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ORIGINAL SCIENTIFIC REPORT

Did the COVID-19 Pandemic Cause a Delay in the Diagnosis of Acute Appendicitis?

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Abstract

Background Appendectomy for acute appendicitis remains one of the most common surgical procedures. This study aims to assess the clinical presentation and delays in diagnosing acute appendicitis during the COVID-19 pandemic.

Methods We evaluated data of all adult patients who underwent an appendectomy at our hospital between June 1, 2019 and June 1, 2020. Demographic data, admission type to the emergency room, radiological findings, pathological findings, and hospitalization time were noted. Patients were divided into four groups of 3-month periods, pre (Groups 5, 4, 3, 2) and during the pandemic (Group 1). Hospitalization time and perforation status of each group were compared. The hospital admission type and their effect on perforation were also evaluated.

Results Two hundred and fourteen patients were included; 135 patients were male, and 57 were female. The median age was 39 years. In Group 1 (pandemic period), 28.8% of patients were referred to us from pandemic hospitals. The median hospitalization time was 7.3 h before pandemics (Group 2–5), 5 h in the pandemic period (Group 1). Perforation rates were 27.8% in Group 1, 23.3% in Group 2, 16.3% in Group 3, 14.0% in Group 4, and 18.6% in Group 5 (0 = 0.58). There was no difference in the patients in Group 1 in the rate of perforated appendicitis in patients who were referred from other pandemic hospitals (29.4) and those admitted via our own emergency room (16.6%) (p = 0.27) during the pandemic period.

Conclusion We did not observe any clear increase in the diagnosis of perforated appendicitis during the pandemic period, even in patients who were transferred from other hospitals.

Introduction

Coronavirus disease 2019 (COVID-19) is a serious health-care problem that has affected millions of people worldwide since December 2019.

The World Health Organization (WHO) declared a pandemic situation on March 11, 2020 [1]. Early in the pandemic, lack of knowledge about the transmission, treatment, and prevention of the disease instilled fear among the population. Many patients in hospitals feared that they would contact the virus from patients admitted with COVID-19, and many started avoiding hospitals as much as possible. Consequently, most common medical conditions might have had a delayed diagnosis and presentation. Although the main symptoms of COVID-19 are respiratory problems, gastrointestinal symptoms like abdominal pain, nausea, and vomiting were also reported [2]. These created some confusion in the emergency rooms early in the pandemic.

In surgical practice, appendicitis remains one of the major causes of acute abdominal pain in adults and one of

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the most common reasons for the need for emergency surgery [3, 4].

The aim of this study was to determine whether there was a delay in the presentation and the diagnosis of acute appendicitis during the COVID-19 pandemic.

Material and methods

Ethical considerations

The data were collected retrospectively and approved by our institutional ethics committee. In addition, we received permission for this study from the Turkish Ministry of Health Scientific Research Commission and Ethics Committee.

Patient selection and method

Turkey reported the first COVID-19 case on March 11, 2020 [5]. Since that date, hospitals have been separated into three groups in our city: pure pandemic hospitals, general hospitals that include pandemic departments or sections, and non-infected hospitals that do not hospitalize confirmed COVID-19 patients. Our hospital was in the third group.

Pure pandemic hospitals were treating only COVID-19 patients except for in their emergency rooms (ERs). When a patient was diagnosed as having a condition needing emergent surgery, such as acute appendicitis, these hospitals were referring patients to other hospitals. General hospitals with pandemic departments were continuing emergency surgeries in a separate part of the same hospital; they did not refer patients to other hospitals. Furthermore, as a non-infected hospital, we continued emergency operations and accepted referred patients from pandemic hospitals.

Between March 1, 2019, and June 1, 2020, we analyzed 214 adult patients who underwent appendectomies with diagnoses of acute appendicitis. The data were collected from the hospital database. Patients who underwent interval appendectomies were excluded. Additionally, seven patients whose pathological analyses were reported as normal appendix vermiformis and three patients diagnosed pathologically with lymphoid hyperplasia were also excluded.

Demographic data, admission type to the ER (individual admission or referred from a pandemic hospital), radiological findings, pathological findings, and hospitalization time, which is defined as the period from the ER to the operation room (OR), were noted.

The patients were diagnosed with a physical examination, laboratory findings that included complete blood counts and biochemical analysis, abdominal ultrasonography, and abdominal computerized tomography (CT) for suspected patients. Preoperative chest CTs were performed for most patients during the COVID-19 pandemic. The preoperative real-time polymerase chain reaction (RT-PCR) test was not performed for all patients because of the late results. Half of the patients who were referred from other hospitals were already diagnosed and had reports of their analyses.

All patients were treated with immediate surgical procedures after diagnosis to minimize the hospitalization period during the pandemic.

Patients were classified as complicated (perforation, abscess, or gangrene of appendix) or uncomplicated according to operation and pathological analysis reports.

Patients were divided into five groups of three-month periods. Group 1 is the pandemic period (March 1st, 2020–May 31st, 2020), Group 2 is December 1st, 2019–February 29th, 2020, Group 3 is September 1st, 2019–November 30th, 2019, Group 4 is June 1st, 2019–August 31st, 2019, and Group 5 is March 1st,2019–May 31st, 2019.

We received permission for this study from the Turkish Ministry of Health Scientific Research Commission and Ethics Committee.

Statistical analysis

Characteristics of patients were given as numbers and percentages, and continuous data were given as medians (minimum–maximum). The hospitalization time and perforation status of each group were compared. Also, the hospital admission type and its effect on perforation were evaluated.

The chi-square test and Fisher's exact test were used to analyze categorical variables, and an independent sample *t*-test analysis was used to analyze continuous variables. p values < 0.05 were considered as statistically significant. All analyses were performed with SPSS software (version 21.0; SPSS Inc., Chicago, IL).

Results and discussion

We analyzed 204 patients after excluding ten patients according to the criteria mentioned in Sect. 2.2. One hundred thirty-five patients (66.2%) were male, and 69 (33.8%) were female. The median age was 39 years (range; 18–83 years) for females and 29 years (range; 18–68 years) for males.

There were 59 patients (28.9%) in the first group and 32 patients (15.7%), 40 patients (19.6%), 37 patients (18.1%), and 36 patients (17.7%) in the other groups, respectively.

In Group 1, 17 of 59 patients (28.8%) were referred to our hospital from pandemic hospitals. Preoperative chest tomography was performed on 41 asymptomatic patients for COVID-19 in this group. Only two patients of these 41 had pulmonary infiltration, which was not demonstrative for SARS-CoV-2. Therefore, those two patients were both tested with RT-PCR after surgery and isolated. RT-PCR test results were obtained after surgery, which showed that both tests were negative.

There were 43 patients (21.1%) who had perforated appendicitis in our series. Twenty-nine (67.4%) of the perforated group were male. Perforation rates were similar in both males and females ($p = 0.84$).

Before the pandemic, the median interval between ER to OR was 7.3 h (h) (range; 4–18.5 h). Similarly, in the pandemic period (Group 1), the median interval was 5 h (range; 2.4–10.2 h). On the other hand, the median interval for patients referred from other hospitals was 3.7 h, and the median interval was 5.8 h for individual admitted patients.

When we compared the median hospitalization time for perforated and non-perforated patients, both were similar: 7.14 ± 1.44 h and 6.41 ± 1.73 h, respectively ($p = 0.44$).

Postoperative final diagnoses are given for five groups in Table 1.

Although perforation rates were slightly higher in Group 1, we could not find statistically significant differences ($p = 0.58$). Also, we compared Group 1 and Group 5 for the final diagnosis. In March 2020, which is the beginning of the pandemic period, none of the 15 patients had perforation. And in March 2019, 7 patients among the total of 17 had perforated appendicitis. On the other hand, during the pandemic, in the second and third month, the perforation rate increased.

In a subgroup analysis of the pandemic period, patients referred from other hospitals and patients admitted individually to the ER were analyzed for a difference in perforation rates. The results are given in Table 2.

There was no significant difference between the two groups ($p = 0.27$).

Coronaviruses (CoVs) were recognized as "novel respiratory tract viruses" over half a century ago. In 2002, CoVs emerged in the form of severe acute respiratory syndrome (SARS) in the Guangdong state of China [6]. A decade later, another highly pathogenic CoV named MERS-CoV appeared in the Middle East [7].

In December 2019, a cluster of insidious coronavirus infections was reported in Wuhan, China, and the disease was named COVID-19 [8].

COVID-19 is characterized by an unpredictable disease course, ranging from asymptomatic infections to severe and life-threatening situations.

Pan et al. observed that 50.5% of patients infected with COVID-19 reported gastrointestinal symptoms, including lack of appetite (78.6% of cases), diarrhea (34% of cases), vomiting (3.9% of cases), and abdominal pain (1.9% of cases), along with the presence of respiratory symptoms [2]. Therefore, the diagnosis of acute appendicitis may be challenging during the COVID-19 pandemic.

In our series, all excluded patients were clinically healed after surgery, although their pathological diagnoses were not acute appendicitis. On the other hand, in macroscopy reports, intraluminal feces in the appendix were observed for all patients. None of those patients had other symptoms of COVID-19 during hospitalization.

The diagnosis of COVID-19 is mainly established with the RT-PCR test. However, this test requires laboratory specifications, and the results may take a long time [9]. Other laboratory investigations are usually non-specific.

Recent studies addressed the importance of chest CT examinations on COVID-19 patients with false negative-PCR results and reported the CT sensitivity as 98% [10]. A recent study showed that 54% of the asymptomatic patients had pneumonic changes on chest CT [11].

Whole-chest CT might not be necessary for COVID-19-positive patients if their lung bases are imaged in the abdominal CT [12]. Chest CT scans are commonly preferred for suspected COVID-19 patients who require emergency surgery [13]. Trauma surgeons recommend a

Table 1 Postoperative diagnosis in the groups

	Postoperative diagnosis		Total patients *N* (%)
	Acute appendicitis Patients *N* (%)	Perforated appendicitis Patients *N* (%)	
Group 1	47 (29.2%)	12 (27.8%)	59 (28.9%)
Group 2	22 (13.7%)	10 (23.3%)	32 (15.7%)
Group 3	33 (20.5%)	7 (16.3%)	40 (19.6%)
Group 4	31 (19.3%)	6 (14.0%)	37 (18.1%)
Group 5	28 (17.3%)	8 (18.6%)	36 (17.7%)

Table 2 Admission type to hospital and postoperative diagnosis

	Postoperative diagnosis		Total patients *N* (%)
	Acute appendicitis Patients *N* (%)	Perforated appendicitis Patients *N* (%)	
Patient admitted to emergency unit	35 (74.5%)	7 (58.3%)	42 (71.2%)
Patient referred from pandemic hospital	12 (25.5%)	5 (41.7%)	17 (28.8%)

chest CT scan to be added into routine diagnostic tools to detect COVID-19 pneumonia, even if the patient has no symptoms [14].

Shortly after the beginning of the pandemic, we added a chest CT scan to our preoperative routine for emergency surgery. None of our patients in this study had positive findings on the chest CT. Despite this, there were positive findings for other patients who had different causes of surgeries.

Appendectomy is the gold standard of treatment for acute appendicitis. However, recent studies suggest that conservative management with intravenous antibiotics can be used as an alternative [3, 15–17]. On the other hand, in adults, appendectomy remains the most effective and safe treatment option and provides curative treatment without recurrence risk.

As noted in retrospective studies, acute appendicitis is a time-dependent disease concerning severity and complication rate [18, 19]. On the other hand, some studies suggest that perforation is most often a prehospital occurrence and not strictly a time-dependent phenomenon [20].

A study of 9048 acute appendicitis patients reported a 15.8% perforation rate, with a higher rate in male patients, with a mean hospitalization time of 8.6 h [20]. The study found no association between perforation and in-hospital time before surgery among adults treated with appendectomy. Kim et al. reported a similar time interval of 8.3 h with a perforation rate of 28.2 [21]. A meta-analysis that analyzed 20 studies reported a 12.7% rate of perforated appendicitis [22].

During the pandemic period, patients were given conservative treatment to keep their hospitalization time to a minimum. Therefore, there was an attempt to reduce the hospitalization time (median 7.3 h before the pandemic and 5 h in the pandemic period).

Although there was a slight increase in perforation during the pandemic period, this negativity was not statistically significant ($p = 0.58$). Perhaps the reason for this may be the decrease in hospitalization time. Furthermore, in Group 1 in the first month, there were no patients who had perforated appendicitis. On the other hand, in the second and third months, the perforation rate increased. We may explain this later increase in perforation rates with the rise in fear of COVID-19 over time, which caused more and more patients to be wary of hospitals.

Complicated appendicitis is described as the existence of pus, necrosis, gangrene, or perforation. In our series, all complicated cases were also perforated.

Complicated appendicitis is more common in females and increases with age [17]. In a study conducted by Chung, the perforated appendicitis rate was 69% for males and 31% for females. Moreover, in the group with normal appendicitis, 64% were male and 36% female [23].

In our series, 21.1% of patients had perforated appendicitis. Although the rate of complicated appendicitis was slightly higher in the male population, perforation detection rates by gender were similar in our series.

In this study, we divided patients into five groups of 3-month periods. The low numbers of each group may cause a lack in the power of statistical analysis. This might be a limitation of this study.

In conclusion, although there was an increase in the diagnosis of complicated appendicitis during the pandemic period, the negative effects of this delay were not statistically significant compared to other periods.

Compliance with ethical standards

Conflict of interest Authors declare that they have no conflict of interest.

Ethical approval Turkish Ministry of Health Scientific Research Commission Approval Code: 2020-06-09T11_18_29.Institutional Review Board Approval Code: 2020-06-09-96.

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