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Research Article

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Effects of Covid-19 Pandemic On Pediatric Appendicitis Management

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ABSTRACT

Aim: COVID-19 was declared pandemic in March 2020. Turkish government issued stay-at-home orders and hospitals cancelled non-emergent surgeries. Our aim was to assess the impact of the COVID-19 pandemic on the presentation and management of pediatric appendicitis.

Materials and Methods: All appendicitis admissions between 01/03/2019-01/03/2021 were reviewed. Two groups were created: 12 months before COVID-19 (Non-pandemic Group) and 12 months after the date elective surgeries were postponed in TURKEY (01/03/2020) for COVID-19 (Pandemic Group). Patient demographics, symptoms, laboratory and imaging results, perforation status, intraoperative and pathological findings, and postoperative outcomes were analyzed.

Results: A total of 471 patients (264 Non-pandemic, 207 Pandemic) were evaluated. Age and gender of both groups did not differ significantly. There was significant increase in time between onset of symptoms and presentation to the hospital in Pandemic-group (1.0±1.8 vs 2.0±1.8 days, p<0.001). Symptoms reported at presentation included fever, abdominal pain, vomiting and anorexia; fever was more common in non-pandemic group being the only symptom significantly more prevalent (63.3% vs 36.7%, p =0.014). The proportion of patients diagnosed with complicated appendicitis was significantly higher during the COVID-19 pandemic (69.3% vs 79.7% p=0.03). CRP levels (50.4±63.8 vs77.87±79.3, p<0.001) and diagnostic sensitivity of abdominal USG (53% vs 66.7% p<0.05) was higher in pandemic group. Although standard therapy protocol was not changed mean length of hospitalization after surgery in Non-pandemic group was significantly lower (3.0±2.1 vs 3.0±1.3days p< 0.001).

Conclusion: The pandemic resulted in higher proportion of complicated appendicitis, most likely as a result of parents' delay in seeking medical care due to fear of Covid-19. Although complicated appendicitis numbers were higher and time of hospitalization was lower in pandemic group there was no significant difference in number and types of complications following surgery Despite presenting later during COVID-19, pediatric patients with appendicitis were treated expediently with good outcomes.

Keyword: *Appendicitis, Covid-19, Children*

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Introduction

Acute appendicitis is one of the most common emergency abdominal surgical indication in pediatrics [(1)]. Despite being a highly common surgical condition, its origin and cause remains unclear[(2)]. Luminal obstruction with fecalith, lymphoid hyperplasia, tumors, genetic predisposition, changes in bacterial composition and dietary intake are the most frequent causes of appendicitis [(3)].

Severe Acute Respiratory Syndrome Corona Virus-2 (SARS-CovV-2) outbreak, a new viral type of pneumonia originated in China, was declared as a global pandemic on march 2020 by World Health Organization [(4)]. As a mitigation response, in order to diminish transmission, worldwide decisions to go into a lock-down by local governments were initiated [(5)]. Similar to global concept, Turkish Government declared social distancing mandates at the beginning of march 2019. National and international traveling restrictions, stay at home orders, closure of non-essential businesses and schools were mandated. As expected, this outbreak had large-scale effects on healthcare system. Structures of hospitals and outpatient clinics were reorganized, medical staff and equipment were re-distributed to pandemic hospitals and ICU facilities and all non-emergent appointments and operations were postponed. As a result there has been a dramatic shift in seeking medical care patterns. Fear of being infected triggered people to minimize contact with medical staff hence diminished hospital admissions.

An increasing number of patients with complicated appendicitis has been observed during the COVID-19 outbreak in several countries [(6,7)] Therefore, we aimed to investigate the incidence and severity of appendicitis in pediatric patients undergoing appendectomy during the COVID-19 pandemic and compare it with its counterparts from a year ago in order to assess the impact of the COVID-19 pandemic on the presentation and management of pediatric appendicitis.

Material and Method

This study is designed as a retrospective cohort, reviewing data of all pediatric patients admitted to a large tertiary teaching hospital for acute or complicated appendicitis between March 2019 and March 2021. Patients were divided into two groups those treated between March 2019- March 2020, before pandemic outbreak (Non-pandemic group), and those treated between March 2020- March 2021, during the course of SARS-Covid-19 pandemic (Pandemic group). Data collected included patient demographics, admission information, symptoms, laboratory test results, imaging findings, management, post-operative complications, length of hospital stay and post-operative outcomes. In each case type of appendicitis was established appendicitis.

This survey was approved by Institutional Ethics Committee of our institution (NO: 2021/03-09). All methods were performed in accordance with the relevant guidelines and regulations.

Statistical Analysis

Patient age and hospitalization characteristics (including time between first symptoms to hospitalization and hospital stay, laboratory results) are reported as means and standard deviations. Patient characteristics (excluding age), and disease variables are reported as numbers and percentages. The chi-square test was used to compare the categorical variables between the study group (during the COVID-19 pandemic) and the control group (1 year prior to the COVID-19 pandemic). The numerical variables were compared using Mann-Whitney U test. The data are expressed as medians with interquartile ranges (IQRs). No adjustment was made for multiple comparisons when the sample size relative to the number of parameters was small. Categorical data are expressed as numbers (n) with percentages (%). To compare the categorical data from the two independent groups, either the chi-square or Fischer's exact test was used. SPSS for MAC (version 20.0; SPSS Inc., Chicago, IL, USA) was used for all data management and inferential statistical analyses. All P-values were two-sided, and the significance level was set at $p< 0.05$.

Results

Medical records of 471 children diagnosed and operated due to appendicitis in the Pediatric Surgery Department between March 2019 to March 2020 were evaluated. Two groups were designed (Non-pandemic group and Pandemic group). Demographic data of both groups of patients are outlined in Table-1. Demographic data and baseline characteristics of both groups of patients did not significantly differ. Diagnosis of appendicitis was set by a combination of symptoms, medical examination, laboratory and radiologic findings. All symptoms and findings are evaluated in Table-2. Appendicitis patients presented predominantly with nausea, vomiting and abdominal pain. Symptoms reported at presentation included fever, abdominal pain, vomiting and anorexia. Abdominal pain was reported in all patients while vomiting and anorexia were more commonly reported in patients presenting during pandemic; fever was more common in non-pandemic group being the only symptom significantly more prevalent (63.3% vs 36.7%, $p =0.014$). The most commonly used imaging modality in both groups was plain abdominal X-ray followed by abdominal ultrasonography. While there was no significant difference in X-rays (fecalith and/or scoliosis),

patients with appendicitis treated before pandemic and during pandemic were nonsignificant, whereas CRP levels were significantly higher in pandemic group (50.4±63.8 vs77.87±79.3, p<0.001)

We noted significant difference in the time between the onset of symptoms, and presentation to the hospital during pandemic period (Non-pandemic 1.0±1.8 days vs Pandemic 2.0±1.8 days, p<0.001), with several patients waiting up to 15 days before seeking medical care due to fear of Covid-19.

In both groups most common type was complicated appendicitis. We identified a significant increase in the number of complicated appendicitis admissions to our department in pandemic period (69.3% in Non-pandemic group vs 79.7% in Pandemic group p<0.05), whereas negative exploration and acute cases did not differ statistically.

Our standard therapy protocol designed by infection control committee for patients with appendicitis is perioperative prophylaxis with ampicillin/sulbactam continued post-operatively in non-complicated cases of appendicitis and treatment with ampicillin/sulbactam; metronidazole and aminoglycoside in complicated cases. This protocol was not changed during the SARS-CoV-2 pandemic. We noted a significant difference in mean length of hospitalization after surgery in Non-pandemic vs Pandemic group (3.0±2.1 vs 3.0±1.3 p<0.001). Although complicated appendicitis numbers were higher and time of hospitalization was lower in pandemic group there was no significant difference in number and types of complications following surgery (10.9% vs 11.5%, p=0.618).

Table-1. Clinical Characteristics of appendicitis patients.

Variables	Non-pandemic (N=264)	Pandemic (N=207)	*p*
Age (year)	11.0±3.5	11±3.4	0.240
Gender			
Male	167(63.2%)	152 (73.4%)	0.019
Female	97 (36.7%)	55 (26.6%)	
Time to hospitalization (days)	1.0±1.8	2.0±1.8	<0.001*
Transport status			
Self-admitted	212(80.3%)	156 (75.4%)	0.198
Transferred	52(19.7%)	51 (24.6%)	
Appendix status			
Negative exp.	21(8.0%)	7(3.4%)	
Non- complicated	60(22.7%)	35(16.9%)	0.021*
Complicated	183(69.3%) [a]	165(79.7%)[a]	
Length of hospital stay (days)	3.0±2.1	3.0±1.3	<0.001*
Post-operative Complication	20 (10.9%)	19 (11.5%)	618

[a]Denotes a statistically significant difference

Table-2. Symptoms and findings

Variables		Non-pandemic N=264	Pandemic N=207	*p*
Symptoms & Signs	Vomiting	138(52.3%)	120 (58%)	>0.05
	Fever*	167 (%63.3)	76 (36.7%)	<0.05
	Anorexia	129 (48.9%)	186 (89.9%)	>0.05
	RLQ-tenderness	239 (%89.8)	205 (%99)	>0.05
Findings on presentation	X-ray (+)	168 (63.6%)	175 (84.5%)	>0.05
	USG (+)*	140 (53%)	138 (66.7%)	<0.05
	CRP*	50.4±63.8	77.87±79.3	<0.001
	WBC	15770±5368	15868±4873	>0.05

*Denotes a statistically significant difference

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Discussion

The beginning of SARS-CoV-2 pandemic resulted in national quarantine, strict stay-at- home orders and travel restrictions in Turkey. The unusual conditions forced hospitals to focus medical resources and staff on individuals with Covid-19, postpone medical appointments, re-organize outpatient clinics and cancel elective surgical procedures while only focusing on emergency surgeries. Since people were advised not to attend medical care facilities unless absolutely necessary, a general lessening of patients admitted to the ER was observed [8].

Acute appendicitis is the most common abdominal surgical emergency in pediatric population with an estimated life time risk of 7-9% [9]. Despite being a common condition, diagnosis of appendicitis in children is challenging in many cases. The classical presentation includes anorexia, fever and mitigation of abdominal pain from umbilicus to right lower quadrant [10]. Typically, a combination of signs, symptoms, laboratory results and imaging modalities help diagnosis and dictate treatment. Appendicitis is a time-sensitive condition, Delays in presentation may affect all presenting signs, symptoms, investigative results and most likely result in complications such as perforation, abscess formation, sepsis, higher morbidity and increased post-surgical complications [11].

Throughout SARS-CoV-2 pandemic number of studies from various centers identified delayed presentation of appendicitis in children [12-14]. In a study from Italy Lazzerini et al. found decreased pediatric emergency hospital visits during COVID-19 outbreak up to 88% when compared to visits within the same time period in 2018 and 2019 [12] Gerall et al. from Germany, associated this delay to fear of contracting Covid-19 in the hospital setting [13]. Snapiri et al. also reported delayed diagnosis of appendicitis in children from Israel with increased complication rates as much as 22% when compared to same period in previous year [14]. Although fear of exposure to Covid-19 in hospital setting may have played a major role in delay of presentation, there were also multiple additional sources of delay such as shift in majority of medical staff towards, Covid-19 cases, changes in structure of healthcare system and delays in reaching OR due to arrangement of protective equipment resulting with more complicated cases with appendicitis in pediatric population. Testing Covid-19 was still limited at our center during these early phases of the pandemic. Therefore, there was no delays due to awaiting antigen test results.

In our center, when we compared the first year of SARS-CoV-2 pandemic to the previous year, our data showed a significant delay in presentation with increased number of patients treated for complicated appendicitis. Although reported duration of symptoms before presentation is a subjective measure, Increased fever and CRP levels during admission in this period can be explained by delayed presentation with more advanced disease in patients. Through this period, our diagnostic imaging strategies did not change, usage of ultrasound continue to be the dominant method for diagnosis appendicitis in children. As a matter of fact, our diagnostic sensitivity of ultrasound increased during pandemic. This could be explained by advanced state of appendicitis during sonographic imaging due to late presentation, decreased unnecessary work load of sonographers due to cancellation of elective appointments and dedicated work ethics of radiology department working in close contact to potentially Covid-19 positive patients.

During SARS- CoV-2 pandemic some centers in Spain, UK and USA adopted non-operative treatment of uncomplicated appendicitis[15] however our institution did not change its practice of standard operative management. Depending on the preference of the surgeon, we mostly perform laparoscopy to non-complicated cases and save classical open technique for more advanced, complicated cases. This also did not change during the year of SARS-CoV-2 pandemic. Our post-operative medical treatment regimen of intravenous fluids and antibiotics for appendicitis remained the same in both groups but length of hospital stay (LOS) significantly decreased in pandemic period. Possible explanation for shorter LOS is patients' and caregivers' fear of hospitalization due to elevated risk of acquiring Covid-19 and general approach of saving hospital beds for possible Covid-19 cases.

While the rate of complicated appendicitis increases and LOS decrease, one can assume an increase in

rate of postoperative complications nevertheless despite the increased severity patient outcome was unaffected. Traditionally, broad spectrum antibiotics covering Gram-positive, Gram-negative and anaerobic bacteria is administered to patients with perforated appendicitis for as long as ten days[16]. However, newer antibiotics may have decreased the needed duration of antimicrobial therapy also in a randomized prospective study Fraser et al. from USA reported that completing antibiotherapy orally has similar results to I.V. therapy [17]. this may explain our unaffected rates of postoperative complications.

A systemic inflammation entity related to SARS-CoV-2 infection; multisystem inflammatory syndrome in children (MIS-C), may present with symptoms mimicking appendicitis such as; abdominal pain, fever, vomiting, and diarrhea and this may delay the diagnosis of either condition if occurring concomitantly [18]. In our series 4 patients were evaluated for potential MIS-C, one negative exploration case with unimproved post-operative symptoms was diagnosed as MIS-C, transferred to infection clinic and treated accordingly. the other 3 cases were initially treated for MIS-C but further evaluation pointed appendicitis and surgery revealed complicated appendicitis.

The main limitations of this study are its single-center retrospective design and relatively small number of cases. Also our study groups were selected based on the date first Covid-19 positive case was acknowledged in Turkey which we believe represents delayed access to health care. However, if a different date was to be selected this might altered our findings.

As a conclusion, pediatric patients who presented to our center with appendicitis during SARS-CoV-2 pandemic had higher rates of delayed presentation and more severe illness when compared to previous year. Despite late presentation with greater inflammatory response and increased proportions of complicate appendicitis, standards of emergency surgery maintained and pediatric patients were treated efficiently with good outcomes. Besides being a medical challenge, this pandemic provided us an opportunity to update and shorted our course and duration of treatment in appendicitis. We recommend centers treating appendicitis to revisit their duration of post-operative management and if possible, consider shortening length of stay in hospital.

References

1. Sartelli M, Baiocchi GL, Di Saverio S, et al. Prospective Observational Study on acute Appendicitis Worldwide (POSAW). World J Emerg Surg. 2018 Apr 16;13:19. doi: 10.1186/s13017-018-0179-0. PMID: 29686725; PMCID: PMC5902943.
2. Arlt A, Bharti R, Ilves I, et al. Characteristic changes in microbial community composition and expression of innate immune genes in acute appendicitis. Innate Immun. 2015 Jan;21(1):30-41. doi: 10.1177/1753425913515033. Epub 2013 Dec 11. PMID: 24336024.
3. Swischuk LE, Chung DH, Hawkins HK, Jadhav SP, Radhakrishnan R. Non-fecalith-induced appendicitis: etiology, imaging, and pathology. Emerg Radiol. 2015 Dec;22(6):643-9. doi: 10.1007/s10140-015-1338-1. Epub 2015 Aug 21. Erratum in: Emerg Radiol. 2016 Jun;23(3):313-4. PMID: 26293120.
4. Tuech JJ, Gangloff A, Di Fiore F, et al. Strategy for the practice of digestive and oncological surgery during the Covid-19 epidemic. J Visc Surg. 2020 Jun;157(3S1):S7-S12. doi: 10.1016/j.jviscsurg.2020.03.008. Epub 2020 Mar 31. PMID: 32249098; PMCID: PMC7269902.
5. Dong CT, Liveris A, Lewis ER, et al. Do surgical emergencies stay at home? Observations from the first United States Coronavirus epicenter. J Trauma Acute Care Surg. 2021 Jul 1;91(1):241-246. doi: 10.1097/TA.0000000000003202. PMID: 34144567; PMCID: PMC8218982.
6. Tankel J, Keinan A, Blich O, et al. The Decreasing Incidence of Acute Appendicitis During COVID-19: A Retrospective Multi-centre Study. World J Surg. 2020 Aug;44(8):2458-2463. doi: 10.1007/s00268-020-05599-8. PMID: 32458019; PMCID: PMC7250252.
7. Orthopoulos G, Santone E, Izzo F, et al. Increasing incidence of complicated appendicitis during COVID-19 pandemic. Am J Surg. 2021 May;221(5):1056-1060. doi: 10.1016/j.amjsurg.2020.09.026. Epub 2020 Sep 28. PMID: 33012500; PMCID: PMC7521886.
8. Fahrner R, Bähler S, Lindner G. COVID-19 lock-down significantly reduced number of surgical presentations in an emergency department. Wien Klin Wochenschr. 2021 Apr;133(7-8):399-402. doi: 10.1007/s00508-021-01810-5. Epub 2021 Jan 28. PMID: 33507348; PMCID: PMC7841980.
9. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. Am J Epidemiol. 1990 Nov;132(5):910-25. doi: 10.1093/oxfordjournals.aje.a115734. PMID: 2239906.

10. Van den Bogaard VA, Euser SM, Van der Ploeg T, et al. Diagnosing perforated appendicitis in pediatric patients: a new model. J Pediatr Surg. 2016 Mar;51(3):444-8. doi: 10.1016/j.jpedsurg.2015.10.054. Epub 2015 Oct 30. PMID: 26628202.
11. Miyauchi H, Okata Y, Hatakeyama T, Nakatani T, Nakai Y, Bitoh Y. Analysis of predictive factors for perforated appendicitis in children. Pediatr Int. 2020 Jun;62(6):711-715. doi: 10.1111/ped.14148. Epub 2020 Jun 8. PMID: 31957108.
12. Lazzerini M, Barbi E, Apicella A, Marchetti F, Cardinale F, Trobia G. Delayed access or provision of care in Italy resulting from fear of COVID-19. Lancet Child Adolesc Health. 2020 May;4(5):e10-e11. doi: 10.1016/S2352-4642(20)30108-5. Epub 2020 Apr 9. PMID: 32278365; PMCID: PMC7146704.
13. Gerall CD, DeFazio JR, Kahan AM, et al. Delayed presentation and sub-optimal outcomes of pediatric patients with acute appendicitis during the COVID-19 pandemic. J Pediatr Surg. 2021 May;56(5):905-910. doi: 10.1016/j.jpedsurg.2020.10.008. Epub 2020 Oct 19. PMID: 33220973; PMCID: PMC7569380.
14. Snapiri O, Rosenberg Danziger C, Krause I, et al. Delayed diagnosis of paediatric appendicitis during the COVID-19 pandemic. Acta Paediatr. 2020 Aug;109(8):1672-1676. doi: 10.1111/apa.15376. Epub 2020 Jun 8. PMID: 32460364; PMCID: PMC7283758.
15. English W, Habib Bedwani N, Smith C, Shatkar V. Investigation and management of suspected appendicitis during the COVID-19 pandemic. Br J Surg. 2020 Aug;107(9):e337-e338. doi: 10.1002/bjs.11787. Epub 2020 Jul 13. PMID: 32658307; PMCID: PMC7404757.
16. Lund DP, Murphy EU. Management of perforated appendicitis in children: a decade of aggressive treatment. J Pediatr Surg. 1994 Aug;29(8):1130-3; discussion 1133-4. doi: 10.1016/0022-3468(94)90294-1. PMID: 7965520.
17. Fraser JD, Aguayo P, Leys CM, et al. A complete course of intravenous antibiotics vs a combination of intravenous and oral antibiotics for perforated appendicitis in children: a prospective, randomized trial. J Pediatr Surg. 2010 Jun;45(6):1198-202. doi: 10.1016/j.jpedsurg.2010.02.090. PMID: 20620320.
18. Yock-Corrales A, Lenzi J, Ulloa-Gutiérrez R, et al. Acute Abdomen and Appendicitis in 1010 Pediatric Patients With COVID-19 or MIS-C: A Multinational Experience from Latin America. Pediatr Infect Dis J. 2021 Oct 1;40(10):e364-e369. doi: 10.1097/INF.0000000000003240. PMID: 34260501; PMCID: PMC8443421.