Is the COVID-19 Pandemic Causing Delays in the Diagnosis of Appendicitis in Children?

COVID-19 Pandemisi Çocuklarda Apandisit Tanısının Konulmasında Gecikmelere Neden Oluyor mu?

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ABSTRACT

Objective: We aimed to investigate whether there is an increase in the number of complicated appendicitis during pandemic period.

Material and Methods: Data of patients were evaluated retrospectively. Patients were divided into two-groups as pre-pandemic and pandemic. Age, gender, duration after the onset of complaints until visiting hospital, WBC count, days after presentation to hospital until surgery, surgical method, whether the appendix was complicated, duration of hospitalization, whether any complications developed, and results of PCR tests were evaluated.

The data of the groups were compared and it was investigated whether there was any difference between them. Statistical analysis was done with the SPSS (Statistical Package for Social Sciences) version 21. $P < 0.05$ was considered significant.

Results: Appendectomy was performed in 327 patients during pandemic and in 295 during pre-pandemic period. Although the ratio of complicated appendicitis increased during pandemic compared to pre-pandemic period (47.1% versus 40.7%), there was no difference between groups. However, duration between onset of symptoms and arrival at hospital (p=0.003), time elapsed before surgery (p=0.021), length-of-stay in hospital (p=0.009), and developed complications (p=0.01) were higher in pandemic group.

Conclusion: Comparing prepandemic, although there was no statistically significant difference during the pandemic period, there was an increase in complicated appendicitis and related complications. It was attributed to late arrival at hospitals due to curfews, parental fear of disease transmission, and prolonged duration of screening tests in the emergency departments.

Key Words: Acute appendicitis, Children, Complicated appendicitis, Covid-19 pandemic, Parental fair, Perforated appendicitis

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Conflict of Interest / *Çıkar Çatışması*: On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethics Committee Approval / *Etik Kurul Onayı*: The study was approved by the Ankara City Hospital, Clinical Research Ethics Committee No. 2. (Number: E2-20-38, Date: Dec 02, 2020)

Contribution of the Authors / Yazarların katkısı*: *DEMIR S: Constructing the hypothesis or idea of research and/or article, Planning methodology to reach the Conclusions, Organizing, supervising the course of progress and taking the responsibility of the research/study, Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments, Taking responsibility in logical interpretation and conclusion of the results, Taking responsibility in necessary literature review for the study, Taking responsibility in the writing of the whole or important parts of the study, Reviewing the article before submission scientifically besides spelling and grammar. ***OZTORUN CI:*** Taking responsibility in necessary literature review for the study. ***KIRIS AG:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. ***ERTURK A:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. ***ERTEN EE:*** Taking responsibility in necessary literature review for the study. ***GUNEY D:*** Taking responsibility in necessary literature review for the study. ***ALTINOK MK:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. ***UZUN AU:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. ***AKKAYA F:*** Reviewing the article before submission scientifically besides spelling and grammar. ***YILMAZ Y:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. ***AZILI MN:*** Reviewing the article before submission scientifically besides spelling and grammar. ***AKBIYIK F:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. ***SENEL E***: Constructing the hypothesis or idea of research and/or article, Planning methodology to reach the Conclusions, Organizing, supervising the course of progress and taking the responsibility of the research/study,Taking responsibility in logical interpretation and conclusion of the results, Taking responsibility in the writing of the whole or important parts of the study, Reviewing the article before submission scientifically besides spelling and grammar.

How to cite / *Atıf yazım şekli* : Demir S, Oztorun CI, Kiriş AG, Erturk A, Erten EE, Guney D, et al. Is the COVID-19 Pandemic Causing Delays in the Diagnosis of Appendicitis in Children?. Turkish J Pediatr Dis 2021;15:155-161.

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Received / Geliş tarihi : 18.02.2021
Accepted / Kabul tarihi : 15.03.2021
Online published : 24.03.2021
Elektronik yayın tarihi
DOI: 10.12956/tchd.879488

ÖZ

Amaç: Çalışmamızın amacı COVID-19 pandemisi sırasında komplike apandisit sayısında artış olup olmadığını araştırmaktır.

Gereç ve Yöntemler: Hastalar COVID-19 pandemisinin başladığı tarih esas alınarak, başvuru tarihlerine göre pre-pandemi ve pandemi grubu olmak üzere iki gruba ayrıldı ve verileri retrospektif olarak tarandı. Yaş, cinsiyet, şikayetlerin başlangıcından hastaneye gelene kadar geçen süre, WBC sayısı, hastaneye başvurudan ameliyat olana kadar geçen süre, uygulanan cerrahi yöntem, ameliyat esnasında apendiksin komplike olup olmadığı, hastanede kalış süreleri, komplikasyon gelişip gelişmediği ve PCR testlerinin sonuçları araştırıldı. Grupların verileri karşılaştırılarak aralarında fark olup olmadığı araştırıldı. İstatistiksel analiz SPSS (Statistical Package for Social Sciences) version 21 programı ile yapıldı. Tüm değişkenler için $p < 0.05$ anlamlı kabul edildi.

Bulgular: Covid-19 pandemisi sırasında 327 hastaya, pandemi öncesi dönemde ise 295 hastaya apendektomi yapıldı. Pandemi sırasında komplike apandisit oranı pandemi öncesi döneme göre artmasına rağmen (%47.1'e karşı %40.7) gruplar arasında istatistiksel olarak fark bulunmadı. Ancak pre-pandemi grubu ile kıyaslandığında, pandemi grubunda semptomların başlangıcı ile hastaneye varış arasındaki süre ($p = 0.003$), ameliyattan önce geçen süre ($p = 0.021$), hastanede kalış süresi ($p = 0.009$) ve gelişen komplikasyonlar ($p = 0.01$) daha yüksek bulundu.

Sonuç: Pre-pandemi grubu ile kıyaslandığında, aralarında istatistiksel olarak fark tespit edilmemekle birlikte, Pandemi döneminde komplike apandisit ve buna bağlı komplikasyonlarda artış tespit edildi. Bu artış sokağa çıkma yasakları nedeniyle hastanelere geç başvurulması, ebeveynlerin bulaş korkusu ve acil servislerde tarama testlerinin uzun sürmesi ile ilişkilendirildi.

Anahtar Sözcükler: Akut apandisit, Çocuk, Komplike apandisit, Covid-19 pandemisi, Ebeveynlerin bulaş korkusu, Perfore apandisit

INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) pandemic has spread rapidly throughout the world since December 1, 2019, when the first case was reported in Wuhan, China, and it has not yet been brought under control. On March 11, 2020, when the disease was declared a pandemic by the World Health Organization (WHO), the Ministry of Health reported that the first confirmed case had been identified in Turkey. According to WHO data, as of December 12, 2020, 71,803,872 confirmed cases and 50,320,398 recovered patients had been reported worldwide. Unfortunately, 1,607,689 people have died due to COVID-19 as of this date. In Turkey during this period, 1,809,809 confirmed cases, 1,51,565 recovered cases, and 16,199 deaths have been reported (1).

Appendectomy is the most common abdominal surgery performed by pediatric surgeons (2,3). Acute appendicitis is clinically divided into simple (acute and suppurative) and complicated appendicitis (gangrenous and perforated) (4). Delay in diagnosis may result in perforation. The perforation rate varies between 16% and 40% (5).

Our hospital, Ankara City Hospital, is Turkey's largest hospital complex with over 3.700 patient beds. Besides being affiliated with two universities, it is an education and research hospital that belongs to the Ministry of Health and provides specialty training. Since the beginning of the pandemic, as the Ministry of Health has declared it a pandemic hospital, it has been one of the health institutions most affected by this process.

Due to its nature, the pandemic has deeply affected routine work in pediatric surgery clinics, as in all medical branches. Although we suspended non-urgent elective surgeries at the beginning of the pandemic, emergency surgeries including appendectomies, emergency surgeries for newborns, trauma surgeries, oncological surgeries, and wound care and surgical procedures for burned children in the pediatric burn center continued. For this reason, the number of emergency surgeries, including appendectomies, did not decrease during the pandemic.

There is controversy as to whether there has been an increase in complicated appendicitis in children due to delayed admission of patients to hospitals caused by lockdown rules and parental concerns regarding COVID-19 exposure during the pandemic period. Although an increase has been reported in some recently published articles, some authors have claimed that this rate has not changed (6-8). In our country, Turanli et al. (9) reported that there was no increase in adults during the pandemic period. As we have not yet identified a study on children in Turkey, we planned to investigate this issue as one of our country's leading pediatric surgery clinics.

We hypothesized that the rate of complicated appendicitis and associated complications increased in children during the pandemic period compared to the previous period. For this purpose, patients who underwent an appendectomy in our clinic before and during the pandemic period were retrospectively compared. It was investigated whether there was any difference between them.

MATERIAL and METHODS

This was planned as a retrospective study. Necessary permission was obtained from our hospital's ethics committee (Number: E2-20-38, Date: Dec 02, 2020). The patients were divided into two groups. The patients who were operated on within eight months (between March 11, 2020 and November 10, 2020) after the beginning of the pandemic were named the "pandemic group", and the patients who were operated on during the previous eight months (between July 11, 2019 and March 10, 2020) were named the "pre-pandemic group".

Patients between one and 18 years of age with no other comorbidities who presented with abdominal pain and were diagnosed with appendicitis and operated on were included in the study. Patients who were younger than one or older than 18 years old, patients who were diagnosed with appendicitis while hospitalized due to chronic comorbid diseases, patients who were operated on with a pre-diagnosis of acute appendicitis but were diagnosed with another intraoperative diagnosis, and patients who underwent interval appendectomy were excluded from the study.

The electronic files of the patients were evaluated retrospectively. Age, gender, number of days after the onset of complaints until visiting the hospital, white blood cell (WBC) count before surgery, days after presentation to the hospital until surgery (defined as the delay between the time of arrival at the emergency room and surgery), surgical method (laparoscopic/open), whether the appendix was complicated or not, duration of hospitalization, whether any complications developed within 30 days postoperatively, and whether the patient (for those in the pandemic group) tested positive for SARS-CoV-2 according to the real-time polymerase chain reaction (RT-PCR) test from nose and throat swabs were evaluated. It was investigated whether there were any statistically significant differences between the two groups.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software version 21 (SPSS Inc., Chicago, IL, USA). Normality tests (visual histogram and Shapiro-Wilk or Kolmogorov-Smirnov tests depending on the situation) were used to determine whether the numerical variables (age, length of hospitalization, WBC count, day they were admitted to hospital, and day they were operated on) were normally distributed. Since the numerical variables were not dispersed according to normal distribution, the differences between groups were investigated using the Mann-Whitney U test. Differences between groups were investigated by crosstabulation with the Chi-Square test for categorical variables such as gender, surgical method, whether the appendix was complicated, whether complications developed within 30 days postoperatively, and whether the RT-PCR test was checked in the pandemic group. $P < 0.05$ was considered statistically significant for all variables

RESULTS

A total of 640 patients with suspected acute appendicitis were operated on between July 11, 2019 and November 10, 2020. A total of 18 patients were excluded from the study because 17 were diagnosed with different diagnoses intraoperatively (Meckel diverticulitis, invagination, and other diagnoses), and one was less than one year old. The remaining 622 patients were included in the study. Of these patients, 327 (52.6%) were operated on during the pre-pandemic period, and the remaining 295 (47.4%) were operated on during the pandemic period. No difference was found between the patients in either group regarding gender, age, and preoperative WBC count ($p = 0.708$, $p = 0.263$ and $p = 0.221$, respectively). The ratio of boys was higher than girls in both groups (Table I).

While 19.6% (64/327) of the pre-pandemic group patients presented directly to our hospital's emergency department, 78.6% (257/327) were referred from other hospitals. During the pandemic period, 38.6% (114/295) of the patients were arrived directly to the emergency department, while 56.6% (167/295) were referred from different hospitals. While there was a decrease in the number of referred patients during the pandemic period, a significant increase was observed in the number of patients who presented directly to our emergency department ($p < 0.001$) (Table I).

The duration between the onset of symptoms and arrival at the hospital in the pre-pandemic group was (minimum–maximum; range) 1.57 (0.0–10.0; 10.0) days and it was 2.11 (0.0–30.0; 30.0) days in the pandemic group ($p = 0.003$). The duration between arrival at the hospital and being taken to the operating room for the patients in the pre-pandemic group was 0.38 (0.0–7.0; 0.69) days on average, and the average length of stay in hospital was 3.55 (0.0–22.0; 22.0) days. In the pandemic group, these durations were found to be 1.39 (0.0–36.0; 5.26) days and 4.66 (1.0–29.0; 28.0) days, respectively. There were statistically significant differences between the groups in terms of these two variables ($p = 0.021$ and $p = 0.009$, respectively) (Table I).

Most appendectomies were performed by the open technique during both periods. However, there was an increase in the laparoscopic appendectomy ratio in the pandemic group compared to the pre-pandemic group (18.3% versus 35.6%). This increase was statistically significant ($p < 0.001$) (Table I).

A total of 272 patients (43.7%) ($n = 622$) had complicated appendicitis. Of these, 133 (48.9%) were in the pre-pandemic group, and 139 (51.1%) were in the pandemic group. The ratio of complicated appendicitis was 40.7% (133/327) in the pre-pandemic group and 47.1% (139/295) in the pandemic group. However, despite the 6.4% increase in the rates, no statistically significant difference was found between the groups ($p = 0.106$) (Table I). While a drainage tube was placed in 10.4% (34/327) of the patients in the pre-pandemic group, it was placed in 11.2% (33/295) in the pandemic group. There was no difference between the two groups in terms of placing drains ($p = 0.751$).

Of the pandemic group, 10 (4.3%) of 234 patients tested positive for SARS-CoV-2 preoperatively (Table I). These patients were operated on while wearing personal protective equipment. Postoperatively, their treatments were completed in isolated rooms, and COVID-19 treatments were administered according to treatment protocols. None of the patients with positive tests had symptoms of respiratory involvement. One patient from the complicated appendicitis group with perforated appendicitis

Table I: Comparative analysis of data of patients operated before and during the Covid-19 pandemic

Variables	Pre-pandemic Group (n=327) (%)	Pandemic Group (n=295) (%)	p
Gender			
Male	210 (64.2%)	194 (65.8%)	0.708*
Female	117 (35.8%)	101 (34.2%)	
Age (Year), †	11.52 (1.0-17.5;16.5)	11.86 (2.0-18.0;16.0)	0.263**
Admission to the hospital			
Referred from another hospital	257 (78.6%)	167 (56.6%)	
From the emergency department	64 (19.6%)	114 (38.6%)	<0.001*
Consulted from different clinic in our hospital	1 (0.3%)	5 (1.7%)	
Examined at the pediatric surgery polyclinic	5 (1.5%)	9 (3.1%)	
WBC count	14379 (3250-31740;4973)	13995 (3980-32670;4973)	0.221**
Duration before admission to hospital (Day), †	1.57 (0.0-10.0;10.0)	2.11 (0.0-30.0;30.0)	0.003**
Duration before surgery in the hospital (Day), †	0.38 (0.0-7.0;7.0)	1.39 (0.0-36.0;36.0)	0.021**
The length of stay in the hospital (Day),	3.55 (0.0-22.0;22.0)	4.66 (1.0-29.0;28.0)	0.009**
Operation technique			
Laparotomy	267 (81.7%)	185 (62.7%)	<0.001*
Laparoscopy	60 (18.3%)	105 (35.6%)	
Conversion from laparoscopic to laparotomy	-	5 (1.8%) ***	
Type of appendicitis			
Simple	194 (59.3%)	156 (52.9%)	0.106*
Complicated	133 (40.7%)	139 (47.1%)	
Drainage tube			
None	293 (89.6%)	262 (88.8%)	0.751*
Placed	34 (10.4%)	33 (11.2%)	
PCR test			
None	-	61	N/A
Tested negative	-	224 (95.7%)	
Tested positive	-	10 (4.3 %)	
Complication in 30 days			
None	304 (93%)	256 (86.8%)	0.01*
Complication developed	23 (7.6%)	36 (13.2%)	

**Chi square test used, **Since variables are not distributed normally Mann-Whitney U test was used, ***Since the pre-pandemic group's cell was zero, this cell was combined with the closest similar group (the laparotomy group) and analyzed, †: Mean(Min-Max; Range)*

Table II: Statistical analysis of data of complicated patients.

Variables	Pre-pandemic Group (n=133) (%)	Pandemic Group (n=139) (%)	p
Gender			
Male	88 (66.2)	97 (69.8)	0.522*
Female	45 (33.8)	42 (30.2)	
Age (Year), †	11.31 (2.5-17.5;15.0)	11.53 (2.0-18.0;12.0)	0.634 **
Duration before admission to hospital (Day), †	2.10 (0.0-7.0;7.0)	2.72 (0.0-30.0;30.0)	0.012**
Duration before surgery in the hospital (Day), †	0.30 (0.0-2.0;2.0)	1.02 (0.0-32.0;32.0)	0.012**
The length of stay in the hospital (Day), †	5.49 (1.0-15.0;14.0)	7.0 (1.0-29.0;28.0)	0.030**
Complication in 30 days			
None	117 (88.0)	109 (78.4)	0.036*
Complication developed	16 (12.0)	30 (21.6)	

**Pearson Chi Square test used, **Mann-Whitney U test used, † Mean(Min-Max; Range)*

was diagnosed with multisystem inflammatory syndrome in children (MIS-C) and was treated postoperatively.

During thirty days postoperatively, complications were seen in 36 patients (13.2%) in the pandemic group and 23 patients (7.6%) in the pre-pandemic group. There was a statistically significant difference between the groups (p = 0.01) (Table I). The most common complication in both groups was prolonged ileus. It developed in seven (30.4%) of 23 patients who developed complications in the pre-pandemic group and in 17 (43.6%) of 36 patients in the pandemic group. These patients were re-

Table III: Detailed list of complications seen in patients within 30 days postoperatively.

Complications	Pre-pandemic Group	Pandemic Group
Wound infection	6 (26.1)	9 (23.1)
Prolonged ileus	7 (30.4)	17 (43.6)
Intraabdominal abscess formation	6 (26.1)	6 (15.4)
Bleeding	2 (8.7)	0
Pleural effusion	1 (4.3)	1 (2.6)
Wound dehiscence	1 (4.3)	2 (5.1)
Skin rashes due to drug allergy	0	2 (5.1)
Lung infection	0	1 (2.6)
Cecal perforation	0	1 (2.6)
Total	**23**	**39**

hospitalized for treatment. Two patients who had hemophilia developed intra-abdominal bleeding and hematomas. One patient was treated with factor VII support. The other patient was reoperated on due to bleeding. The distribution of complications is detailed in Table III.

When only patients with complicated appendicitis were compared, no significant difference was found between the pre-pandemic and pandemic groups in terms of gender and age ($p = 0.522$ and $p = 0.634$, respectively). However, the duration between the onset of symptoms and arrival at the hospital, the duration between arrival at the hospital and being taken to the operating room, and the length of stay in the hospital were all found to be longer in the pandemic group. There were significant differences between the groups ($p = 0.012$, $p = 0.012$, and $p = 0.030$, respectively). There was a statistically significant increase in the incidence of complications in the pandemic group (21.6% versus 12.0%) ($p = 0.036$). The statistical analysis of complicated appendicitis according to the groups is presented in detail in Table II.

Two boys in the pandemic group were diagnosed with MIS-C. One tested positive for COVID-19, while the other tested negative. Antibodies were found to be positive in both cases. The patient who tested positive was from the complicated appendicitis (perforated) group, while the one from the simple appendicitis group tested negative.

DISCUSSION

The results of this study indicate that there was an increase in the number of complicated appendicitis cases in children during the pandemic. The reasons for this increase were determined as follows: late arrival at hospitals due to the curfews imposed by the government, and parental fear of disease transmission to their child while in hospital, and prolonged duration of screening tests for COVID-19 in the emergency departments. As a result, when compared to the pre-pandemic group, it was observed that in the pandemic group, the duration between the onset of their first complaints and the day they presented to the hospital was much longer, the duration between the moment they arrive at the hospital and when they were taken to the operating room was much longer, and they had a much longer length of stay in hospital.

Some recent publications have claimed that the number of complicated appendicitis cases has increased in adults during the pandemic (8,10,11). However, there are few publications about children. The results of this study are similar to the results of previous studies on adults (7).

Gunadi et al.(12) claimed that the number of complicated appendicitis cases did not increase in children in Indonesia during the pandemic. Similarly, Montalva et al. (13) reported that although there was an increase in the number of acute appendicitis cases in tertiary pediatric surgery centers in France compared to pre-pandemic numbers, there was no increase in complicated appendicitis cases. The same authors reported that they did not find a difference in the length of stay and complication rates of patients during the pandemic compared with the pre-pandemic period. On the contrary, we identified an increase in the length of stay and complications during the pandemic. Some authors have also reported an increase in the number of complicated appendicitis cases during the pandemic period. Snapiri et al. (7) attributed the increase in the number of complicated appendicitis cases to late admissions due to parental fears of COVID-19 transmission while in hospital and inadequate evaluation of patients by family physicians using the telemedicine method. Similar to our results, despite the increase in the actual number of complicated appendicitis cases, Snapiri et al. (7) did not identify a statistically significant difference between groups when comparing the pandemic era with the previous period ($p = 0.06$). Rafaelle et al. (6) in Italy reported similar results to our study. In their study, although the number of complicated appendicitis cases increased from 15% to 50% compared to the pre-pandemic period, no statistical difference was found ($p = 0.05$). In the same study, it was determined that the time elapsed from the onset of the patients' symptoms to arrival at the hospital and the time spent for evaluation in the

emergency room increased. Our results are similar regarding these two parameters. However, they reported no increase in their patients' length of stay in hospital and complications rates (6). Our results regarding these two variables were different. Our patients' length of stay in hospital was longer during the pandemic, and the incidence of complications was higher (Tables I and II).

During the pandemic, most centers implemented their own independent policies and, unfortunately, did not act together. Therefore, it can be said that the pandemic process is not being managed properly. For example, some centers have instituted non-operative treatment (NOT) to treat uncomplicated acute appendicitis in both adults and children for reasons such as not consuming hospital resources and protecting healthcare professionals from possible contamination during surgery (6,14 -18). However, it was not instituted in our center because of our doubts about NOT. After taking the necessary precautions for the safety of the healthcare professionals, all patients' treatments were performed surgically because it is still the gold standard for appendicitis. It was only in the first months of the pandemic that laparoscopic surgeries were suspended in line with national and international pediatric surgery associations' guidelines. Towards the end of April 2020, every hospitalized patient was tested for COVID-19." After that, except in emergency cases, clinicians waited for PCR results, and patients were treated as indicated. Accordingly, the open surgery technique was preferred in patients with signs of peritonitis and intrabdominal mass or abscess on imaging (ultrasound or abdominal computed tomography). Laparoscopic surgery was preferred in other patients. For this reason, our laparoscopic surgery ratio was higher during the pandemic than during the pre-pandemic period.

One of our study's remarkable results is the increase in the number of patients who presented directly to our hospital's emergency department with complaints of abdominal pain during the pandemic period. During the pre-pandemic period, only 19.6% (64/327) of these patients presented directly to the emergency department, while this rate increased to 38.6% during the pandemic. Contrary to our findings, Montalva et al. (13), working in a tertiary pediatric hospital similar to ours, noted an increase in the number of referred patients. Society's perception could be attributed to the thought that the surgeries stopped in the surrounding peripheral hospitals where families applied before and society's trust in tertiary hospitals.

COVID-19 infection in children may be asymptomatic or milder than in adults [19]. Thus, they can play a role in the rapid spread of the disease (20). For this reason, in our clinics, every patient who is hospitalized is isolated in a single room as if they are positive until there is a negative test result. This ensures the safety of healthcare professionals and prevents spread to other patients. Another reason to wait for the test result is the possibility that COVID-19 sometimes presents with acute appendicitis-like gastrointestinal symptoms (21-23) . As a matter of fact, five patients who presented to the emergency department with a complaint of abdominal pain and were consulted with a pre-diagnosis of acute appendicitis were diagnosed with MIS-C and were not operated on. Under normal circumstances, there are many examination and observation rooms in the emergency departments of our hospital. These areas enabled us to create COVID-19 examination and observation areas in the emergency department, separate from the normal emergency, beginning on the first day of the pandemic. Therefore, while patients with suspected COVID-19 were isolated from other patients, non-COVID-19 emergency examination areas continued to be used as they were before the pandemic. For this reason, our acute appendicitis numbers did not decrease much. Compared to 327 patients in the pre-pandemic period, 295 patients were operated on during the pandemic period. This slight decrease was attributed to the decreased number of children living in the province as a result of the introduction of restrictions and the transition of schools to online education, as many citizens returned to their rural cities.

There are some limitations of this study. The first is that it is a retrospective study. Another limitation is that it is a single-center study. Single-center studies may not give accurate results due to migration of the domestic population during the pandemic. While the number of patients in one center may increase, a noticeable decrease may be observed in another center in the same city. For example, studies conducted in two separate centers in New York City reported that while a significant decrease in cases was observed in one center compared to previous years, the number of cases did not change in the other (24,25). Therefore, multicenter studies at the national level should be conducted to understand whether complicated appendicitis is actually increasing or not.

CONCLUSION

During the COVID-19 pandemic, both the delay in coming to the hospital due to parental fears of their child being exposed to the virus and the prolongation of the examination periods in the emergency departments due to screening for COVID-19 increased the time before the patient went to the operating room. As a result, it increased the number of complicated appendicitis cases, complication rates, length of hospital stay, and morbidity. Therefore, in light of our experiences gained during the pandemic, we have listed our suggestions to guide the hospitals:

1. During pandemics it should be acted on as other types of disasters. Therefore, every hospital should have an emergency action plan for pandemic periods.
2. Patients presenting with disease complaints that are consistent with the pandemic should be examined in separate areas. Emergency departments should be rearranged for this.

3. Family concerns about the issue should be alleviated by providing information through social media, television, and printed media, and delays should be prevented by informing parents that their children will be examined in non-pandemic areas.
4. The examination and testing processes in the emergency department should be accelerated, and unnecessary delay of time should be avoided.
5. Thus, the number of complicated appendicitis cases can be reduced by shortening the duration patients wait before surgery.

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