

# Characteristics and Outcomes of Acute Appendicitis Cases During the COVID-19 Pandemic

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## Research article

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## Abstract

**Background:** Our aim in this study was to investigate the effects of the COVID-19 pandemic on acute appendicitis cases.

**Methods:** This study was designed as a single-center, retrospective, and observational study. The patients were divided into three groups relative to the date of the first COVID-19 case in Turkey, which was March 10, 2020 (Group A: before the pandemic; Group B: pandemic period; Group C: the same period one year before the pandemic). A total of 413 patients were included in the study.

**Results:** In terms of treatment modality, the rate of open appendectomy was significantly higher in group B ( $p<0.001$ ). Rates of conversion to open surgery, as well as rates of complicated appendicitis were also significantly higher in group B ( $p=0.027$ ,  $p=0.024$ , respectively). While there was no difference between the groups in terms of preoperative hospitalization duration ( $p=0.102$ ), it was found that the duration of symptoms, operation time, and postoperative length of hospital stay were significantly higher in Group B ( $p<0.001$ ,  $p=0.011$ ,  $p=0.001$ , respectively). In addition, the complication rate in group B (8.9%) was also significantly higher than in the other two groups ( $p=0.023$ ).

**Conclusion:** We found that the rate of open surgery, the rate of conversion of laparoscopic surgery to open surgery, complication rates, mean operation time, and postoperative hospital stay were significantly higher in acute appendicitis patients that underwent surgery during the COVID-19 pandemic period. We believe that the main reason for this negative outcome is the late admission of the patients to the hospital.

## Background

The novel virus, which first appeared in Wuhan, China in December 2019, was named "severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)" by the International Committee on Taxonomy of Viruses, and on February 11, 2020, the emerging clinical syndrome was defined as COVID-19 by the WHO [1]. After this date, COVID-19 spread very rapidly around the world. On March 11, 2020, the WHO declared the infection a pandemic. In Turkey, early measures, such as international travel restrictions, held off the emergence of the first COVID-19 case, which was eventually detected on March 10, 2020, a later date compared to many countries. Since this date, the Turkish Ministry of Health has undertaken a series of measures, such as the closure of schools at all levels, closure of universities, curfews for citizens over 65 and under 18 years old, and the conversion of many hospitals into pandemic response centers. Despite these measures, the number of infected people within the first month of the epidemic exceeded 47,000, the number of new cases per day topped 4,700 and the total number of deaths surpassed 1,000. These numbers prompted the Ministry of Health to take new and more aggressive measures, such as restricting travel in and out of many regions, as well as curfews for all citizens in many provinces. In addition to these measures, it has been emphasized on news outlets and many social media platforms that hospitals should not be visited unless absolutely necessary.

AA continues to be one of the most common causes of acute abdominal pain in the emergency department and requires rapid surgical intervention. It has been reported that the overall incidence of AA in the USA is 9 out of 10,000 and the lifetime risk is around 7% [2]. Although it has been shown that conservative treatment can be applied in some selected cases, appendectomy is still considered to be the gold standard in AA treatment [3, 4].

While the vast majority of the published literature on COVID-19 focuses on disease transmission characteristics, pathogenesis, treatment options, and patient outcomes, the impact of the pandemic on other areas of medicine and recommendations for solutions have not yet been adequately investigated. Our aim in this study was to investigate the impact of COVID-19 pandemic on AA cases that are frequently encountered in emergency abdominal surgery practice. We also elaborated on changes that can be made to address these issues.

## Methods

Ethics committee approval was obtained from the Clinical Research Ethics Committee of our university before initiation of the study. This study was designed as a single-center, retrospective, and observational study, and was carried out in accordance with the Declaration of Helsinki.

## Patients

Based on the date of March 10, 2020, when the first COVID-19 case was detected in Turkey, the data of patients treated in our hospital between December 10, 2019 - June 10, 2020 and March 10, 2019 - June 10, 2019 were retrospectively analyzed from the hospital data record system. The inclusion criteria for the study were radiological or intraoperative diagnosis of AA, age over 18 years, and access to all medical data records. The exclusion criteria for the study were pregnancy and application of additional interventional procedures (such as oophorectomy) during the appendectomy. A total of 413 patients were included in the study. A flow chart of the study population is presented in Fig. 1.

The patients were divided into 3 groups based on the March 10, 2020 date. Patients treated for AA in the 3-month period before this date (December 10, 2019–10 March 2020) were included in Group A. Patients treated for AA in the 3-month period after this date (March 10, 2020 - June 10, 2020) were included in Group B and the patients treated for AA between the same dates 1 year ago (March 10, 2019–10 June 2019) were included in Group C.

## Data Collection and Definitions

Patients sociodemographic data, the surgical technique applied (open or laparoscopic), intra-operative findings (operation time, uncomplicated appendicitis, or complicated appendicitis), postoperative complications, mortality, and postoperative length of hospital stay were evaluated. Simple, focal or suppurative appendicitis was considered uncomplicated appendicitis, while gangrenous, perforated appendicitis, and periappendiceal abscess were considered complicated appendicitis. Perforation was

evaluated based on intraoperative findings. In equivocal cases, perforation was assessed using the patient's pathology report. Complications occurring within 30 days after the patient's first discharge were accepted as postoperative complications. The time when nausea, vomiting, dyspepsia, epigastric pain, or any other abdominal pain was first reported by the patients was defined as the time of symptom onset. The time between the onset of symptoms and admission to the hospital was defined as the symptomatic time, while the time between admission and start of the surgery was designated as the preoperative hospitalization time. If the symptom onset time was fully recorded, the symptomatic time was calculated based on this record. In cases where an approximate time was given, it was defined as follows: if the symptoms began in the morning, the symptom onset time was set to 7 a.m. and if the symptoms began in the evening, the symptom onset time was set as 7 p.m.

## Statistical Analyses

SPSS 22.0 (Statistical Package for Social Sciences, IBM Inc., Chicago, IL, USA) was used for statistical analysis of the data. Continuous variables were expressed as mean  $\pm$  standard deviation. The Kolmogorov-Smirnov test was applied to test the normality of the distribution. Chi-square or Fisher's exact tests were used to compare groups related to categorical variables. When comparing two groups, the Student-t test was used for parametric data, while the Mann-Whitney U test was used for non-parametric data. Age, symptomatic time, preoperative hospitalization time, operation time, and postoperative length of hospital stay were compared with a Kruskal-Wallis one-way analysis of variance, followed by a Mann-Whitney post hoc test. A p value of less than 0.05 was considered statistically significant.

## Results

There were no significant differences between the groups in terms of age and gender ( $p = 0.313$ ,  $p = 0.245$ , respectively). Similarly, there were also no significant differences between the groups in terms of medical comorbidities. The patient demographic data are shown in Table 1.

**Table 1**  
**Sociodemographic Data**

	<b>Group A</b> <b>n = 128</b>	<b>Group B</b> <b>n = 149</b>	<b>Group C</b> <b>n = 136</b>	<b>p</b>
<b>Age<sup>a</sup></b>	32.80 ± 11.61	35.74 ± 14.29	33.70 ± 13.01	0.313
<b>Gender n (%)</b>				
Female	57 (44.5)	81 (54.4)	65 (47.8)	0.245
Male	71 (55.5)	68 (45.6)	71 (52.2)	
<b>Medical Comorbidities n (%)</b>				
DM	12 (9.4)	8 (5.4)	9 (6.6)	0.418
HT	3 (2.3)	4 (2.7)	5 (3.7)	0.796
CAD	2 (1.6)	3 (2)	3 (2.2)	0.927
COPD	1 (0.8)	1 (0.7)	1 (0.7)	0.994

DM: Diabetes mellitus, HT: Hypertension, CAD: Coronary artery disease, COPD: Chronic obstructive pulmonary disease. <sup>a</sup> Mean ± standard deviation.

Evaluation in terms of treatment modality showed that the rate of open appendectomy in Group B was significantly higher as compared to the other two groups ( $p < 0.001$ ). In addition, the conversion from laparoscopic surgery to open surgery occurred in 4 (3.6%) patients in Group A, 11 (12.1%) patients in Group B, and 5 (4.3%) patients in Group C. This conversion rate was significantly higher in Group B ( $p = 0.027$ ). Data on treatment approach modalities and rates of conversion of laparoscopic surgery to open surgery are given in Table 2. Moreover, the rates of complicated appendicitis were significantly higher in Group B compared to the other two groups ( $p = 0.024$ ) (Table 2).

Table 2  
Data on Treatment Type, Grade of Appendicitis, Symptomatic Duration, Preoperative Hospitalization Time, Operation Time, Postoperative Length of Hospital Stay, and Complications

	Group A	Group B	Group C	p
<b>Treatment n (%)</b>				
Conservative	4 (3.1)	3 (2)	3 (2.2)	< 0.001
Open appendectomy	14 (10.9)	55 (36.9)	18 (13.2)	
Laparoscopic appendectomy	110 (86)	91 (61.1)	115 (84.6)	
<b>Conversion to open surgery n (%)</b>	4 (3.6)	11 (12.1)	5 (4.3)	0.027
<b>Grade of appendicitis n (%)</b>				
Normal appendix	2 (1.6)	1 (0.7)	2 (1.2)	0.024
Uncomplicated appendicitis	110 (88.7)	112 (76.7)	116 (87.2)	
Complicated appendicitis	12 (9.7)	33 (22.6)	15 (11.3)	
<b>Symptomatic time<sup>a</sup></b>	1475.35 ± 705.85	2737.13 ± 1266.67	1613.45 ± 773.07	< 0.001
<b>Preoperative hospitalization time<sup>a</sup></b>	358.81 ± 112.93	346.25 ± 145.77	348.68 ± 126.37	0.102
<b>Operation time<sup>a</sup></b>	43.67 ± 14.45	48.60 ± 16.93	42.82 ± 12.73	0.011
<b>PLHS<sup>b</sup></b>	1.38 ± 1.80	2.07 ± 3.31	1.30 ± 1.54	0.001
<b>Complications n (%)</b>				
Wound infection	2 (1.6)	10 (6.8)	2 (1.5)	0.023
Intraabdominal abscess	2 (1.6)	4 (2.7)	1 (0.8)	
Pneumonia	-	5 (3.4)	1 (0.8)	
Mortality	-	1 (0.7)	-	
Total	3 (2.4)	13 (8.9)	4 (3)	

PLHS: Postoperative length of hospital stay, <sup>a</sup> minutes, <sup>b</sup> days

There was a significant difference between the groups in terms of symptomatic duration, and post hoc analysis indicated that the symptomatic duration was significantly higher in Group B ( $p < 0.001$ ), while no significant difference was detected between Groups A and C ( $p = 0.477$ ). On the other hand, no significant differences were found between the groups in terms of preoperative hospitalization time ( $p = 0.102$ ). However, it was determined that there was a significant difference between the groups in terms of operation time ( $p = 0.011$ ). The post hoc analysis indicated that the operation time in Group B was

significantly longer compared to Groups A and C ( $p = 0.045$ ,  $p = 0.021$ , respectively). In addition, it was revealed that there was a significant difference between the groups in terms of postoperative length of hospital stay ( $p = 0.001$ ). The post hoc analysis showed that the mean postoperative length of hospital stay in Group B, with an average of 2.07 days, was significantly higher compared to Groups A and C ( $p = 0.024$ ,  $p = 0.001$ , respectively).

Complications developed in the postoperative period occurred in 3 (2.4%) patients in Group A, 13 (8.9%) in Group B, and 4 (3%) in Group C, and the rate of complications in Group B was significantly higher than the other two groups ( $p = 0.023$ ). In addition, among the patients included in our study, the only mortality occurred in one patient in Group B. Data on complications are given in Table 2.

## Discussion

The number of AA cases in the pandemic period in our study was similar to those of the pre-pandemic period and the same period last year. Our city's population is approximately 450,000 and there are two hospitals, including ours, with similar capacities. During the pandemic, the other hospital was designated as a treatment center for patients infected with COVID-19 (AA cases were not treated in the other hospital during this time). Considering this detail, it can be interpreted that there was actually a decrease in the number of AA cases. Similarly, Tankel J et al. have reported a decrease in the incidence of AA during the COVID - 19 pandemic [5]. However, a better assessment could have been carried out by including the number of AA cases of the other hospital before the pandemic and same period last year.

We found that open surgery rates during the pandemic period were higher compared to other periods. This preference for open surgery may be due to the higher rates of complicated appendicitis during the pandemic period compared to other periods in our study. Moreover, in patients diagnosed with complicated appendicitis in the preoperative period, the concerns of possible insufficient drainage and debridement during laparoscopic surgery might have affected the surgeon's choice of operation technique. Similarly, we think that high rates of complicated appendicitis during the pandemic period also impacted the rates of conversion of laparoscopic surgery to open surgery during this period. While our rate of conversion to open surgery in non-pandemic periods was similar to the studies in the literature, this rate was higher during the pandemic period [6, 7]. Moreover, we also found that the mean operation time during the pandemic period was longer as compared to the other periods. This might be because of the high rates of complicated appendicitis, which may lead to a technically difficult procedure and thus prolong the operation. Moreover, surgeons might have taken more time to be more careful due to the concern of contamination.

While our complication rates in the non-pandemic period were similar to the studies in the literature, the rate of complications was higher during the pandemic period [8, 9]. The high level of postoperative wound infection and pneumonia during this period is noteworthy. In addition, the only mortality among our cases occurred during the pandemic period. We think that the high rate of complicated appendicitis during this period explains the high complication rates.

On the other hand, the mean postoperative length of hospital stay in the non-pandemic period was consistent with the studies in the literature, while during the pandemic period it was higher [10, 11]. We think that the high rate of complications in the postoperative period may have led to the longer duration of postoperative hospital stay during the pandemic period.

In our study, adverse conditions during the pandemic period, such as the high rate of open surgery, high rate of conversion to open surgery, high complication rate, longer operation time, and the prolonged postoperative length of hospital stay are actually combined in one denominator, which is the high rate of complicated appendicitis. In a study conducted by Kim JW et al. that included 1753 patients, it was reported that the increase in the time between the onset of AA symptoms and admission to the hospital was a risk factor for development of perforation and complications [12]. Indeed, in our study, we also found that the mean time between the onset of AA symptoms and admission to the hospital during the pandemic period was longer than in non-pandemic periods. At this point, it may be thought that a similar result may occur if the time elapsed between the hospital admission and start of the operation is prolonged. However, in our study, the similarity between the mean time between the hospital admission and the operation start time in the pandemic period and the non-pandemic periods eliminates this possibility. Therefore, we believe that the basis of the negative consequences that occurred in AA patients during the pandemic period was the late admission of patients to the hospital.

One of the reasons for patients' late arrival to the hospital after the onset of AA symptoms may have been the patients' anxiety and worry about transmission of COVID-19 from patient-to-patient in the emergency department. Indeed, studies have shown that hospitals create high-risk environments for transmission of respiratory diseases during epidemics [13–15]. We think that due to this concern, patients refrained from going to the hospital during the initial period of symptom onset and came to the hospital only when symptoms worsened. However, prospective studies on this subject need to be carried out in order to reach a definitive judgment. Another reason for late admission to the hospital might have been the complete curfew that was implemented for 3–4 days on certain days of the week in the first 3 months of the pandemic. This curfew might have caused the patients to delay going to the hospital. In addition, we are of the opinion that the perception of "not going to hospitals unless absolutely necessary" that was emphasized on many platforms, especially on social media, resulted in the late admission of patients to the hospital.

During the pandemic period, patients delayed coming to the hospital for various reasons. However, in order to prevent this late application to the hospitals, the question of "what could be done during the pandemic period?" should be emphasized. We believe that our health systems should be reviewed to include more guidance. Curfews and travel restrictions succeeded in preventing aggressive spread of the disease in Turkey. Since hospitals are risky environments in terms of contamination during epidemic periods, we believe that healthcare systems need to provide adequate technical equipment and be able to reach affected patients at home rather than waiting for them to come to the hospitals. For example, many delayed cases could be avoided by establishing a communication network where patients with any

symptoms could call or consult via a phone application and then, if necessary, have their first examination at their own location or home.

The limitations of the study are the retrospective design and the fact that it was conducted in a single center.

## **Conclusions**

In this study we found that rates of open surgery, conversion of laparoscopic surgery to open surgery, complications, mean operation time, and mean postoperative length of hospital stay were higher in AA patients treated during the pandemic period compared to non-pandemic periods. We believe that the main reason for this negative outlook is patients' late admission to the hospital. In this regard, we believe that re-evaluation of the health system is needed so that during pandemics, such as COVID-19, health care professionals are still able to reach patients with symptoms at home by establishing a communication network instead of waiting for their arrival at hospital.

## **Abbreviations**

WHO: World Health Organization; AA: Acute appendicitis;

## **Declarations**

### **Ethical approval:**

Ethics committee approval was obtained from the Clinical Research Ethics Committee at Yozgat Bozok University before initiation of the study (Decision number: 2017-KAEK-189\_2020.05.28\_14).

### **Consent for publication:**

Not applicable.

### **Availability of data and materials:**

All data were collected and are kept by the corresponding author. Parts of the data are available by contacting the corresponding author.

### **Competing interests:**

The authors declare that they have no competing interests.

## Funding:

None.

## Authors' contributions:

MB and MKK conceived the idea of the study and developed the protocol with MB. MKK did the literature search. MB selected the studies. MB and MKK extracted the relevant information. MB synthesized the data. MB wrote the first draft of the paper. MB and MKK critically revised successive drafts of the paper and approved the final version. MB and MKK are the guarantors of the review. All Authors read and approved the final version of the manuscript

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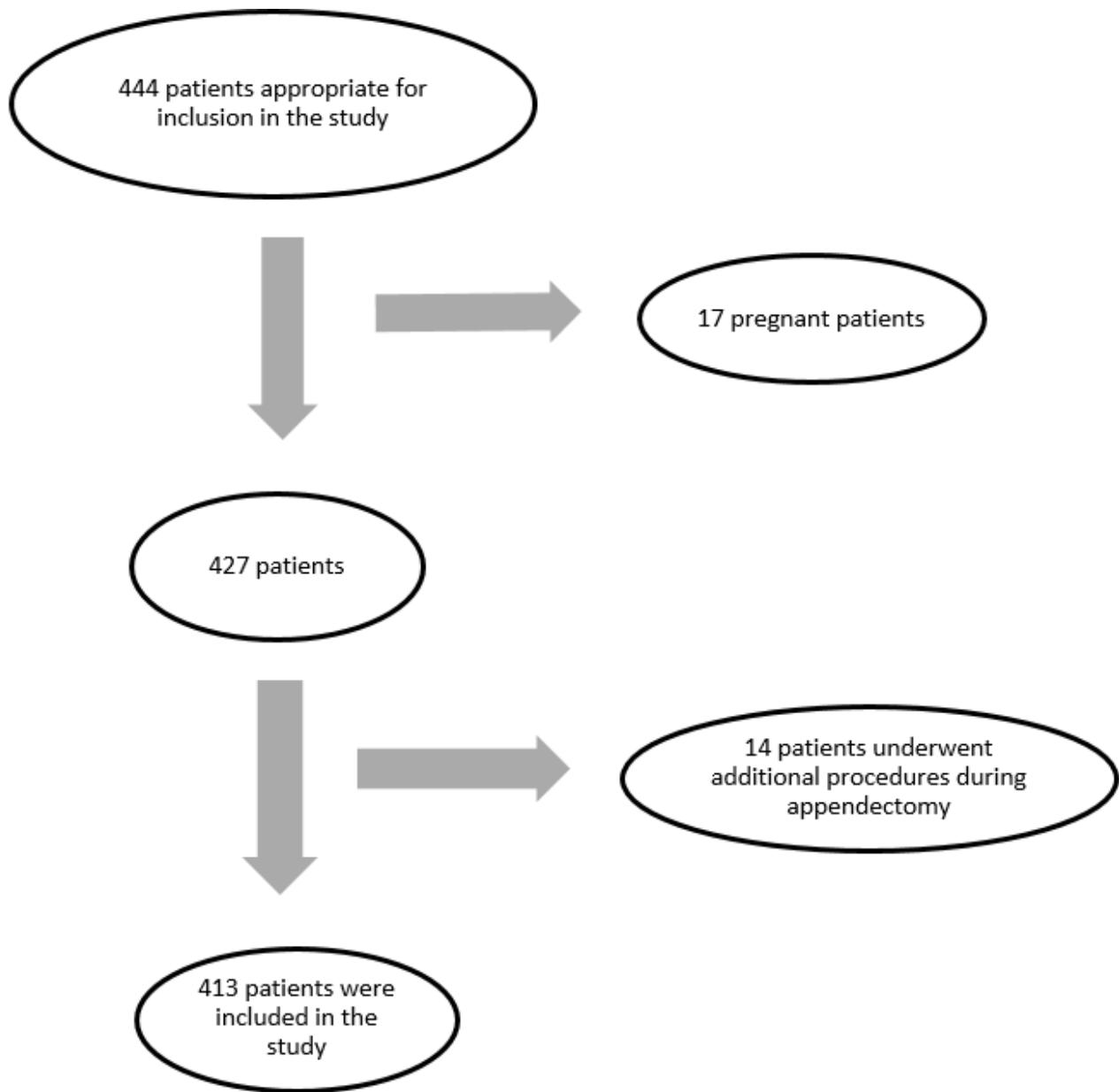
Not applicable.

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## Figures



**Figure 1**

Study flow chart