

Factors affecting post-operative complications and mortality in surgical patients with and without COVID-19

Factores que afectan a las complicaciones postoperatorias y a la mortalidad en pacientes quirúrgicos con y sin COVID-19

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Abstract

Objective: The objective of the study was to evaluate the effect of COVID-19 on the outcomes of surgical patients and the factors associated with postoperative complications and mortality. **Methods:** The study included hospitalized patients with similar demographic and clinical features, who underwent similar surgical operations with a positive polymerase chain reaction test for SARS CoV-2 before or within days following the surgery (COVID-19 group) and a control group was formed of patients who tested negative for COVID-19. The two groups were compared in terms of demographic, clinical, and laboratory data, the presence of pneumonia, complications, and 30-day post-operative mortality. **Results:** The diagnosis for COVID-19 increased the risk of complications and mortality. Age, CRP, D-dimer, ASA Grade 3-4, > 2 comorbidities, and pneumonia were determined to be factors increasing the risk of complications. Age, CRP, > 2 comorbidities, emergency operations, and pneumonia were determined to increase the risk of mortality. **Conclusion:** As patients with peri/post-operative COVID-19 positivity might be at increased risk of postoperative complications and mortality, emergency surgery in infected cases should be delayed in appropriate cases.

Keywords: COVID-19. Surgery. Complications. Mortality.

Resumen

Objetivo: Nos propusimos evaluar el efecto de la COVID-19 en los resultados de los pacientes quirúrgicos y los factores relacionados con las complicaciones postoperatorias y la mortalidad. **Métodos:** Se incluyeron los pacientes hospitalizados sometidos a operaciones quirúrgicas similares con características demográficas y clínicas similares con una prueba de reacción en cadena de la polimerasa positiva para el CoV-2 del SARS antes/en los días siguientes a la cirugía (grupo COVID-19) y los controles negativos. Los dos grupos se compararon en términos demográficos, clínicos y de laboratorio de la presencia de neumonía, las complicaciones y la mortalidad a los 30 días del postoperatorio. **Resultados:** El diagnóstico de COVID-19 aumentó el riesgo de complicaciones y mortalidad. La edad, la CRP, el Dímero D, el grado 3-4 de la ASA, tener más de 2 comorbilidades y neumonía se relacionaron con un mayor riesgo de complicaciones. Mientras que la

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edad, la PCR, tener más de dos comorbilidades, las operaciones de urgencia y la neumonía se relacionaron con un mayor riesgo de mortalidad. **Conclusiones:** Los pacientes con COVID-19 pre/postoperatorio podrían tener un mayor riesgo de complicaciones postoperatorias y de mortalidad, por lo que las cirugías de urgencia en casos infectados podrían retrasarse en los casos adecuados.

Palabras clave: COVID-19. Cirugía. Complicaciones. Mortalidad.

Introduction

The novel coronavirus, SARS-CoV-2, as the agent of coronavirus 2019 disease (COVID-19) was first reported in Wuhan, China at the end of December 2019. With rapid spread across the world, COVID-19 was declared a global pandemic in March 2020. The virus enters respiratory cells through angiotensin converting enzyme receptors 2 (ACE-2), and the morbidity and mortality in infected patients are usually due to severe viral pneumonia. Antiviral agents such as favipiravir and remdesivir have been used in treatment, but a specific treatment for COVID-19 is still not widely available¹. During the 1st few months of the pandemic, all elective operations were cancelled and only urgent cases were operated on. However, as the SARS CoV-2 infection could not be eradicated and continued to spread rapidly, eventually elective surgical operations were re-started. Although most centers checked cases preoperatively for COVID-19 with a nasopharyngeal swab polymerase chain reaction (PCR) test for SARS CoV-2, emergency operations had to be performed even if the patient had a positive PCR test, and some cases developed COVID-19 postoperatively. Pre/post-operative COVID-19 infection has been reported to be related with an increased risk of post-operative complications and mortality²⁻⁶. However, surgeries for acute abdominal pathologies decreased after the outbreak of the pandemic due to the fear of SARS CoV-2 infection, and in cases with COVID-19, a delayed intervention may result in complications related to an underlying urgent pathology^{7,8}. To make the decision for surgery in patients infected with SARS-CoV-2, the post-operative risk related to COVID-19 infection must be evaluated carefully and the risk/benefit ratio should be assessed. Therefore, there is a need to investigate the effect of COVID-19 on the course of surgical cases in detail. The aim of this study was to evaluate the effect of COVID-19 infection on the outcomes of surgical patients and the factors associated with post-operative complications and mortality in cases with pre/post-operative SARS CoV-2 infection.

Material and methods

The study group (COVID-19 group) consisted of adult inpatients who underwent a surgical procedure and had SARS-CoV-2 PCR positivity in nasopharyngeal swab before/within 10 days following the surgery in Sultan 2. Abdülhamit Han Training and Research Hospital between March 15, 2020, and May 15, 2021. The control group was formed of patients hospitalized before the pandemic (January 1, 2019, and February 1, 2020), who underwent the same operations and had similar demographic, clinical features, and American Society of Anesthesiologists (ASA) grade but did not have a positive PCR result for SARS-CoV-2 before or within 10 days after the surgery. The study was approved by the Local Ethics Committee (Approval date and number: May 27, 2021, and B.10.1.THK.4.34.H.G .P.0.01/180). Data were extracted from the medical records in respect of demographic information, comorbidities [disseminated cancer, diabetes mellitus (DM), hypertension (HT), congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and acute renal failure (ARF)], systemic sepsis, the need for mechanical ventilation, steroid treatment, smoking status, ASA grade, preoperative functional status, type of surgery (elective/urgent and Group AB/CD) and anesthesia (local/general), laboratory parameters on admission (leukocyte, lymphocyte, eosinophil, and thrombocyte counts, and serum level of CRP and D-dimer), the presence of pneumonia and superinfection, clinical course and outcome (duration of hospitalization and/or ICU follow-up, post-operative complications including thrombolytic, hemorrhagic, pulmonary, cardiac, neurological, and local complications, and mortality). The pre-operative pulmonary functional status data were not available in detail, only pathological findings such as history of chronic pulmonary disease and presence of pneumonic infiltrations on the pre-operative chest X-ray and/or thorax computed tomography (CT) were noted in the medical files. The emergency operations included surgery for acute cholecystitis, gastroduodenal perforated ulcers, acute appendicitis, acute gynecological disorders, trauma,

and intracranial hemorrhage. The COVID-19 and control groups were compared in terms of age, sex, smoking status, comorbidities, laboratory parameters, the presence of pneumonia and complications, and 30-day postoperative mortality. The factors associated with complications and mortality were also analyzed.

Statistical analysis

Data obtained in the study were analyzed statistically with the IBM Statistical Package for the Social Sciences (SPSS) for Windows 23.0 software (IBM Corp., Chicago, IL, USA). Discrete data were stated as frequency and percentage. Continuous data were stated as mean \pm standard deviation, median, interquartile range, minimum, and maximum values. The Mann–Whitney U test was used to compare the two groups, and two groups of categorical data were compared using the Chi-Square test. Logistic Regression Analysis was performed to examine the factors associated with survival and developing complications. A value of $p < 0.05$ was considered statistically significant.

Results

The comparisons of the demographic data of the two groups are shown in table 1. The distribution of patients according to age, sex, age groups, ASA grades, minor/major, and elective/urgent surgery was similar in both groups ($p > 0.05$). The durations of hospitalization and ICU follow-up were longer in the COVID-19 group compared to the control group (16.39 ± 15.6 days vs. 9.37 ± 9.02 days and, 10 ± 10 days vs. 5 ± 9 days, $p = 0.003$ and $p = 0.003$, respectively). Urgent operations were performed on 15/38 (39.5%) patients in the COVID-19 group and on 22/76 (28.9%) patients in the control group ($p = 0.358$). The mortality rate was higher in the COVID-19 group compared to the control group (14/38 (36.8%) vs. 7/76 (9.2%); ($p = 0.001$). The rate of post-operative superinfection was 12/38 (31.6%) in the COVID-19 group and 16/76 (21.1%) in the control group ($p = 0.317$). The rate of major surgery was similar in the COVID-19 group [20/38 (52.6%)] and the control group [48/76 (63.2%)], ($p = 0.28$).

The comparisons of clinical and laboratory features between the two groups are shown in tables 2 and 3. Surgery was performed under general anesthesia in 31/38 (81.6%) cases in the COVID-19 group and in 62/76 (81.6%) cases in the control

Table 1. The comparisons of demographic data of the two groups

	Control (n = 76)	COVID-19 (n = 38)
Age, years		
Mean (SD)	58.14 (18.01)	55.03 (19.04)
n (%)		
Age groups, years		
< 40	14 (18.4)	9 (23.7)
40-49	11 (14.5)	6 (15.8)
50-59	11 (14.5)	3 (7.9)
≥ 60	40 (52.6)	20 (52.6)
n (%)		
Sex		
Male	50 (65.8)	24 (63.2)
Female	26 (34.2)	14 (36.8)
Smoking (+)	20 (26.3)	6 (15.8)
n (%)		
ASA Grade		
I	5 (6.6)	3 (7.9)
II	28 (36.8)	13 (34.2)
III	31 (40.8)	15 (39.5)
IV	12 (15.8)	7 (18.4)
Duration of stay in ICU, days		
Mean (SD)	5 (9)	10 (10)
Duration of hospitalization, days		
Mean (SD)	9.37 (9.02)	16.39 (15.6)
Superinfection	16 (21.1)	12 (31.6)
n (%)		
Operation type		
Elective	54 (71.1)	23 (60.5)
Urgent	22 (28.9)	15 (39.5)
n (%)		
Operation Group		
AB (Major)	48 (63.2)	20 (52.6)
CD (Minor)	28 (36.8)	18 (47.4)
n (%)		
Final outcome		
Survival	69 (90.8)	24 (63.2)
Death	7 (9.2)	14 (36.8)

^aMann Whitney U-test

^b χ^2 test

SD: Standard deviation, ASA: American Society of Anesthesiologists, ICU: Intensive care unit.

group ($p = 1.000$). Post-operative systemic sepsis was diagnosed in 6/38 (15.8%) patients in the COVID-19 group and in 8/76 (10.5%) patients in the control group ($p = 0.546$). Pneumonia was not observed in any of the control group and pneumonia developed in 15/38 cases in the COVID-19 group ($p < 0.0001$).

Table 2. Comparisons of clinical features between the two groups

	Control (n = 76)	COVID-19 (n = 38)
	n (%)	
Anesthesia		
General	62 (81.6)	31 (81.6)
Local	14 (18.4)	7 (18.4)
Functional status loss		
No	57 (75.0)	24 (63.2)
Partial	9 (11.8)	9 (23.7)
Total	10 (13.2)	5 (13.2)
Use of steroids	2 (2.6)	0 (0.0)
Systemic sepsis	8 (10.5)	6 (15.8)
Ventilator dependent	5 (6.6)	5 (13.2)
Disseminated cancer	16 (21.1)	5 (13.2)
Diabetes mellitus		
Treated with OAD	12 (15.8)	9 (23.7)
Treated with Insulin	6 (7.9)	4 (10.5)
Hypertension	54 (71.1)	22 (57.9)
Congestive heart failure	9 (11.8)	3 (7.9)
COPD	8 (10.5)	2 (5.3)
Hemodialysis	1 (1.3)	3 (7.9)
Acute renal failure (Serum creatinine level > 1.5 mg/dl at time of hospitalization)	9 (11.8)	8 (21.1)

^bχ² test

OAD: Oral anti-diabetic, COPD: Chronic obstructive pulmonary disease.

The mean lymphocyte and eosinophil counts were significantly lower, and the mean serum CRP level was significantly higher in the COVID-19 group compared to the control group ($1.29 \pm 0.85 \times 10^3/\text{ml}$ vs. $1.72 \pm 1.03 \times 10^3/\text{ml}$, $0.15 \pm 0.20 \times 10^3/\text{ml}$ vs. $0.18 \pm 0.20 \times 10^3/\text{ml}$, and $99.13 \pm 93.72 \text{ mg/dl}$ vs. $58.99 \pm 79.32 \text{ mg/dl}$, $p = 0.024$, $p = 0.039$, $p = 0.005$, respectively).

Complications developed 2.4-fold more in the COVID-19 group than in the control group; in 20/38 (52.6%) patients in the COVID-19 group and in 24/76 (31.6%) patients in the control group ($p = 0.049$). Pneumonia developed in 15/38 (39.5%) patients in the COVID-19 group. Pulmonary, cardiac, and local complications were significantly more frequent in the COVID-19 group than in the control group [16/38 (42.1%) vs. 13/76 (17.1%), 13/38 (34.2%) vs. 9/76 (11.8%) and 10/38 (26.3%) vs. 4/76 (5.3%), $p = 0.008$, $p = 0.017$, $p = 0.002$, respectively] (Table 4).

Table 3. Comparisons of laboratory data between the groups

	Control (n = 76)	COVID-19 (n = 38)
Lymphocyte count, $\times 10^3/\text{ml}$ Mean (SD)	1.72 (1.03)	1.29 (0.85)
Serum D-Dimer, ng/ml Mean (SD)	1314.96 (1998.74)	1925.11 (3989.35)
Eosinophil count, $\times 10^3/\text{ml}$ Mean (SD)	0.18 (0.20)	0.15 (0.20)
Thrombocyte count, $\times 10^3/\text{ml}$ Mean (SD)	241.24 (70.3)	256.9 (88.93)
Serum CRP, (mg/dl) Mean (SD)	58.99 (79.32)	99.13 (93.72)
Leukocyte count, $\times 10^3/\text{ml}$ Mean (SD)	9.57 (3.53)	11.06 (6.22)

^aMann Whitney U-test, SD: Standard deviation.**Table 4. Comparisons of complications between the two groups**

	Control (n = 76)	COVID-19 (n = 38)
All complications	24 (31.6)	20 (52.6)
Thrombolytic complications	4 (5.3)	3 (7.9)
Hemorrhagic complications	2 (2.7)	2 (5.3)
Pulmonary complications	13 (17.1)	16 (42.1)
Cardiac complications		
Atrial fibrillation	3 (3.9)	4 (10.5)
Shock	6 (7.9)	9 (23.7)
Neurological complications		
Delirium	7 (9.2)	3 (7.9)
TIA	-	1 (2.6)
Local Complications	4 (5.3)	10 (26.3)

^bχ² test

TIA: Transient ischemic attack.

The results of the univariate and multivariate analysis of factors associated with developing complications and mortality are shown in tables 5 and 6. The COVID-19 group patients developed complications more frequently than the control subjects (OR: 2.407 and CI: 1.082-5.356, $p = 0.031$). Age, serum CRP, and D-dimer were determined to be associated with an increased risk of post-operative complications (OR: 1.054, CI: 1.027-1.083; OR: 1.009, CI: 1.004-1.015; OR: 1.001, CI: 1.000-1.002, $p < 0.0001$, $p < 0.0001$, $p < 0.0001$, respectively). Lymphocyte count was determined to be associated with a decreased risk of developing complications

Table 5. Analysis of factors associated with the development of complications

	Univariate analysis		Multivariate analysis	
	OR (95%CI)	p-value	OR (95%CI)	p-value
Group				
Control	1 (Reference)	-	1 (Reference)	-
COVID-19	2.407 (1.082-5.356)	0.031	2.403 (0.406-14.213)	0.334
Age	1.054 (1.027-1.083)	< 0.0001	1.001 (0.945-1.053)	0.927
Sex				
Female	1 (Reference)	-		
Male	1.095 (0.498-2.408)	0.821		
Serum CRP level (mg/dl)	1.009 (1.004-1.015)	< 0.0001	1.003 (0.995-1.011)	0.524
Lymphocyte count×10 ³ /ml	0.387 (0.230-0.653)	< 0.0001	1.013 (0.379-2.706)	0.979
Eosinophil count×10 ³ /ml	0.100 (0.007-1.407)	0.088		
Serum D-dimer	1.001 (1.000-1.002)	< 0.0001	1.001 (1.000-1.002)	0.037
ASA grade				
1-2	1 (Reference)	-	1 (Reference)	-
3-4	13.200 (4.621-37.709)	< 0.0001	7.695 (0.510-11.609)	0.141
Comorbidity				
None	1 (Reference)	-	1 (Reference)	-
1 comorbidity	1.250 (0.404-3.868)	0.699	0.737 (0.049-10.984)	0.825
2 or more comorbidities	3.240 (1.176-8.929)	0.023	1.111 (0.087-14.188)	0.935
Operation				
Elective	1 (Reference)	-	1 (Reference)	-
Emergency	6.360 (2.687-15.052)	< 0.0001	1.307 (0.291-5.877)	0.727
Group of operations				
A-B (major)	1 (Reference)	-		
C-D (minor)	0.762 (0.351-1.655)	0.492		
PCR positivity (preop./postop.)	1.042 (0.876-1.239)	0.642		
Pneumonia				
No	1 (Reference)	-	1 (Reference)	-
Yes	32.200 (4.049-256.084)	0.001	5.943 (0.697-25.355)	0.997

OR: Odds ratio, CI: Confidence interval, CRP: C-reactive protein, ASA: American Society of Anesthesiologists, PCR: Polymerase chain reaction.

(OR: 0.387, CI: 0.230-0.653; $p < 0.0001$). Patients with ASA grade 3-4 developed more complications than those with ASA grade 1-2 (OR: 13.2, CI: 4.621-37.709, $p < 0.0001$). Patients with two or more comorbidities developed significantly more complications compared to patients without comorbidities (OR: 3.24, CI: 1.176-8.929, $p = 0.023$). Patients who underwent urgent operations developed more complications than those operated on electively (OR: 6.36, CI: 2.687-15.052, $p < 0.0001$), and patients with pneumonia developed more complications than those without pneumonia (OR: 32.20, CI: 4.049-256.084, $p = 0.001$). The multivariate analysis revealed that only the D-dimer level was associated with an increased risk of complications (OR: 1.001, CI: 1.000-1.002).

The diagnosis of COVID-19 infection was determined to increase the risk of mortality (OR: 5.75, CI: 2.075-15.934, $p = 0.001$). Age and serum CRP level were associated with an increased risk of mortality (OR: 1.063, CI: 1.024-1.104; OR: 1.011, CI: 1.005-1.016, $p = 0.001$, $p < 0.0001$, respectively). Lymphocyte count and eosinophil count were found to be associated with a decreased risk of mortality (OR: 0.139, CI: 0.047-0.412; OR: 0.005, CI: 0.001-0.011, $p < 0.0001$, $p = 0.001$ respectively). The mortality risk was seen to be significantly higher in patients with two or more comorbidities compared to patients without comorbidities (OR: 12, CI: 1.498-96.149, $p = 0.019$). Patients who underwent urgent operations had an increased risk of mortality compared to

Table 6. Analysis of factors associated with mortality

	Univariate Analysis		Multivariate Analysis	
	OR (95%CI)	p-value	OR (95%CI)	p-value
Group				
Control	1 (Reference)	-	1 (Reference)	-
COVID-19	5.750 (2.075-15.934)	0.001	3.06 (0.507-18.491)	0.223
Age	1.063 (1.024-1.104)	0.001	1.002 (0.92-1.052)	0.625
Sex				
Female	1 (Reference)	-		
Male	1.909 (0.731-4.988)	0.187		
Serum CRP (mg/dl)	1.011 (1.005-1.016)	< 0.0001	1.003 (0.993-1.012)	0.593
Lymphocyte count, $\times 10^3/\text{ml}$	0.139 (0.047-0.412)	< 0.0001	0.198 (0.032-1.21)	0.08
Eosinophil count, $\times 10^3/\text{ml}$	0.005 (0.001-0.011)	0.001	0.219 (0.001-1.305)	0.68
Serum D-dimer	1.001 (1.000-1.002)	0.123		
ASA Grade				
1-2	1 (Reference)	-		
3-4	7.700 (4.321-17.544)	0.997		
Comorbidity				
None	1 (Reference)	-	1 (Reference)	-
1 comorbidity	3.600 (0.379-34.229)	0.265	16.02 (0.371-69.1)	0.149
2 or more comorbidities	12.000 (1.498-96.149)	0.019	37.165 (0.928-148.78)	0.055
Type of operation				
Elective	1 (Reference)	-	1 (Reference)	-
Urgent	23.368 (6.229-87.663)	< 0.0001	9.431 (1.469-60.542)	0.018
Group of the operation				
A-B (major)	1 (Reference)	-		-
C-D (minor)	1.439 (0.555-3.732)	0.454		0.454
PCR positivity (preop./postop.)	1.012 (0.847-1.209)	0.897		0.897
COVID-19 pneumonia				
No	1 (Reference)	-	1 (Reference)	-
Yes	184.000 (21.021-1610.6)	< 0.0001	15.27 (2.06-113.095)	0.008

OR: Odds ratio, CI: Confidence interval, CRP: C-reactive protein, PCR: Polymerase chain reaction, ASA: American Society of Anesthesiologists.

those operated on electively (OR: 23.368, CI: 6.229-87.663, $p < 0.0001$), and patients with pneumonia were at greater risk of mortality than patients without pneumonia (OR: 184, CI: 21.021-1610.6, $p < 0.0001$). The multivariate analysis revealed that only emergent surgery and having pneumonia were risk factors for increased post-operative mortality (OR: 9.431, CI: 1.469-60.542, and OR: 15.27, CI: 2.06-113.095, respectively).

Discussion

In the study, patients with and without pre/post-operative COVID-19 infection were compared postoperatively. The durations of hospitalization and ICU follow-up were

longer in the COVID-19 group and the mortality rate of 36.8% was significantly higher compared to the control group (9.2%). In a previous study, the 30-day post-operative mortality rate was reported as 23.8%, which was mostly due to pulmonary complications⁴. Several studies have reported increased morbidity and mortality rates among surgical patients pre/postoperatively infected with SARS CoV-2²⁻⁶. In contrast, Seretis et al. evaluated general surgery patients operated for emergency abdominal pathologies and reported a 5% overall postoperative respiratory complication rate, and 3% infection rate for COVID-19; neither the stay in ICU and need for mechanical ventilation nor the postoperative mortality rate were determined to be increased related to COVID-19 infection. It was concluded that if

indicated, emergency surgery should not be delayed because of fear of COVID-19-related morbidity or mortality risks. However, that study included cases operated on during the first 3 months of the pandemic so the data were from a low number of patients⁹.

In the current study, the risk of developing postoperative complications was seen to be increased 2.4-fold more in the COVID-19 group than in the control group. Local, pulmonary and cardiac complications were more frequent in the COVID-19 group. In a multicenter study, the rate of pulmonary complications was 57.9 % which was comparable with the results of previous studies⁴. The rate of pulmonary complications in the current study was 42.1%, which was compatible with the results of the above-mentioned cohort. Prasad et al. investigated the risk of postoperative complications in patients who had a negative PCR test before surgery but developed COVID-19 postoperatively and the complication rate ratio for the COVID [-/+] group vs. COVID [-/-] was reported to be 8.4 (CI: 4.9-14.4) for pulmonary complications, 3.0 (CI: 2.2-4.1) for major complications, and 2.6 (CI: 1.9-3.4) for any complication³. In contrast, a study that compared the clinical outcomes of patients infected with SARS CoV-2 pre and postoperatively who underwent emergency surgery reported that patients with a concomitant diagnosis of COVID-19 preoperatively had a lower mortality rate (14.3% vs. 33.3%), lower ARDS rate (28.5% vs. 50.0%), lower rates of preoperative invasive ventilation (14.3% vs. 50.0%) and postoperative invasive ventilation (28.5% vs. 100.0%), and a shorter duration of invasive ventilation compared to patients with severe postoperative COVID-19¹⁰. In the current study, there was no further analysis of the morbidity and mortality rates of patients with pre/postoperative COVID-19. However, this issue may be a subject for further studies.

There are limited data in literature about the postoperative complications and mortality rates in Turkey. In a previous study which evaluated 26 patients who underwent cancer surgery, 4 of whom were diagnosed with COVID-19 infection, the post-operative complication rate was reported to be 2/26 and mortality was 1/26¹¹. Only 1/4 COVID-19 patients developed surgery-related post-operative complications and the other complications and mortality were reported to be unrelated with COVID-19. However, as the number of COVID-19 patients was quite low in that study, the current study findings cannot be compared with these results.

It has been reported that coincidentally asymptomatic COVID-19 patients who undergo surgery may develop severe complications and the preoperative chest X-ray evaluation is not sufficient to detect asymptomatic patients with SARS CoV-2 infection, and therefore all surgical cases should be tested for COVID-19 before surgery¹². This may also help to prevent postoperative COVID-19 in surgical patients. The monitoring of patients for symptoms of COVID-19 after surgery is also important. Lei et al. reported that all patients who developed COVID-19 postoperatively developed pneumonia and the most frequent symptoms were fever, fatigue, and dry cough⁶.

The analyses of the current study showed that age, PCR positivity, increased serum CRP and D-dimer levels, ASA grade 3-4, having 2 or more comorbidities, emergency operations, and COVID-19 pneumonia were associated with an increased risk of complications, while the lymphocyte count was associated with a decreased risk of developing postoperative complications. The mortality risk was determined to be 5.75-fold greater in the COVID-19 group than in the control group. Similarly, age, PCR positivity, increased serum CRP level, having 2 or more comorbidities, emergency operations, and COVID-19 pneumonia were associated with increased mortality while the lymphocyte count and eosinophil count were associated with survival. In a multicenter study including a total of 1128 surgical patients, 294 of whom were detected as COVID-19 (+) preoperatively, the 30-day mortality rate was 38% and increased risk for mortality was associated with male sex, age > 70 years, ASA grade 3-5, operation for malignancy, emergency, and major surgery⁴. Rasslan et al. reported that of patients with COVID-19-positivity who were operated on for abdominal emergencies, the postoperative morbidity and mortality rates were high in patients with respiratory compromise¹³. In the current study, pneumonia was also a risk factor for complications and mortality but no effects were detected of sex, malignancy, and major surgery. This may have been due to the small sample size of this study.

The current study results showed that the mean level of serum CRP was higher in the COVID-19 group and the mean lymphocyte and eosinophil counts were significantly lower compared to the control group. The mean serum D-dimer level was also increased in the COVID-19 group but the difference was not statistically significant. These laboratory findings are frequently observed in COVID-19 patients

and in addition to older age and comorbidities these laboratory parameters have been reported to be associated with poor COVID-19 prognosis in several studies¹⁴⁻¹⁷. Therefore, it can be assumed that the factors associated with poor clinical course and outcome in SARS CoV-2 infection may also be associated with the development of post-operative complications and mortality.

There were some limitations to this study, primarily that the sample size was small as it was a single center study. There is need for multicenter studies to support these results. A second limitation was that the surgery performed was not evaluated in detail such as surgery for malignant / benign disease, or abdominal surgery, neurosurgery, and orthopedic surgery. Third, the effect of obesity could not be evaluated because of the lack of body mass index data in most of the patients. Finally, again because of the relatively low number of patients, it was not possible to evaluate if there was any difference among the COVID-19 patients according to the time of SARS CoV-2 infection – pre- or post-operative PCR positivity - in terms of morbidity and mortality.

Conclusion

From the results of this study, it was concluded that age, emergency surgery, higher ASA grade, 2 or more comorbidities and SARS CoV-2 infection, D-dimer, and pneumonia were associated with an increased risk of postoperative complications and mortality. A detailed risk evaluation should be performed in surgical patients concerning these prognostic factors to assess the postoperative risk, especially in patients infected with COVID-19. Delaying operations in appropriate surgical patients with COVID-19 may also help to decrease morbidity and mortality rates.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in

accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

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