

The impact of COVID-19 on postoperative outcomes of emergency general surgery operations

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ABSTRACT

Aims: During the pandemic due to Coronavirus disease 2019 (COVID-19) many elective operations were postponed, while emergency surgical operations inevitably continued. Emergency general surgery procedures are known to have worse outcomes compared to elective ones. Besides, it is conceivable that COVID-19 itself may worsen surgical outcomes due to it may cause respiratory distress and multi-organ dysfunction. We aimed to present patients' data who underwent surgery due to trauma and emergency general surgery diseases during the COVID-19 pandemic and the effect of COVID-19 on surgical outcomes in this study.

Methods: Two hundred and thirty-five patients who underwent surgery due to trauma or emergency between March 2020 and January 2021 were enrolled. Two groups were created according to the COVID-19 status as positive (n=16) and negative (n=219). The demographics, clinical, laboratory, and perioperative data were analyzed and compared between these groups.

Results: The median age of the patients was 51 (18-97) years, and 144 (61.2%) of them were male. The most common diagnosis was acute appendicitis (n=121, 51.5%) followed by ileus. Subgroup comparisons showed that the COVID-19 (+) group had more patients with comorbidity and had higher C-reactive protein values, these differences were significant (p=0.049, p=0.001, respectively). Open surgery was performed significantly more in the COVID-19 (+) group (p=0.037). Serious postoperative complications and mortality were seen more in the COVID-19 (+) group, but the differences were not significant. Patients with COVID-19 had significantly longer hospital stay (p=0.007).

Conclusion: COVID-19 positivity was found to have a negative impact on postoperative surgical outcomes in terms of emergency operations. It is not clear whether this negativity is due to the COVID-19 disease itself or the worse characteristics of patients with COVID-19.

Keywords: Coronavirus, emergency surgery, pandemic

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an infection that causes severe and acute respiratory failure caused by the new type of coronavirus and was declared as a pandemic by the World Health Organization in December 2019. COVID-19 infection was detected for the first time on 11 March 2020 in Turkey, and the first deaths due to this disease has been reported on 18 March 2020.¹ Especially in the early period of the pandemic, even though elective surgeries were postponed, as suggested by the European Society of Trauma and Emergency Surgery, emergency surgical operations inevitably continued.² In addition, recommendations were made on how to act in emergencies and inevitable situations.³ Patients in need of urgent surgical intervention are a specific population with high risk.⁴ Previously, emergency general surgery procedures were found to have worse outcomes compared to elective ones.⁴ Besides, it is conceivable that COVID-19 itself

may worsen surgical outcomes. Because it may cause respiratory distress, hypercoagulation, and multiorgan dysfunction.⁵ In the literature, the studies are mostly on comparisons of patient characteristics and surgical outcomes between the pandemic and pre-pandemic periods.^{6,7} We aimed to present patients' data who underwent surgery due to trauma and emergency general surgery diseases during the COVID-19 pandemic and the effect of COVID-19 on surgical outcomes in this study.

METHODS

This study was approved by the İnönü University Scientific, Researches Ethical Committee (Date: 17.07.2023, Decision No: 2023/4708). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. During the COVID-19 pandemic, between March

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2020 and January 2021, 735 patients were admitted to our clinic for emergencies. Among these patients, patients aged 18 years or older and who underwent surgery due to trauma or emergency were included, while patients who were reoperated due to complications after elective surgery or followed up without surgery were excluded. Finally, 235 patients were enrolled in the study. The demographics, clinical, laboratory, and perioperative data for each patient including age, gender, comorbidities, the American Society of Anesthesiology (ASA) score, preoperative radiological imaging methods, preoperative diagnosis, white blood cell (WBC) count ($10^3/\mu\text{L}$) and C-reactive protein (CRP) value (mg/dL) at admission, procalcitonin (ng/ml) (for patients with COVID-19), ferritin (ng/ml) (for patients with COVID-19), interleukin-6 (pg/ml) (for patients with COVID-19), operation severity, operation type, the diagnosis of COVID-19, postoperative complications, mortality, and length of hospital stay were obtained from the electronic medical record. Patients were divided into two groups as COVID (+) (n=16) and COVID (-) (n=219) according to the diagnosis of COVID-19, and the data mentioned above were analyzed and compared between these groups. Operative severity was classified according to the Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) as minor, moderate, major, and major plus.^{8,9}

Postoperative complications and mortality were defined as complications or mortality in the first 30-day postoperatively or during the hospital stay. Clavien–Dindo classification was used for grading postoperative complications.¹⁰ A serious postoperative complication was defined as complication equal to or greater than Grade 3 according to the Clavien–Dindo classification. All patients were evaluated via real-time reverse transcription-polymerase chain reaction (RT-PCR) and/or chest computed tomography (CT) or chest X-Rays for COVID-19 and the diagnosis was made according to radiological, clinical, and laboratory findings.

Statistical Analysis

Kolmogorov-Smirnov test was used for analyzing the normality of the distribution of continuous variables. Due to all the continuous variables being distributed non-normally, they were given as median (minimum-maximum) and were compared by using the Mann-Whitney U test. Categorical variables were expressed as frequency (percentage), and the comparisons were done via the Chi-Square or Fisher's Exact tests, as appropriate. The analyses were made via IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, N.Y., USA). We accepted a two-tailed p-value < 0.05 as significant.

Table 1. Demographics and other data of the whole study group and subgroups according to COVID-19

	Whole study group (n=235)	COVID-19 (-) group (n=219)	COVID-19 (+) group (n=16)	P value
Age (years)	51 (18-97)	49 (18-97)	53,5 (31-86)	0,208
Gender (male)	144 (61,3%)	136 (62,1%)	8 (50%)	0,337
Comorbidity (yes)	106 (45,1%)	95 (43,4%)	11 (68,8%)	0,049
ASA score				0,085
1	129 (54,9%)	124 (56,6%)	5 (31,3%)	
2	77 (32,8%)	70 (32,0%)	7 (43,8%)	
3	26 (11,1%)	23 (10,5%)	3 (18,8%)	
4	3 (1,3%)	2 (0,9%)	1 (6,3%)	
Radiological imaging				
USG	232 (98,7%)	216 (98,6%)	16 (100%)	1
CT	187 (79,6%)	172 (78,5%)	15 (93,8%)	0,205
Diagnosis				0,257
Acute appendicitis	121 (51,5%)	115 (52,5%)	6 (37,5%)	
Acute cholecystitis	3 (1,3%)	3 (1,4%)	-	
Gunshot wound of the abdomen	5 (2,1%)	5 (2,3%)	-	
Ileus	64 (27,2%)	60 (27,4%)	4 (25%)	
Stab wound of the abdomen	5 (2,1%)	5 (2,3%)	-	
Blunt abdominal trauma	4 (1,7%)	4 (1,8%)	-	
Perforated peptic ulcer	12 (5,1%)	9 (4,1%)	3 (18,8%)	
Spontaneous small bowel perforation	5 (2,1%)	4 (1,8%)	1 (6,3%)	
Acute mesenteric ischemia	3 (1,3%)	3 (1,4%)	-	
Others	13 (5,5%)	11 (5,0%)	2 (12,5%)	
WBC count ($10^3/\mu\text{L}$)	12,1 (1,7-32,1)	12,1 (1,7-32,1)	12,95 (2,5-22,7)	0,858
CRP (mg/dL)	3 (0,3-44)	3 (0,3-40)	9 (1,9-44)	0,001
Operation severity				0,234
Mild	18 (7,7%)	18 (8,2%)	-	
Moderate	123 (52,3%)	117 (53,4%)	6 (37,5%)	
Major	59 (25,1%)	53 (24,2%)	6 (37,5%)	
Major plus	35 (14,9%)	31 (14,2%)	4 (25%)	
Operation type				0,037
Open	148 (63,2%)	134 (61,5%)	14 (87,5%)	
Laparoscopy	86 (36,8%)	84 (38,5%)	2 (12,5%)	
Postoperative complication (yes)	55 (23,4%)	51 (23,3%)	4 (25%)	0,254
Grade 1	19 (8,1%)	19 (8,7%)	-	
Grade 2	7 (3,0%)	7 (3,2%)	-	
Grade 3a	3 (1,3%)	2 (0,9%)	1 (6,3%)	
Grade 3b	2 (0,9%)	2 (0,9%)	-	
Grade 4a	4 (1,7%)	4 (1,8%)	-	
Grade 4b	-	-	-	
Grade 5	20 (8,5%)	17 (7,8%)	3 (18,8%)	
Severe postoperative complication (yes)	29 (12,3%)	25 (11,4%)	4 (25%)	0,118
Mortality (yes)	20 (8,5%)	17 (7,8%)	3 (18,8%)	0,144
Length of hospital stay (days)	3 (1-38)	2 (1-38)	6,5 (2-30)	0,007

COVID-19: Coronavirus disease 2019, ASA: The American Society of Anesthesiologists, USG: Ultrasonography, CT: Computed tomography, WBC: White blood cell, CRP: C-reactive protein

RESULTS

Table 1 shows the demographics and other data of the whole study group and subgroups according to the COVID-19. The median age of the patients was 51 (18-97) years, and 144 (61.2%) of them were male. COVID-19 positivity was detected in 16 (6.8%) patients. About half of the patients had at least one comorbidity, while more than fifty percent of them had an ASA score of 1. Abdominal ultrasonography (USG) was used for diagnosis in almost all patients, and abdominal CT was used more selectively. The most common diagnosis was acute appendicitis (n= 121, 51.5%) followed by ileus. Operations were mostly moderate in terms of severity, and about two-third were performed via open techniques. Approximately one in five patients developed postoperative complications, but just half of them were serious. The patients' median duration of hospital stay was 3 days (1-38).

The mortality rate was 8.5% (n=20). Two subgroup comparisons showed that the COVID-19 (+) group had more patients with comorbidity and had higher CRP values, these differences were significant (p= 0.049, p= 0.001, respectively). ASA score was mostly 1 in the COVID-19 (-) group, while it was mostly ≥ 2 in the COVID-19 (+) group, but the difference was not significant. Open surgery was performed significantly more in the COVID-19 (+) group (p= 0.037). Serious postoperative complications and mortality were seen more in the COVID-19 (+) group, but the differences were not significant. Patients with COVID-19 had significantly longer hospital stay (p= 0.007).

An RT-PCR test was performed pre- or post-operatively in 108 (45.9%) patients, seven (6.4%) of these had a positive test. Nine patients got COVID-19 diagnosis radiologically, although their RT-PCR tests were negative. The data of patients with COVID-19 are summarized in **Table 2**. Seven (43.8%) patients with

Table 2. The characteristics of patients who were diagnosed with COVID-19

Patients	Age (years)	Gender	Comorbidity	ASA score	Diagnosis	Operation type	Covid symptoms	RT-PCR test	Chest CT	WBC (10 ³ /uL)	CRP (mg/dl)	PCT (ng/ml)	Ferritin (ng/ml)	IL-6 (pg/ml)	Hospital stay (days)	Complication	Outcome
1	31	M	No	1	Acute appendicitis	Appendectomy	No	+	Normal	18.4	14.2	5.0	241.4	33.3	5	No	Discharge
2	35	FM	No	1	Acute appendicitis	Laparoscopic appendectomy	No	+	Normal	16.0	16.8	1.7	22.8	19.8	2	No	Discharge
3	39	FM	DM	2	Peptic ulcer perforation	Primary repair	Cough	+	Ground-glass opacity	14.0	9.0	4.0	56.7	4947	21	Covid pneumonia	Exitus
4	42	M	No	1	Perforated acute appendicitis	Appendectomy	Cough	-	Ground-glass opacity	13.9	25	42.6	593.5	836.7	14	No	Discharge
5	51	M	DM, chronic renal failure, coronary artery disease	4	Spontaneous small bowel perforation	Resection and end ileostomy	Fever	+	Ground-glass opacity	22.7	34.5	16.5	267.2	235.2	7	Covid pneumonia and multi-organ failure	Exitus
6	51	FM	Operated servix cancer	2	Brid ileus	Bridectomy, small bowel resection, and end ileostomy	Fever	-	Ground-glass opacity	7.2	2.2	1.0	302.1	58.6	30	Incision wound infection and pneumothorax	Discharge
7	51	M	No	1	Acute appendicitis	Laparoscopic appendectomy	No	-	Ground-glass opacity	15.3	4.0	1.1	Unknown	Unknown	2	Covid pneumonia	Discharge
8	53	FM	DM	2	Perforated acute appendicitis	Appendectomy	No	-	Ground-glass opacity	10.7	2.0	3.1	98.1	28.3	5	Covid pneumonia	Discharge
9	54	M	Gastric cancer, peritoneal carcinomatosis	3	Perforated acute appendicitis	Appendectomy	Fever	+	No	13.0	5.0	27.5	148.4	151.7	2	No	Discharge
10	55	M	HT	2	Peptic ulcer perforation	Primary repair	No	-	Ground-glass opacity	15.9	6.4	39.0	301.6	346.3	13	Covid pneumonia	Discharge
11	61	FM	No	1	Ileus (sigmoid colon cancer)	Anterior resection and loop ileostomy	Cough	-	Ground-glass opacity	12.9	3.0	0.05	35.3	21.1	5	Covid pneumonia	Discharge
12	63	FM	HT, passed on Covid-19	2	Ileus (sigmoid colon cancer)	Hartmann's procedure	No	-	Ground-glass opacity	12.0	1.9	0.3	209.4	32.2	5	Covid pneumonia	Discharge
13	67	FM	HT, coronary artery disease, chronic lung disease	3	Intra-abdominal abscess	Laparotomy and drainage	Fever and cough	+	Ground-glass opacity	12.4	13.6	0.4	339.6	157.3	9	No	Discharge
14	67	M	DM, HT	2	Iatrogenic bile duct injury	Roux-n Y hepaticojejunostomy	No	+	Ground-glass opacity	10.0	9.0	2.9	249.5	214.1	7	No	Discharge
15	73	M	HT, coronary artery disease	2	Peptic ulcer perforation	Primary repair	Fever and sore throat	-	Ground-glass opacity	2.5	16.8	3.0	87.7	14.5	6	Covid pneumonia	Discharge
16	86	FM	HT, coronary artery disease	3	Ileus, cecum perforation (rectum cancer)	Total colectomy and end ileostomy	Cough	-	Ground-glass opacity	6.2	44.0	100.0	261.8	826.0	27	Covid pneumonia, acute kidney failure, and metabolic acidosis	Exitus

COVID-19: Coronavirus disease 2019, ASA: The American Society of Anesthesiologists, RT-PCR: Real-time reverse transcription-polymerase chain reaction, CT: Computed tomography, WBC: White Blood Cell, CRP: C-reactive protein, PCT: Procalcitonin, IL-6: Interleukin 6, M: Male, FM: Female, DM: Diabetes mellitus, HT: Primary hypertension

COVID-19 positivity were asymptomatic. The most common symptoms were fever and cough (both $n=5$, 31.3%) and the most common CT finding was ground-glass opacity ($n=13$, 81.3%). Most of them underwent surgery for acute appendicitis ($n=6$, 37.5%). Mortality occurred in three (18.8%) patients.

DISCUSSION

In this study, we found higher postoperative complication rates (both for overall and serious ones), higher mortality rate, and longer hospital stay in patients with COVID-19, however, the differences were not significant except for hospital stay.

COVID-19 is a disease that may affect everyone, but older or people with comorbidities may be at higher risk for severe disease. Although fever and cough are the most common symptoms (similar to this study), some patients may be asymptomatic.¹¹ In a meta-analysis, the rate of being asymptomatic was found as 35.1%,¹² less than we found. This may be due to the limited number of COVID-19 positive patients in this study. The further diagnosis of COVID-19 contains RT-PCR and CT. A previous study, in which the RT-PCR test was used as a reference, stated that the chest CT had a sensitivity of 97%.¹³ In addition, the authors presented CT as a more reliable, rapid, and practical diagnostic tool compared to RT-PCR.¹³ Since we found that CT abnormality is higher than RT-PCR positivity in COVID-19 (+) patients, our opinion is in line with the authors mentioned above. Ground-glass opacity was found previously as the most frequent CT abnormality.¹¹ This was parallel to our findings, as all the CT abnormalities in this study were ground-glass opacity.

Indications for emergency surgery in the COVID-19 outbreak are mostly parallel with those before the pandemic. But the pandemic has also brought some controversial issues. One of them is about the management of the diseases. For example, some authors have highlighted non-operative treatments for conditions such as acute appendicitis and acute cholecystitis, which are treated primarily via surgery under normal conditions.¹⁴ Another one is the surgical outcomes in patients with COVID-19. In a study by Osorio et al.¹⁵, the outcomes of emergent operations of general and gastrointestinal surgery in the pandemic were examined and compared between COVID-19 positive and negative patients. The authors found that the patients with COVID-19 were older, were with higher ASA grade and CRP values, and have more comorbidities. Besides, in COVID-19 positive patients, hospital stay was longer and the 30-day mortality rate and postoperative complications (overall and serious) were higher. These differences were statistically significant. But after propensity score matching analyses, while the 30-day mortality rate were still higher, the difference were not found to be significant. With these results, the authors stated that poorer outcomes in COVID-19 patients may be due to patients characteristics (such as older age, higher ASA score, and more comorbidities) rather than the effect of COVID-19. The patients in COVID-19 (+) group in this study had the same characteristics as mentioned above. Therefore, our results may have been affected by this situation, and the worse outcomes in this group may be associated with worse patients' characteristics. Supporting the idea mentioned above, de Bock et al.¹⁶ found that increased age and higher ASA score were independent predictors of postoperative complications after emergency surgery during the outbreak, while the COVID-19 positivity was not. In another study, patients with severe acute respiratory syndrome who underwent

elective or emergency surgery were divided into two groups according to the COVID-19 status, and the surgical outcomes were compared.¹⁷ After matching the patient characteristics, the 30-day mortality rate and postoperative complications were higher in the COVID-19 positive patients. The authors emphasized that these results are evidences for postponing selected emergency cases. Another study involving 34 patients, 6 of whom had COVID-19 pneumonia, found only the length of hospital stay to be significantly longer in COVID-19 positive patients.¹⁸ The differences in mortality and postoperative complications rates (although higher) were not significant. These results were similar to ours. Interestingly, in this study, it was shown that emergency surgery was advantageous on the resolution of pulmonary inflammation.

Limitations: The study had some limitations. The number of patients was relatively less, especially in the COVID-19 (+) group. We accepted this situation as normal because there may be a decrease in hospital admissions due to the pandemic (including emergencies). Additionally, the groups were not homogeneous in terms of patient characteristics, diagnoses, and operational features. Although no significant difference was observed in many variables, this non-homogeneity may have affected the results. Finally, the retrospective and single-centered design of the study may carry the natural bias factors.

CONCLUSION

In conclusion, COVID-19 positivity has a negative impact on postoperative surgical outcomes in terms of emergency operations. It is not clear whether this negativity is due to the COVID-19 disease itself or the worse characteristics of patients with COVID-19. Further studies, especially focusing on this aspect, are needed.

ETHICAL DECLARATIONS

Ethics Committee Approval: This study was approved by the İnönü University Scientific, Research Ethical Committee (Date: 17.07.2023, Decision No: 2023/4708).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: BB and YMB: Study concept and design. BB: Acquisition of data. YMB: Statistical analysis. BB and YMB: Analysis and interpretation of data. BB and YMB: Drafting of the manuscript. BB: Study supervision. All authors read and approved the final manuscript.

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