

Comparative Analysis of the Acute Appendicitis Management in Children before and During the Coronavirus Disease-19 Pandemic

Koronavirüs-19 Pandemisi Öncesi ve Sırasında Çocuklarda Akut Apendisit Yönetiminin Karşılaştırmalı Analizi

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Özet

Amaç: Koronavirüs-19 (COVID-19) salgınında pek çok hastalığın tanı ve tedavisinde gecikme olmuştur. Bu çalışmanın amacı COVID-19 salgını öncesinde ve sırasında akut apandisit (AA) insidansını ve şiddetini karşılaştırmaktır. COVID-19 salgınının apandisit hasta sayısı ve komplikasyonları üzerindeki etkisini araştırmaktır.

Gereç ve Yöntemler: Bu çok merkezli çalışma üç tıp fakültesi hastanesinde 15 Mart-30 Haziran 2019 tarihi ile pandemi dönemi olan 15 Mart-30 Haziran 2020 tarihleri arasında retrospektif olarak yapıldı. İki grup oluşturuldu. Grup A, 2019 yılında acile karın ağrısı nedeniyle başvuran 1655 hastadan (64 hasta AA tanılı) oluşurken, Grup B pandemi döneminde karın ağrısı ile acile başvuran 1120 hastadan (77 hasta AA tanılı) oluşmaktadır. Her gruptaki hastaların klinikopatolojik özellikleri arasında karşılaştırma yapıldı.

Bulgular: Acil servise karın ağrısı nedeniyle başvuran hastalar, akut ve komplike apandisit olarak değerlendirildi. Grup A'de toplam karın ağrısı ile başvuran 1655 hastanın 64'ü (%3.86) apandisit tanısı alırken, Grup B'de 1120 hastanın 77'si (%6.87) apandisit olmak üzere toplam 141 hastaya apandisit teşhisi konuldu. Grup A 64 apandisit hastasının 52'si (%81) akut apandisit, 12'si (%18.75) komplike apandisit, Grup B 'de 77 hastanın 47'si (%61) akut apandisit, 30'u (%38.9) komplike apandisit olarak değerlendirildi.

Sonuç: Akut pandemik dönemde karantina dışı döneme göre daha az hasta başvurdu ama yüksek oranda apandisit tanısı konmuştur. COVID-19 döneminde, daha fazla apandisit hastası hastalığın geç evresinde başvurmuştur. Vakalarımızda pandemi döneminde komplike apandisit oranının yüksek olmasının, COVID-19 salgını nedeniyle gecikmiş tanı sebebiyle olduğuna inanıyoruz.

Anahtar kelimeler: Apandisit, Covid-19, Komplike apandisit

Abstract

Objective: Acute appendicitis (AA) is one of the most common surgical emergency in pediatric population. Herein, we aimed to compare the incidence and severity of AA before and during the Coronavirus Disease-19 (COVID-19) outbreak.

Materials and Methods: This multicenter study was conducted in three medicine faculty hospitals between the periods of 15 March-30 June 2019 (Group A), and the pandemic period of 15 March-30 June 2020 (Group B). We evaluated the clinicopathological characteristics of the patients in each group in terms of age, gender, serum leukocyte, C-reactive protein, radiological imaging use of postoperative peritoneal drain and presence of serious complications.

Results: A total of 141 patients were identified and divided into two groups as Group A (n=64) and Group B (n=77). We found higher complication rates in Group B. Fewer patients applied in Group B, but a higher rate of AA was diagnosed. During the COVID-19 period, more patients were admitted with the later stages of the AA and with significant complications. Radiological imaging of patients with appendicitis in Group B showed more severe findings compared to Group A.

Conclusion: Higher rate of perforated and complicated appendicitis in the pandemic period was due to misdiagnosis/delayed diagnosis in primary care centers as a result of fear from contagious coronavirus. Although the period of the COVID -19 pandemic brings out difficulties in treatment of patients, comprehensive assessment and physical examination in children with suspected surgical conditions should always be emphasized.

Keywords: Appendicitis, COVID-19, Complicated appendicitis

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INTRODUCTION

The COVID-19 pandemic has spread rapidly, causing more than a million people to become infected worldwide (1). Adults showed multiple signs of illness and 20% of infected adults were treated as critically ill. While the estimated mortality rate was as high as 2%, the children facing the coronavirus mostly suffered from severe respiratory distress syndrome (2,3,4). Many countries are struggling to prevent the spread of COVID-19 using different strategies. In many countries, authorities have instructed to stay at home and avoid visiting local clinics and hospitals as possible (5). However, emerging diseases continue to appear during the current outbreak, and must be promptly diagnosed. Delayed diagnosis and treatment of common pediatric emergencies lead to significant morbidity. While the majority of published literature on COVID-19 has investigated the virus transmission, treatment options, and patient outcomes, its impact on the surgery has not been investigated comprehensively.

Acute appendicitis (AA) is one of the most common emergency surgical diseases in the pediatric population (6,7). 1-8% of children with acute abdominal pain are diagnosed as AA in the emergency service (8). It represents 4.5% of all abdominal pain cases (2). More than 250000 appendectomies are performed each year in the United States of America alone (3). Early diagnosis and treatment is the best choice to reduce complication rates. The most common treatment of AA is appendectomy and the surgical procedure can be performed open or laparoscopically. While surgical treatment is still considered the gold standard for AA treatment, a conservative approach is advocated in selected cases by using antibiotics as first-line therapy. In recent years, some studies on conservative treatment approach in the treatment of uncomplicated appendicitis are promising, but definitive results have not yet developed (9,10).

Early diagnosis of AA and, accordingly, appropriate surgery or antibiotherapy are important in children, because early diagnosis and treatment may prevent complications including appendix perforation, abscess formation and the other postoperative complications (11,12). In general, appendix perforation occurs 36-48 hours after the onset of symptoms and its incidence is approximately 20% in children aged 10-17 years (11,13). Abscess formation rate is roughly 20% in children with perforated appendicitis, and the rate of abscess formation is approximately 0.8% in patients with AA (14).

There are no studies analyzing the effect of the COVID-19 pandemic episode on the number of patients with AA and their surgical treatment. The aim of this study was to analyze the effect of COVID-19 on the number and characteristics of patients with AA,

and to compare them with the non-pandemic period. In addition, comparison of the incidence of AA before and during the onset of COVID-19 and evaluation of whether there was a change in the characteristics or severity of patients was also a major purpose of this study.

MATERIALS AND METHODS

This is a multicenter retrospective study conducted in three medical faculty hospitals. All patients diagnosed with AA were included in our study. Approval was obtained from the Ethics Committee of Clinical Trials of the Faculty of Medicine (Approval no: 21, Date: 24.6.2020). The study was conducted in accordance with the principles of the Declaration of Helsinki. Inclusion criteria of the identified cases in the study were determined as having a diagnosis of appendicitis diagnosed radiologically or during surgery, being under 18 years of age and having electronic medical records.

Epidemiological, clinical data, blood parameter levels, radiological and histopathological results were obtained from the electronic medical record systems of the three centers. The surgical intervention method performed was open appendectomy in all three centers. The information obtained from the patients included demographic and clinicopathological data. In case of acute inflammation, intraoperative findings were recorded. AA was defined as complicated appendicitis in the presence of gangrene, perforation or peri-appendicular abscess. Data such as age, gender, blood biochemical values including leukocyte number, C-reactive protein (CRP), radiological data (appendix diameter, presence of fecalitis, abscess), postop peritoneal drainage and presence of serious complications were recorded (**Table 1**). The patients who admitted to the emergency department with abdominal pain, diagnosed with AA and complicated appendicitis were analyzed (**Table 2**).

A comparison was made between the complication rates during the COVID-19 period (15 March-30 June 2020) and the same months of the year 2019. The reason to investigate the same periods (March-June) in the following years was to exclude the seasonal difference in appendicitis (15).

All statistical analyzes were performed in SPSS, version 21 (IBM SPSS Statistics for Windows, version 21.0. Published 2012. Armonk, NY: IBM Corp). Categorical variables were defined as frequency and percentage, continuous variables as mean and standard deviation. To check the distribution of variables, the Kolmogorov-Smirnov test was performed. Univariate comparisons between the two groups were made using Chi Square or Fisher's exact test for ordered or categorical variables. For continuous variables, Mann-Whitney U test or Student T test were used appropriately. A p value

Table 1. Basic demographic and clinical data between Group A and Group B were analyzed.

	Total n=141	Group A (non-pandemic) n=64	Group B (acute pandemic) n=77	p
Age (mean)	11.26±4	11.22±3.9	11.30±4.08	0.907
Male (n)	89	42 (65.6%)	47 (61%)	0.574
Female (n)	52	22 (34.4%)	30 (39%)	
Leukocyte count (mean) (μ l/ml)	14.583±4.9	13.966±5	15.078±4.8	0.229
CRP (mean) (mg/L)	38±56.5	30.1±48	44.4±62.3	0.187
Appendix diameter (mm)	11.7±11.9	9.14±2.5	14.9±16.1	0.301
Acute appendicitis (n)	107	52 (78.1%)	47 (74.0%)	0.571
Perforated appendicitis (n)	33	12 (21.9%)	30 (26%)	
Fecalite (n)	23	8	15	0.264
Abscess (n)	14	4	10	0.183
Peritoneal drain (n)	13	4	9	0.266
Serious complication (n)	3	1	2	0.672
Diagnosing with CT (n)	18	5	13	0.108

CRP: C Reactive protein, CT: Computerized tomography

Table 2. Numerical values of patients who applied to the emergency department with abdominal pain, acute appendicitis (AA) and complicated appendicitis were analyzed.

	Abdominal pain	Diagnosed with appendicitis	Diagnosed with AA	Diagnosed with complicated appendicitis	p
Group A	1655	64	52	12	0.009
Group B	1120	77	47	30	

of <0.05 was considered statistically significant and all intervals were calculated with 95% confidence interval.

RESULTS

Between the study periods (15 March-30 June 2019 and 15 March-30 June 2020), a total of 141 patients, 64 patients in Group A and 77 patients in Group B were collected in three medical centers. Appendicitis was diagnosed in 77 children between March 1 and June 30, 2020 (Group B), of which 30 patients had complications such as perforation or abscess formation. During the same period in 2019 (Group A), a total of 64 children were diagnosed with appendicitis, but only 12 patients had perforated appendicitis. Basic demographic and clinical data for these patients are described in **Table 1** as Group A (non-pandemic period in 2019) and Group B (acute pandemic period in 2020).

We found that the mean age of the participants was

11.26±4.00 the mean age of Group A was 11.22±3.9, and the mean age of Group B was 11.30±4.08. Among 141 patients, 89 (63.12%) patients were male and 52 (36.8%) patients were female. Group A included 42 males (65.6%) and 22 females (34.4%). Group B was consisted of 47 males (61%) and 30 females (39%). There was no significant difference between the two groups in terms of average age and gender.

The mean value of blood leukocyte count in all participants was 14.583±4.9 (μ l/ml). In Group A, the mean leukocyte count was 13.966±5086 (μ l/ml), while in Group B the mean leukocyte count was 15.07±4.8 (μ l/ml). The mean value of CRP in all participants was 38.04±56 (mg/L). The mean value of CRP in Group A was 30.12±48 (mg/L), while the mean value of CRP in Group B was 44.42±62 (mg/L). The differences between the blood leukocyte and CRP values between Group A and B were not significantly different.

In total, 97 patients (68.7%) among 141 patients were diagnosed with acute appendicitis, and those were 50 patients (78.1%) in group A and 47 patients (61.0%) in group B. A total of 44 patients (31.2%) were diagnosed with perforated appendicitis, among them 14 patients (21.9%) were in Group A and 30 patients (39%) were in Group B. We found that the rate of perforated appendicitis in the pandemic period (group B) was statistically higher, compared to the non-pandemic period ($p < 0.029$). We calculated the mean diameter of appendix as 11.7 ± 11.9 mm in all patients by preoperative ultrasonography (USG). In Group A, the average value of the appendix diameter was 9.14 ± 2.5 mm, while in Group B the average value of the appendicitis diameter was 14.9 ± 16.13 mm. The difference in appendicitis diameters in Group A and Group B was not statistically significant. Fecalitis related with appendicitis was seen in 23 patients (16.3%) among all participants, in which 8 patients (12.5%) were in Group A and 15 patients (19.5%) were in Group B. Intraabdominal abscess was seen in 14 patients (9.9%) in total, in which 4 patients (6.5%) were in Group A and 10 patients (13%) were in Group B. Postop peritoneal drain was applied to 13 patients (9.2%) in total, 4 of them (6.3%) were in Group A and 9 (11.7%) were in Group B. Among 141 patients, 3 patients had complications, these were postop ileus and peritonitis. Among them, 1 patient was belonged to Group A and 2 patients were belonged to Group B.

18 patients (12.7% of the total participants) were evaluated with abdominal CT due to the suspicious diagnosis, in which 5 patients (7.8%) were from Group A and 13 patients (16.9%) were from Group B. Among 18 patients who underwent CT, 11 were diagnosed with perforated appendicitis, 9 patients were in Group B, 2 patients were in Group A.

The severity of the appendicitis was higher in the acute pandemic period. During the COVID-19 pandemic, there were fewer patients who presented to the emergency department for abdominal pain, but we found that these patients presented with more severe stage of appendicitis (Table 2).

DISCUSSION

COVID-19 has fundamentally changed the way of working in the hospitals. Many clinics of children's hospitals have been transformed into clinics for adult patients to accommodate the adult COVID-19 patients. With the limited availability of the beds in the clinics, the total number of the patients who were given treatment and have been followed-up have inevitably decreased.

During COVID-19, the rate of complications of appendicitis (peritonitis, abscess) was roughly higher than the rate of complications in the same period of the previous year. The COVID-19 pandemic has completely changed the medical evaluation and decision-making process of patients, family members and physicians. There were several important reasons for the delay in diagnosis during the COVID-19 outbreak. The first was parental anxiety as seen in several of the cases above. Families were extremely concerned about the contagious COVID-19 in the emergency room. Hospitals, including surgical units, have reported fewer non-COVID emergencies during the pandemic period (1). It is observed that the rate of severe complicated appendicitis cases has increased in the acute pandemic period. These results are consistent with the hypothesis that the people postponed going to the polyclinics and emergency department until their symptoms become severe in the acute pandemic period. After analyzing some of the interviews with parents arriving at the hospital, we believe that the potential cause of this delay was the fear of exposure to confirmed cases of coronavirus in hospitals. However, these data were not analyzed in the results, as no qualitative study has been conducted.

The two important complications of appendicitis are perforation (resulting in the peritonitis) and peri-appendicular abscess formation. Perforation rate is approximately 20% in children aged 10-17 years (13). The rate of peri-appendicular abscess formation is approximately 20% in children with perforated appendicitis, and this rate is 0.8% in AA (14). In our series, all patients were diagnosed 24 hours or after the onset of symptoms. As a result, most patients with perforated appendicitis had peri-appendicular abscess. In our cases, 30 patients (39%) out of 77 patients during the pandemic period had perforated appendicitis, and 10 (33.3%) of the patients with perforated appendicitis had abscess. In the 2019 non-pandemic period, 14 patients (21.9%) out of 61 patients had perforated appendicitis and 4 patients (28.5%) had abscesses. Abscesses were seen more frequently during the pandemic period. Rothrock et al. showed an approximately 100% perforation rate in children diagnosed with appendicitis 48 hours after the onset of symptoms (11). Another study found that the incidence of perforation was roughly five times higher in children with appendicitis after 48 hours of symptoms and 56% longer hospital stay than those presenting in the first 24 hours (17). Most of the patients diagnosed with AA did not have complications such as additional perforation and abscess formation. Our complication rates were also low in patients with perforated appendicitis (2.1%).

We should also mention that the patients who undergo appendectomy should not be treated conservatively during this period. During the pandemic period, early operative treatment may be preferred to conservative treatment due to the possible shorter hospital stay. Early appendectomy will also prevent complications from unsuccessful conservative treatment. It is worth remembering that open appendectomy has an excellent result. Compared to laparoscopic appendectomy, there were significantly shorter operating times in the open appendectomy (34.2 versus 59.2 minutes) and a reduced hospital stay (median: 1 versus 2 days). Management of surgical patients during the pandemic process is a difficult task and we believe that laparoscopic procedures should be avoided (18). The excellent results are obtained with early open appendectomy in the COVID-19 period in patients diagnosed clinically with appendicitis. We treated our patients with open appendectomy during this pandemic period. We successfully operated the patients with a shortened observation time and reduced the duration of hospitalization as much as possible.

We have some limitations in our study. The presented cases were collected within a short period of time from only three centers of national pediatric surgery clinics. However, the number of patients diagnosed with AA during the pandemic was not significantly different from the previous year. There were 77 patients in the pandemic period (March-June 2020) and 64 patients in the nonpandemic period (March-June 2019). Considering patients who were diagnosed as non-complicated appendicitis, the overall number was

lower during the COVID-19 pandemic than the number in the same period of 2019. In 2019, we operated 50 patients (78.1%), while in 2020 we operated 47 (61%) patients (**Figure 1**). We compared rates of complicated appendicitis between the two periods and showed higher rates during the pandemic period. Among all 141 participants, 44 patients (31.2%) were diagnosed with perforated appendicitis, in which 14 patients (21.9%) were in Group A and 30 patients (39%) were in Group B. The rate of perforated appendicitis was higher in the pandemic period compared to the non-pandemic period, and this was statistically significant ($p < 0.029$). Of the 18 patients who underwent CT, 11 were diagnosed with perforated appendicitis, 9 of these perforated patients were in Group B and 2 patients were in Group A. In the acute pandemic period, CT scans of patients whose diagnosis was not clearly diagnosed by USG or physical examination showed higher disease severity than the cases in the non-pandemic period.

In conclusion, fewer patients applied in the acute pandemic period compared to the non-quarantine period, but a higher rate of acute appendicitis was diagnosed. Radiological scans of patients with appendicitis in the acute pandemic period showed higher disease severity than cases in the non-pandemic period. During the COVID-19 period, more patients were admitted with the later stages of the disease and with significant complications. Based on the findings and statistics, we believe that the higher rates of perforated and complicated appendicitis encountered in our study was due to the delayed diagnosis and delayed admission to hospitals during the pandemic period.

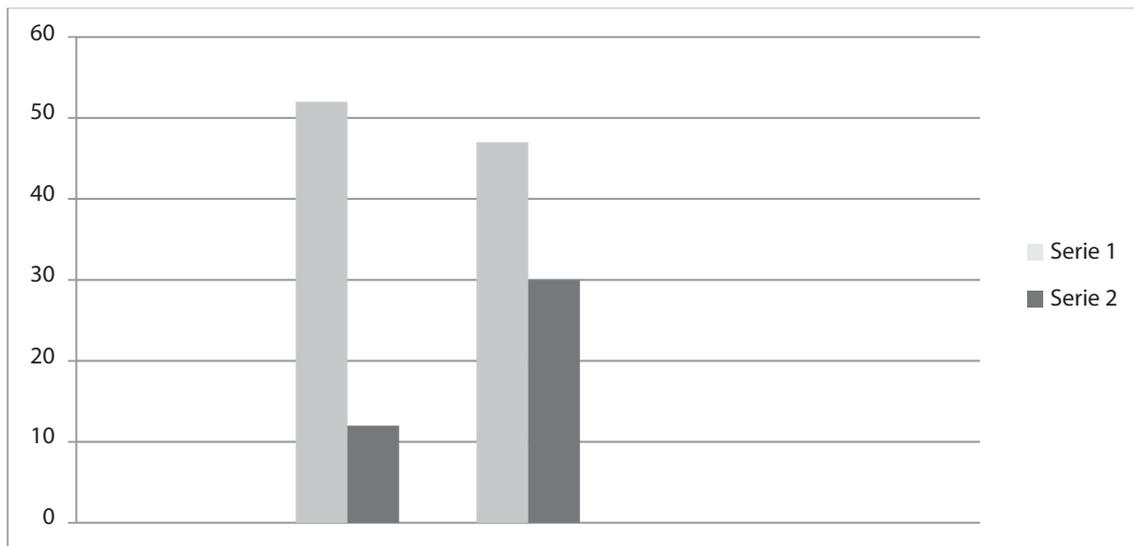


Figure 1. The graph of the rate of acute and complicated appendicitis in Group A (non-pandemic year 2019) and Group B (pandemic year in 2020). Serie 1 shows the incidence of acute appendicitis (AA), and serie 2 shows complicated appendicitis. A higher rate of complicated appendicitis cases are shown in the acute pandemic period compared to the non-pandemic period.

While the period of the COVID - 19 pandemic presents difficulties in treating infected patients, we would like to emphasize the importance of a comprehensive assessment and physical examination in children with suspected surgical conditions. In this case, clinicians have more tasks than ever before. Management of any disease requires a variety of staff and materials. As financial resource availability, we provided safe care throughout the pandemic in accordance with COVID-19 testing capacity and the clinic constraints. We hope that our findings and experiences in this study would help healthcare professionals and shed light for development of the surgical algorithms during the pandemic.

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