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Reconstructive

Incidence of Postoperative Complications among Patients with Active or Resolved COVID-19 Undergoing Elective Abdominal Wall Reconstruction

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Background: The incidence of postoperative complications among patients with coronavirus disease 2019 (COVID-19) positivity undergoing elective surgical operations is poorly understood. This study aimed to identify differences in postoperative complications after elective abdominal wall reconstruction (AWR) in patients diagnosed with COVID-19 compared with patients presenting prepandemic.

Methods: A single-institution, retrospective chart review was performed of patients undergoing AWR between January 2017 and September 2022. Patients were stratified by date: pre-COVID-19 (January 2017 to December 2019) and post-COVID-19 (January 2020 to September 2022). Patients confirmed as COVID-19-positive were also identified. Data collected included demographics, clinical characteristics, and complications. Univariate and multivariate analyses were performed.

Results: We included 168 patients. The mean age was 54 years, and the mean body mass index was 33 kg/m2. Seventy-five patients underwent surgery pre-COVID-19 and 93 patients after. Of 93 patients, 16 (17%) had a positive COVID-19 test before surgery or during the perioperative period. These 2 groups were risk-matched. Patients with COVID-19 had no significant increase in postoperative complications. Major complications occurred at 13.3% in the pre-COVID-19 group and 7.5% in the post-COVID-19 group. Patients with COVID-19 were more likely to be younger (48 versus 57; $P = 0.049$) and more likely to have a shorter length of stay in the hospital (3 versus 5.8; $P = 0.038$).

Conclusions: In our case series, there was an associated increase in the incidence of overall pulmonary-related complications in the postpandemic group. This study is limited by its small sample size. Further investigation should be carried out on this topic.
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INTRODUCTION

The global pandemic of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2, had significant implications on the healthcare system globally and will undoubtedly continue to have lasting effects on patients, hospitals, and healthcare workers for years to come. As of March 2023, there were almost 677 million confirmed cases of COVID-19 worldwide, with a death count of just more than 6.88 million.[1] The pandemic significantly impacted the United States in particular, representing 15.34% of total COVID-19 cases and 16.33% of total deaths, higher than any other country.

During the height of the pandemic, elective procedures in the United States were halted for patient safety and proper allocation of resources. Studies have shown that operating on patients with COVID-19 results in an increased incidence of postoperative complications, such as thromboembolic events, various pulmonary complications, shock, and an overall increase in 30-day mortality.[2–6] A study of perioperative testing for COVID-19 in asymptomatic presurgical patients during November 2020 showed a positive rate of about 3.6%.[7] Regarding a timeline to reschedule surgery for patients who are COVID-19 positive, professional societies agree that patients should not be operated on for 4 weeks after a positive test to

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minimize the chances of postoperative complications. Most professional associations differ after this 4-week mark, with some suggesting delaying surgery for up to 12 weeks depending on symptom severity.[8] This delay in treatment time has led to a more advanced disease presentation in some patients who choose to avoid seeking earlier evaluation.[9] However, COVID-19 is known to cause a hypercoagulable state,[10] and numerous studies have evaluated long-term complications in patients even after the resolution of COVID-19 infection.[11] Our objective is to assess the incidence of postoperative complications, particularly thromboembolic events, in patients with convalesced COVID-19 undergoing elective abdominal wall reconstruction (AWR).

Takeaways

Question: In the context of elective abdominal wall reconstruction (AWR), do patients with a history of, or active COVID-19 infection, show any difference in postoperative complications compared with patients presenting prepandemic?

Findings: Our cohort of patients who were COVID-19 positive or COVID-19 convalesced undergoing elective AWR had an increase in the incidence of overall pulmonary-related complications. Based on COVID-19 status, there was no associated increase in the reoperation rates or any major postoperative complications, including skin necrosis, seroma, hematoma, infection, deep vein thrombosis, or pulmonary embolism.

Meaning: Patients who underwent elective AWR in the postpandemic group had an associated increase in the incidence of overall pulmonary-related complications.

METHODS

Patient Selection

An institutional review board approved a retrospective chart review that was conducted for all patients undergoing AWR between January 2017 and September 2022 by the senior author at The University of Alabama at Birmingham, a tertiary referral hospital and academic medical center. Specifically, these patients underwent AWR utilizing either a component separation technique or local flap repair with or without acellular dermal matrix (ADM) placement. Patients undergoing this procedure within the specified time frame were identified by querying the following Current Procedural Terminology codes on our electronic medical record system: 49560, 49561, 49565, and 49566. Patients were then stratified into 2 groups, prepandemic and postpandemic, based on the dates of initial COVID-19 reports globally (January 2020). The prepandemic cohort underwent AWR from January 2018 to December 2019. The postpandemic group experienced the same procedure from January 2020 to September 2022.

Data Collection and Analysis

A retrospective analysis of each patient record was performed, and data were collected about demographics, clinical characteristics, and postoperative outcomes. Asymptomatic patients found to be COVID-19-positive by routine preoperative nasopharyngeal nucleic acid amplification test at our institution were identified, and the positive test date was recorded. COVID-19-positive patients were also noted within the last 30 days at the time of visit, either by chart record or self-report. The University of Alabama at Birmingham's timeline for implementing and modifying COVID-19 testing protocols is as follows: March 19, 2020: commencement of COVID-19 testing for all inpatient admissions; April 3, 2020: introduction of COVID-19 testing for all procedures; and June 2022: discontinuation of all pre-procedural testing.

Demographic information collected included age, sex, race, tobacco use history, body mass index, and hernia etiology. Significant comorbidities were recorded, such as diabetes, obesity, hypertension, cardiovascular disease, renal disease requiring dialysis, and a history of liver transplantation. Pertinent laboratory values included preoperative pulmonary function tests and preoperative and postoperative albumin, hemoglobin, and renal function panels. Primary outcomes analyzed for the cohort were the development of any postoperative complications, which included delayed wound healing, infection, necrosis, dehiscence, seroma, hematoma, deep venous thrombosis, pulmonary embolism, acute kidney injury, and recurrence of hernia. Postoperative complications were classified as major, requiring readmission and/or surgical intervention, or minor, requiring bedside, outpatient, or no intervention.

As mentioned, descriptive statistics were used to summarize the variables for the cohort as a whole. Once patients were stratified by the pandemic date, univariate and multivariate data analyses were performed to assess for any differences in demographics, clinical characteristics, and postoperative outcomes between the prepandemic and postpandemic populations. The entire postpandemic population was included in this analysis stage to capture patients who may have been COVID-19-positive previously during the height of the pandemic. Still, they were either unaware or needed access to testing. Patients were then further stratified into prepandemic versus patients confirmed as COVID-19-positive to represent the physiological differences between the patient populations more accurately. Normality was tested using the Kolmogorov–Smirnov test. Mean and SD were listed for continuous variables with P values generated via the Student t test. Categorical variables were analyzed using χ^2 tests. SPSS was used for data analysis.

RESULTS

Demographics and Clinical Characteristics

The initial database query yielded a final cohort of 168 patients during the specified period, with 75 patients undergoing AWR before January 1, 2020, and 93 patients undergoing AWR thereafter. The cohort mean age was 55 (±13) years, and 70.2% (118) of patients were women.

Table 1. Demographics of Our Patient Cohort and *P* Value Calculated Using Fisher Exact Test

Demographics			
	Pre-COVID-19	Post-COVID-19	*P*
	Total	Total	
No. patients	75	93	
Sex			
Female	52 (70%)	66 (71%)	0.408
Male	23 (30%)	27 (29%)	0.408
Race			
White	62 (82%)	72 (78%)	0.200
African American	11 (15%)	19 (20%)	0.166
Hispanic	2 (3%)	2 (2%)	0.413*
Smokers	7 (9%)	8 (8.6%)	0.434
Diabetes	18 (24%)	27 (29%)	0.232
Hypertension	43 (57%)	51 (54%)	0.373
History of liver transplant	5 (6.6%)	12 (12.9%)	0.091
Heart disease	13 (17%)	12 (12.9%)	0.211
Age, y	57 (±12)	53 (±13)	0.0561
BMI, kg/m^2	34 (±6)	32 (±7)	0.0685
Hernia size range, cm	2 × 4 to 30 × 25	2 × 3 to 20 × 30	0.228
Preoperative albumin	4 (±0.4)	4 (±0.4)	0.186
Operative time, min	252 (±86)	262 (±117)	0.257
Preoperative hemoglobin	13 (±1.5)	13 (±1.8)	0.124
Postoperative hemoglobin	11 (±2.3)	11 (±2.1)	0.358
LOS	5.8 (±4.6)	5.1 (±4.7)	0.134

BMI, body mass index.

For race, 134 patients were White (80%), 30 were Black (18%), and 4 were Hispanic (2%). The mean body mass index for the cohort was 33 (±6) kg/m^2. As determined by preoperative anesthetic evaluation, patient smoking status was as follows: 62% never smoker, 9% current smoker, and 29% former smoker. Regarding relevant comorbid conditions among the cohort, 56.0% of patients had hypertension, 27% had diabetes, and 15% had cardiac disease. There were 17 patients (10%) with a history of liver transplantation (Table 1). Sixteen patients (17%) were COVID-19-positive within the cohort. Of these, 12 patients tested positive before surgery, 3 tested positive after surgery, and 1 patient tested positive both before and after surgery. Hernia size varied within the population, ranging from 2 cm × 3 cm to 30 cm × 25 cm. The most common hernia location was ventral (137, 82%), followed by lateral (15, 9%), and mixed ventral and lateral (16, 10%). The grade of hernia distribution was as follows: 11% grade 1, 64% grade 2, 17% grade 3, and 8% grade 4. All patients had AWR/component separation, 98 without ADM and 118 with ADM. There were 98 patients (58%) whose operation utilized a component separation technique, and there were 118 patients (70%) who received a biologic mesh (ADM) in their repair. The mean preoperative and postoperative hemoglobin values were 13 (±1.6) and 11 (±2.2), respectively. All patients underwent DVT prophylaxis according to postoperative protocol, including low-molecular-weight heparin, and the application of a sequential compression device. The mean operative time for the cohort was 260 (±104) minutes, and the mean length of stay (LOS) in the hospital was 5.5 days (±5).

Once stratified into prepandemic (75) and postpandemic (93) based on the specified date, analyses showed that there was a significant difference in mean age between the groups: 57 (±12) years in the pre-COVID-19 group versus 53 (±13) years for the post-COVID-19 group ($P = 0.024$). For all of the aforementioned variables discussed earlier (demographics, comorbid conditions, hernia etiology, and operative characteristics), no significant differences were found in the data between the prepandemic and postpandemic groups. Once the cohort was further stratified into prepandemic (75) versus patients confirmed as COVID-19-positive (16), analyses showed a significant difference in age and LOS between the groups. For COVID-19-positive patients, the mean age was 48 (±13) versus 57 (±12) years in the prepandemic group ($P = 0.049$). The mean LOS for COVID-19-positive patients was 3 days (±2) compared with a mean of 5.8 days (±5) for the prepandemic group ($P = 0.038$). When comparing the prepandemic population to patients confirmed as COVID-19-positive, no significant differences were found in any of the other variables assessed in terms of demographics or clinical and operative characteristics.

Postoperative Outcomes: Major Complications

For the overall cohort of 168 patients, 26 (16%) experienced significant postoperative complications, of which 17 required a second operation and 9, inpatient management for DVT and PE. Major complications requiring reoperation included skin necrosis (occurring in 5.4% of the total cohort), followed by seroma (4%), hematoma (1%), and infection (1%). A total of 6 patients

Table 2. Postoperative Complications Comparing Pre-COVID-19 and Post-COVID-19 Cohorts and *P* Value Calculated Using Fisher Exact Test

Complications	Pre-COVID-19	Post-COVID-19	*P*
	Total	Total	
No. patients	75	93	
Minor complications			
Total	30 (40%)	39 (41%)	0.399
Acute kidney injury resolved	4 (3%)	3 (3%)	0.248*
Seroma	15 (20%)	24 (25%)	0.187
Hematoma	3 (4%)	3 (3%)	0.394*
Skin necrosis	10 (13%)	8 (9%)	0.162
Infection	4 (5%)	3 (3%)	0.248*
Dehiscence	2 (3%)	3 (3%)	0.41*
Seroma	11 (15%)	22 (24%)	0.072
Major complications			
Total	15 (20%)	11 (12%)	0.072
Additional operation			
Total	10 (13%)	7 (8%)	0.107
Skin necrosis	4 (5%)	5 (5%)	0.495*
Seroma	4 (5%)	2 (2%)	0.134*
Hematoma	1 (1%)	0	0.132*
Infection	1 (1%)	0	0.132*
PE	1 (1%)	2 (2%)	0.345*
DVT	4 (5%)	2 (2%)	0.134*
Pulmonary-related	20 (27%)	55 (59%)	**<0.001**

*Indicates a statistical test performed to obtain the *P* value.
Values in boldface are statistically significant.

(4%) required admission to manage a DVT, and 3 (2%) were admitted for PE. Once stratified into prepandemic (75) and postpandemic (93), there were no significant differences found in the incidence of major postoperative complications between the groups, occurring in 15 patients (20%) in the prepandemic group and 11 patients (12%) in the postpandemic group ($P = 0.072$). There was also no difference in the reoperation rate between the groups, with 10 patients (13%) requiring reoperation in the pre-COVID-19 group and 7 patients (8%) in the post-COVID-19 group ($P = 0.107$). There was no significant difference in the incidence of skin necrosis, seroma, hematoma, infection, DVT, or PE between the pre- and postpandemic populations. However, 55 (59%) patients were found to have a pulmonary-related complication (dyspnea, acute respiratory distress syndrome, atelectasis, pneumonia, and new oxygen requirement) in the post-COVID-19 group versus 20 (27%) patients in the pre-COVID-19 group ($P < 0.001$). A summary of these findings is showcased in Table 2.

After further stratifying the cohort into prepandemic (n = 75) versus patients confirmed as COVID-19-positive (16), there was still no significant difference found in the reoperation rate, occurring in 10 patients (13%) in the prepandemic group and 3 patients (20%) in the COVID-19-positive group (Table 3). No significant difference in any major postoperative complications was assessed between the prepandemic and COVID-19-positive groups. Seroma formation was the most common complication in both groups, occurring in 20% of the prepandemic group and 25% of the COVID-19-positive group ($P = 0.32$). The second most common complication for both groups was skin necrosis, experienced by 19% of the prepandemic population and 6% of the COVID-19-positive population ($P = 0.112$). There were 5 cases (7%) of infection in the prepandemic group versus 1 patient (6%) in the COVID-19-positive group ($P = 0.475$). There were no cases of hematoma, wound dehiscence, DVT, or PE within the COVID-19-positive group, and none were significant compared with the prepandemic group (Fig. 1). Finally, there was difference in the overall incidence of pulmonary-related complications between the groups. Based on these later observations, additional categorization of pulmonary symptoms was conducted. It was observed that the group of patients affected after the pandemic more often required supplemental oxygen compared with the group before the pandemic (Fig. 2).

DISCUSSION

The incidence of postoperative complications among patients with active or resolved COVID-19 undergoing elective surgery is of great interest. The COVID-19 pandemic has profoundly impacted surgical practice, with various guidelines and recommendations developed to ensure the safety of patients and healthcare providers. Understanding the risks associated with performing surgery on patients with COVID-19 is crucial for clinical decision-making and optimizing patient outcomes. Several studies have investigated the risk of postoperative complications in patients with active or resolved COVID-19

Table 3. Further Stratification of Cohorts into Prepandemic versus Confirmed COVID-19-positive Patients Still Showed No Significant Differences

Demographics and Complications			
	Pre-COVID-19	**COVID-19-positive**	***P***
Total patients	75	16	
Sex			
Female	52 (70%)	8 (50%)	0.061
Male	23 (30%)	8 (50%)	0.061
Race			
White	62 (82%)	13 (81%)	0.046
African American	11 (15%)	3 (19%)	0.39*
Hispanic	2 (3%)	0 (0%)	0.241*
Smoker	7 (9%)	1 (6%)	0.35*
Diabetes	18 (24%)	4 (25%)	0.46*
Hypertension	43 (57%)	8 (50%)	0.304
History of liver transplant	5 (7%)	2 (13%)	0.20*
Heart disease	13 (17%)	1 (6%)	0.13*
Age, y	57 (±12)	48 (±13)	**0.049**
BMI, kg/m^2	34 (±6)	32 (±6)	0.063
Preoperative albumin	4 (±0.4)	4 (±0.4)	0.15
Operative time	252 (±85)	236 (±64)	0.18
Preoperative hemoglobin	13 (±2)	13 (±2)	0.17
Postoperative hemoglobin	11 (±2)	11 (±2)	0.34
LOS	5.8 (±5)	3 (±2)	**0.038**
Hematoma	4 (5%)	0 (0%)	0.172*
Skin necrosis	14 (19%)	1 (6%)	0.112*
Infection	5 (7%)	1 (6%)	0.475*
Dehiscence	2 (3%)	0 (0%)	0.254*
Seroma	15 (20%)	4 (25%)	0.32*
Pulmonary complication	20 (27%)	2 (13%)	0.22
DVT	4 (5%)	0 (0%)	2.254*
PE	1 (1%)	0 (0%)	0.321*
Additional operation	10 (13%)	3 (19%)	0.287*

*Indicates a statistical test performed to obtain the *P* value.
Values in boldface are statistically significant.
P value calculated using the Fisher exact test.
BMI, body mass index.

undergoing elective surgery. Deng et al[6] conducted a retrospective analysis of a national database in the United States; the authors aimed to assess the risk of postoperative complications after major elective surgery in patients with active or resolved COVID-19. Their study showed that patients with active COVID-19 had a significantly higher risk of postoperative complications than those who had resolved the infection. These results suggest that the timing of surgery concerning the resolution of COVID-19 infection is an important consideration when planning elective procedures. The timing of surgery in patients with COVID-19 has been debated and addressed in various guidelines and consensus statements. El-Boghdadly et al[12] developed a multidisciplinary consensus statement on behalf of several medical associations, stating to postpone elective surgery for at least 4–7 weeks in patients with active COVID-19. The statement emphasizes the need to carefully assess the patient's clinical condition and the risks of delaying surgery. In addition, researchers noted that many nonacute plastic surgery cases were delayed up to 8 weeks during the pandemic to minimize the use of hospital resources, such as personal protective equipment and ventilatory equipment.[13]

Researchers also investigated the risk of postoperative mortality and pulmonary complications in patients with COVID-19. Khonsari et al[14] conducted a study assessing the risks of early mortality and pulmonary complications after surgery in patients with COVID-19. The authors found that patients with severe COVID-19 infection had significantly higher mortality and pulmonary complication rates than those with moderate or mild disease. These results highlight the need for careful preoperative assessment and optimal timing of surgery to minimize these risks. Another study by Prasad et al[15] examined the increased complications in patients who tested positive for COVID-19 after elective surgery. The authors found that patients who tested positive postoperatively had higher rates of wound complications, respiratory complications, and mortality than those who tested negative. The aforementioned suggests that preoperative and postoperative screening for COVID-19 may be necessary to identify patients at higher risk of complications. The literature has also discussed the proposed delay for safe surgery after COVID-19. Kovoor et al[16] proposed a delay for safe surgery after COVID-19 infection, suggesting a waiting period of at least 6–8 weeks after the resolution of symptoms. This

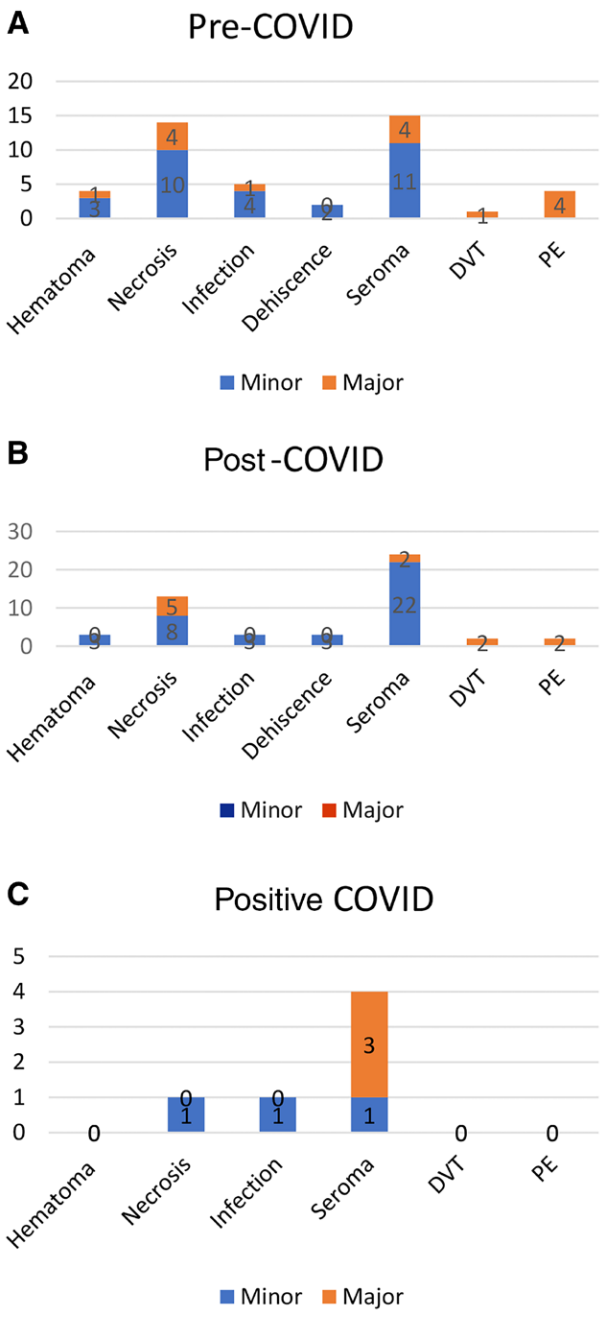

Fig. 1. Overall complication of patients comparing the different subgroups. A, Pre-COVID-19. B, Post-COVID-19. C, Patients that tested positive for COVID-19.

delay allows the patient to recover from the infection and for the inflammatory response to subside, reducing the risk of postoperative complications.

Our objective is to evaluate the incidence of postoperative complications in patients with convalesced COVID-19 undergoing elective AWR. In particular, there was a concern that thromboembolic events such as DVT and PE, as well as skin and flap thrombosis resulted in skin necrosis. Although this study did not find an associated increase in prothrombotic complications such as DVT, PE, and skin or flap thrombosis/necrosis, we did find an associated increase in the incidence of pulmonary-related complications in patients undergoing AWR with component separation and ADM. Interestingly, patients who were COVID-19 positive were also found to be younger and have shorter hospital stays. These findings are consistent with previous research suggesting patients with COVID-19 may have a higher risk of surgical complications due to their compromised immune system and potential for systemic inflammation.[17] Another important finding from our study is that there was no significant increase in wound healing complications or surgical site infections (SSIs). SSIs are a primary concern in AWR surgery, as they can lead to prolonged hospital stays, increased healthcare costs, and even death in severe cases.[18]

Other studies did show an increased risk of SSIs in patients with active COVID-19 may be attributed to the viral shedding and persistent inflammation associated with the active infection, which can impair wound healing and increase the susceptibility to bacterial infections,[19] highlighting the need for strict infection control measures during and after surgery, including appropriate antibiotic prophylaxis and wound care techniques. Interestingly, this study also revealed no increased rate of postoperative pulmonary complications among patients with resolved COVID-19 compared with those with active COVID-19. This unexpected finding challenges the notion that active COVID-19 infection poses the most significant risk for respiratory complications in surgical patients.[20] Moreover, this study found no increase in a higher rate of postoperative complications among patients with COVID-19 compared with a control group without COVID-19.

It is essential to acknowledge the limitations of this study. The sample size was relatively small, and the study was conducted at a single center, which may limit the generalizability of the findings. A power analysis was performed on the dataset for this study. The available sample size of 75 pre-COVID-19 and 16 post-COVID-19 patients was modest, with limited statistical power. There would be 80% power to detect a difference in proportions of 40% pre-COVID-19 versus 79% post-COVID-19, or 20% versus 59%. In addition, the study did not evaluate the long-term outcomes of the patients, such as the impact on abdominal wall functionality or quality of life. Future research should address these limitations and provide more comprehensive insights into the outcomes and complications of AWR in patients with COVID-19.

CONCLUSIONS

Our cohort of patients undergoing elective AWR had an associated increase in the incidence of overall pulmonary-related complications in the postpandemic group. There was no associated increase in the reoperation rates or any major postoperative complications, including skin necrosis, seroma, hematoma, infection, DVT, or PE, based on COVID-19 status. Although there seems to be a statistical significance in patients who had COVID-19, it is plausible that physicians were more attentive to pulmonary symptoms and more diligent in recording them due to heightened awareness

Symptoms	Pre-COVID (22 patients)	Post-COVID (41 patients)
Dyspnea	9 patients	11 patients
ARDS	3 patients	1 patient
Atelectasis	2 patients	5 patients
Pneumonia	2 patients	2 patients
New Oxygen requirement	6 patients	22 patients

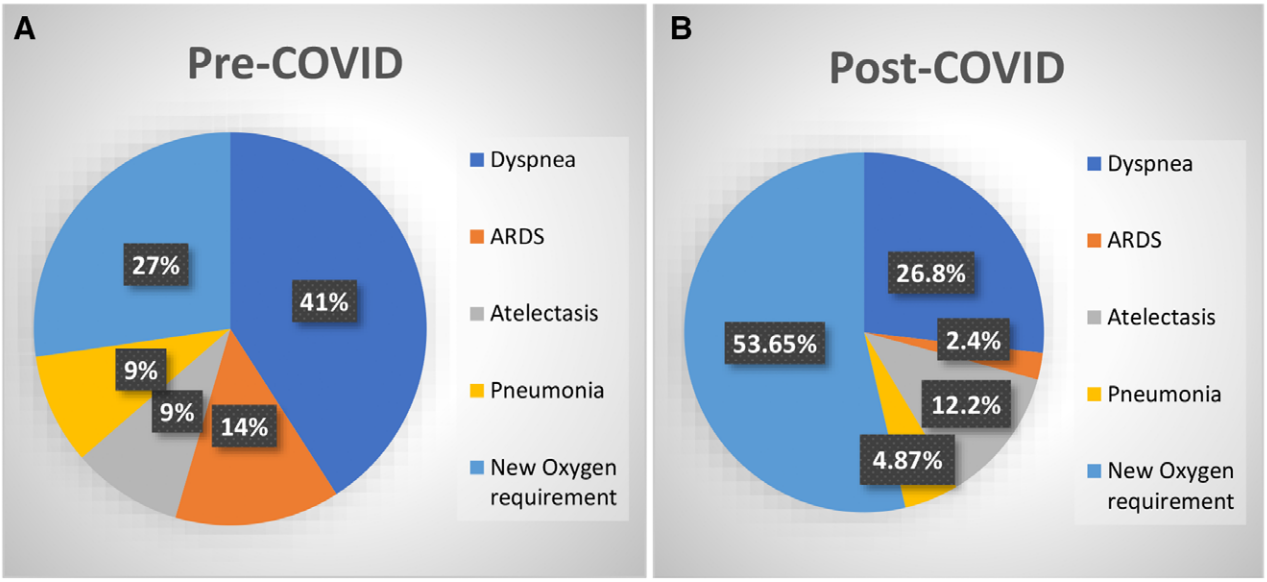

Fig. 2. Pulmonary symptoms of patients (A) pre-COVID-19 versus (B) post-COVID-19. ARDS, acute respiratory distress syndrome.

of COVID-19. Thus, it remains uncertain whether this disparity may primarily indicate increased attention to documenting pulmonary-related symptoms rather than a genuine difference. It is important to note that this study is constrained by its small sample size. Additional research is necessary to yield more robust conclusions on this matter.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

REFERENCES

1. John Hopkins University. Coronavirus resource center. Available at https://coronavirus.jhu.edu/map.html. Published January 22, 2020. Accessed June 19, 2023.
2. Doglietto F, Vezzoli M, Gheza F, et al. Factors associated with surgical mortality and complications among patients with and without coronavirus disease 2019 (COVID-19) in Italy. *JAMA Surg.* 2020;155:691–702.
3. Abbott TEF, Fowler AJ, Dobbs TD, et al. Mortality after surgery with SARS-CoV-2 infection in England: a population-wide epidemiological study. *Br J Anaesth.* 2021;127:205–214.
4. COVIDSurg Collaborative & GlobalSurg Collaborative. SARS-CoV-2 infection and venous thromboembolism after surgery: an international prospective cohort study. *Anaesthesia.* 2022;77:28–39.
5. Jonker PKC, van der Plas WY, Steinkamp PJ, et al; Dutch Surgical COVID-19 Research Collaborative. Perioperative SARS-CoV-2 infections increase mortality, pulmonary complications, and thromboembolic events: a Dutch, multicenter, matched cohort clinical study. *Surgery.* 2021;169:264–274.
6. Deng JZ, Chan JS, Potter AL, et al. The risk of postoperative complications after major elective surgery in active or resolved COVID-19 in the United States. *Ann Surg.* 2022;275:242–246.
7. Bloom JA, Erlichman Z, Tian T, et al. The prevalence of asymptomatic carriers of COVID-19 as determined by routine preoperative testing. *J Infect Prev.* 2021;22:7–11.
8. Khan IA, Zaid MB, Gold PA, et al; AAHKS EBM Committee. Making a joint decision regarding the timing of surgery for elective arthroplasty surgery after being infected with COVID-19: a systematic review. *J Arthroplasty.* 2022;37:2106–2113.e1.
9. Lapalorcia LM, Mobaraki PD, Guarro G, et al. Collateral damage to elderly patients presenting with advanced skin cancer. Another toll to pay due to COVID-19 pandemic. *Indian J Cancer.* 2022;59:300–301.
10. Han H, Yang L, Liu R, et al. Prominent changes in blood coagulation of patients with SARS CoV-2 infection. *Clin Chem Lab Med.* 2020;58:1116–1120.
11. Desai AD, Lavelle M, Boursiquot BC, et al. Long-term complications of COVID-19. *Am J Physiol Cell Physiol.* 2022;322:C1–C11.
12. El-Boghdadly K, Cook TM, Goodacre T, et al. SARS-CoV-2 infection, COVID-19 and timing of elective surgery: a multidisciplinary consensus statement on behalf of the Association of Anaesthetists, the Centre for Peri-operative Care, the Federation of Surgical Specialty Associations, the Royal College of Anaesthetists and the Royal College of Surgeons of England. *Anaesthesia.* 2021;76:940–946.

13. Chi D, Chen AD, Dorante MI, et al. Plastic surgery in the time of COVID-19. *J Reconstr Microsurg*. 2021;37:124–131.
14. Khonsari RH, Bernaux M, Vie JJ, et al; AP-HP/Universities/INSERM COVID-19 Research Collaboration, AP-HP COVID Clinical Data Warehouse Initiative. Risks of early mortality and pulmonary complications following surgery in patients with COVID-19. *Br J Surg*. 2021;108:e158–e159.
15. Prasad NK, Lake R, Englum BR, et al. Increased complications in patients who test COVID-19 positive after elective surgery and implications for pre and postoperative screening. *Am J Surg*. 2022;223:380–387.
16. Kovoor JG, Scott NA, Tivey DR, et al. Proposed delay for safe surgery after COVID-19. *ANZ J Surg*. 2021;91:495–506.
17. Aziz H, Filkins A, Kwon YK. Review of COVID-19 outcomes in durgical patients. *Am Surg*. 2020;86:741–745.
18. Whitehead-Clarke T, Windsor A. Surgical site infection: the scourge of abdominal wall reconstruction. *Surg Infect (Larchmt)*. 2021;22:357-362.
19. Guan WJ, Ni ZY, Hu Y, et al; China Medical Treatment Expert Group for Covid-19. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med*. 2020;382:1708–1720.
20. Wong J, Goh QY, Tan Z, et al. Preparing for a COVID-19 pandemic: a review of operating room outbreak response measures in a large tertiary hospital in Singapore. *Can J Anaesth*. 2020;67:732–745.