Prior to the cardiac surgery, including sternotomy and cardiopulmonary bypass, knowing that the patient has previously had pneumonia can be concerning for both the anesthesia team and cardiac surgeons. However, our study demonstrated that a recent occurrence of COVID-19 pneumonia does not increase the risk of postoperative pneumonia.

The pulmonary complication rate for the entire study group was determined to be 5.95% in this study. Upon examination of these complications, it was observed that the majority consisted of pleural effusion (4.16%) and atelectasis (1.19%). The most common pulmonary complication observed in this study was postoperative pleural effusion. The occurrence of pleural effusion after CABG is not uncommon.<sup>[23,24]</sup> Pleural fluid is detected in almost all patients, albeit to a minimal extent, particularly in the early postoperative period and the left hemithorax. The development of this condition is expected due to left internal mammary artery preparation, reactions related to topical hypothermia, disruption of pleural lymphatic drainage, and the effect of leaked fluid into the mediastinum.<sup>[25]</sup> However, these fluids reabsorbed from the pleural surface typically start to decrease significantly by the end of the first week.<sup>[26]</sup> There is no study specifically addressing the frequency of postoperative pleural effusions in the post-COVID-19 period. In our study, significantly more pleural effusion was observed in patients who had experienced COVID-19 pneumonia. This situation may be attributed to the potential inflammatory effects of the coronavirus on lung parenchyma and pleural tissues.

This study has some limitations. First, the small sample size can be considered a limitation. However, it is known that the number of surgeries decreased worldwide in the early postpandemic period. Additionally, to reduce possible biases during study planning, only isolated CABG cases were selected, resulting in a smaller sample size. Despite this sample limitation, the number of patients with a history of pneumonia is sufficient and close to 17% of the total group. There are numerous reasons that can cause pleural effusion, and only a fraction of these reasons could be examined. However, when reviewing the literature in this field, it is evident that not all parameters have been investigated in studies conducted. Cases with a clearly proven history of COVID-19 pneumonia

were included in the study. It should be kept in mind that some patients may have experienced pneumonia asymptotically. Nevertheless, considering that this study was conducted during a period with an unprecedented number of chest computed tomography scans and mandatory polymerase chain reaction tests, we believe the impact of this bias is negligible. Finally, off-pump CABG procedures may play a role in pulmonary complications; however, the limited number of patients undergoing off-pump CABG restricts a comprehensive evaluation of this effect.

In conclusion, the significant differences in pulmonary complications among patients with a history of coronavirus disease 2019 pneumonia did not translate into an alteration of the postoperative mortality rate among the study groups. Additionally, our findings reveal that vaccination did not exert a significant influence on perioperative and postoperative parameters, with both vaccinated and unvaccinated individuals exhibiting a similar postoperative course. Despite its limitations, our study advances knowledge in the field and emphasizes the need for further research with larger cohorts to validate and expand upon our findings.

**Ethics Committee Approval:** The study protocol was approved by the Başkent University Medical and Health Sciences Research Board (date: 09.01.2024, no: KA23/455). The study was conducted in accordance with the principles of the Declaration of Helsinki.

**Patient Consent for Publication:** A written informed consent was obtained from each patient.

**Data Sharing Statement:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

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