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Research article

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The effect of the Covid-19 outbreak on the management of acute appendicitis: A retrospective comparative cohort study

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Abstract

Background/Aim: Covid-19 pandemic (Cov19) has affected the world since December 2019. The management of acute appendicitis (AA) has also changed distinctly during the Cov19 outbreak. The aim of this study is to evaluate and compare the results of AA during the pre-pandemic period and the first wave of the Cov19 outbreak.

Methods: Patients diagnosed with AA from March to July 2019 (pre-pandemic, 2019), and from March to July 2020 (first wave of the pandemic, 2020) were included in this study, and evaluated for age, gender, nationality, length of stay (LOS), ultrasonography (USG), computed tomography (CT) findings, C-reactive protein level (CRP), white blood cell count (WBC), treatment results, operation type, and pathological examination results retrospectively.

Results: One hundred patients from 2019, and seventy-seven patients from 2020 were included in the study. The male ratio, false negative USG, number of CTs performed (especially among conservatively treated patients), CRP levels, the rate of conservative treatment were higher, and LOS was longer among patients treated in 2020 ($P<0.05$ for all). In 2019, 91.8% of the AA operations were performed laparoscopically, whereas in 2020, 73.2% of them were open operations ($P<0.001$). Complicated AA was more frequent in 2019 than in 2020 (12.2% vs 9.8%).

Conclusion: During the Cov19 pandemic, a longer LOS, and a higher ratio of male to female AA patients were observed. CT was more useful during the Cov19 pandemic for diagnosing AA and especially for choosing the suitable patients for conservative treatment. Conservative treatment was preferred more frequently than surgery with a lower recurrence rate in selected uncomplicated patients; and for surgery, the open technique was preferred more frequently during the Cov19 pandemic.

Keywords: Acute appendicitis, Covid-19 pandemic, Conservative treatment, Appendectomy

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Ethics Committee Approval
The ethics committee of Prof. Dr Cemil Taşçıoğlu City Hospital (16 June 2020 date and 249 number)
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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Introduction

Covid 19 (Cov19) pandemic, which started in December 2019 in Wuhan, China, affected the world from January 2020 until today. All healthcare services and staff had to deal with Cov19 patients due to the high intensity and severity of disease. Curfew, the flexible working hours of health institutions and the risk of Cov19 contamination from hospitals caused decreased admission of patients to the hospital and increased the number of more complicated diseases [1]. In addition, treatment algorithms of surgery, as well as emergency surgery, were changed to protect the patients, health professionals and critical resources, namely, hospital and intensive care unit (ICU) beds [2].

Acute appendicitis (AA) is the most common emergency surgery disease and mostly treated with surgical intervention. Detailed examination and imaging have become more important and difficult due to complaint of abdominal pain, vomiting, diarrhea, and fever which are the gastrointestinal symptoms of Cov19 as well as AA [3]. Appendectomy is the surgical treatment of AA and is performed with the open (OA) or laparoscopic (LA) methods. LA has fewer wound infections and post-operative pain, shorter length of hospital stays and earlier return to work; however, the intra-abdominal abscess rate is higher than OA. Conservative treatment of acute appendicitis is recommended in selected uncomplicated patients with 41-85% effectiveness and 20% recurrence rate [4]. Conservative treatment or OA was recommended during the initial stages of the Cov19 outbreak by some study groups [5]. This study aimed to compare the differences in the management of acute appendicitis during the Cov19 pandemic with the same period a year ago.

Materials and methods

After receiving institutional approval from the ethics committee of Prof. Dr Cemil Taşçıoğlu City Hospital (16 June 2020 date and 249 number), the accessible records of AA patients from March 2019 to July 2019, and from March 2020 to July 2020, were evaluated retrospectively.

The period from March to July 2020, the first wave of the Cov19 pandemic, is hereinafter referred to as the pandemic, and the one from March to July 2019, the same period a year ago, is hereinafter referred to as the pre-pandemic period.

Patients' age, gender, nationality, length of hospital stays (LOS), ultrasonography (USG), and computed tomography (CT) findings, white blood cell (WBC) count, C-reactive protein (CRP) levels, and treatment were evaluated in terms of the pandemic and the pre-pandemic period retrospectively. The nationality criterion was classified as a citizen or a noncitizen. USG and CT criteria were classified as not performed, performed but negative, performed and positive, and the diameter of appendix was evaluated from the USG or the CT result. Treatment was evaluated as conservative or operated. Patients' results were evaluated according to the treatment type in the pandemic and the pre-pandemic period.

Operated patients were additionally evaluated according to the operation type, pathology, pathological diameter of the appendix, luminal pathology, and additional pathology comparing the pandemic and the pre-pandemic periods. The operation type was evaluated as laparoscopic, open, or laparoscopic converted to open. Pathological examination results were categorized as acute appendicitis, phlegmonous appendicitis, suppurative appendicitis and complicated appendicitis (appendicitis which is complicated by a local or contained perforation with an appendiceal abscess or mass formation). Luminal pathology was evaluated as fecaloid and obliterated. Additional pathology was evaluated as neuroma, serrated adenoma, diverticulum, and neuroendocrine tumor.

Statistical analysis

Statistical analysis was performed with SPSS 16.0 (Chicago, SPSS Inc.). Age (years), LOS (days), USG diameter (mm), CT diameter (mm), CRP (mg/dl), WBC (10^6/uL), and pathological diameter (mm) were presented as mean (SD). Nonparametric values were evaluated with the Mann Whitney U test, and parametric values were evaluated with the t-test. $P<0.05$ was considered significant.

Results

One hundred patients from the pre-pandemic period and seventy-seven patients from the pandemic were included in the study. The mean age was 34.4 (13.9) in the pre-pandemic period, and 34.7 (15.7) during the pandemic ($P=0.87$). During the pandemic, the percentage of male patients was higher, and the percentage of noncitizen patients was lower. The mean LOS was 1.45 (1.1) days in the pre-pandemic period, and 2.48 (1.8) days during the pandemic. The difference in gender distribution, nationality and LOS were significant ($P=0.002$, $P=0.024$, and $P<0.001$ respectively) (Table 1). While USG was preferred more often in the pre-pandemic period, CT was preferred more often during the pandemic (Table 1). There was no significant difference in the mean appendix diameter on USG and CT between the two periods ($P=0.394$, and $P=0.157$ for USG and CT results respectively) (Table 1). The mean CRP in the pre-pandemic and pandemic periods were 56.7 (75.1) mg/dl and 93.4 (97.9) mg/dl, respectively ($P=0.006$). There was no significant difference in WBC counts between the pre-pandemic and pandemic periods (Table 1).

Table 1: The results of patients by period

Parameters	Pre-pandemic		Pandemic		*P*-value
Age*	34.4(13.9)		34.7 (15.7)		0.87
Gender	n	%	n	%	0.002
Female	38	38	13	16.9	
Male	62	62	64	83.1	
Nationality	n	%	n	%	0.024
Citizens	82	82	72	93.5	
Noncitizens	18	18	5	6.5	
LOS*	1.45 (1.1)		2.48 (1.8)		<0.001
USG	n	%	n	%	0.001
Not Performed	0	0	6	7.8	
Performed	100	100	71	92.2	
USG Diameter*	9.5 (2.1)		9.9 (3.3)		0.394
CT	n	%	n	%	<0.001
Not Performed	57	57	21	27.3	
Performed	43	43	56	72.3	
CT Diameter*	11.5 (2.8)		10 (4.1)		0.157
WBC*	15.1 (4.4)		14.6 (4.3)		0.51
CRP*	56.7 (75.1)		93.4 (97.9)		0.006
Treatment	n	%	n	%	<0.001
Conservative	2	2	36	46.8	
Operated	98	98	41	53.2	

*Median (standard deviation), LOS: Length of Stay, USG: Ultrasonography, CT: Computed Tomography, WBC: White Blood Cell, CRP: C-Reactive Protein

In the pre-pandemic period, the mean age of the conservatively treated patients was 63.5 (7.8) years, while that of the operated ones was 33.8 (13.3) years. The difference in age was statistically significant ($P=0.002$). There was no significant

difference in gender, nationality, and LOS between the conservatively treated and operated patients during this period (Table 2). None (0/2) of the conservative, 27.3% (27/98) of the operated had negative USG findings (P=0.549). None (0/2) of the conservative and 58.2% (57/98) of the operated had no CT; 0% (0/2) of the conservative, 7.3% (3/41) of the operated had negative CT findings (P=0.162). There was no significant difference in the mean appendix diameter in USG and CT, WBC levels, and CRP levels between the conservatively treated and operated patients (P=0.771, P=0.443, P=0.185, and P=0.668 respectively) (Table 2).

During the pandemic, there was no significant difference in age, gender, nationality, or LOS between the conservatively treated and operated patients. 8.3% (n=3) of the conservative, 7.3% (n=3) of the operated had no USG; 42.4% (14/33) of the conservative, 44.7% (17/38) of the operated had negative USG findings (P=0.936). Four (11.1%) of the conservative and 41.5% (n=17) of the operated had no CT; 12.5% (4/32) of the conservative, 12.5% (3/24) of the operated had negative CT findings. The difference in those without CTs was statistically significant (P=0.007). Like it was the case in the pre-pandemic period, there was no significant difference in the mean appendix diameter in USG and CT, WBC levels, and CRP levels between the conservatively treated and operated patients (P=0231, P=0.854, P=0.069, and P=0.441 respectively) (Table 2).

Table 2: The results of patients by period with treatments

Parameters	Pre-Pandemic			Pandemic		
	Conservative	Operated	*P*	Conservative	Operated	*P*
Age*	63.(7.8)	33.8 (13.3)	0.002	38.3 (17.9)	31.6 (12.8)	0.063
Gender	n %	n %	0.782	n %	n %	0.208
Female	1 50	37 37.8		4 11.1	9 22.0	
Male	1 50	61 62.2		32 88.9	32 78.0	
Nationality	n %	% %	0.679	n %	n %	0.542
Citizens	2 100	80 81.6		33 91.7	39 95.1	
Noncitizens	0 0	18 18.4		3 8.3	2 4.9	
LOS*	1.5 (0.7)	1.45 (1.1)	0.947	2.81 (1.6)	2.2 (1.8)	0.133
USG	n %	n %	0.549	n %	n %	0.936
Not Performed	0 0	0 0,0		3 8.3	3 7.3	
Performed	2 100	98 100		33 91.7	38 92.7	
USG Diameter*	9.1 (1.3)	9.5 (2.1)	0.771	9.3 (1.6)	10.6 (4.3)	0.231
CT	n %	n %	0.162	n %	n %	0.007
Not Performed	0 0	57 58.2		4 11.1	17 41.5	
Performed	2 100	41 41.8		32 88.9	24 58.5	
CT Diameter*	10 (1.4)	11.6 (2.9)	0.443	9.9 (4.1)	10.1 (4.3)	0.854
WBC*	11 (0.4)	15.1 (4.4)	0.185	13.7 (3.5)	15.5 (4.8)	0.069
CRP*	34.1 (40)	57.2 (75.7)	0.668	102.6 (82.8)	85.1 (110)	0.441

* Mean (Standard Derivation), LOS: Length of Stay, USG: Ultrasonography, CT: Computed Tomography, WBC: White Blood Cell, CRP: C-Reactive Protein

Evaluation of the results of operated patients by period revealed that 91.8% (n=90) in the pre-pandemic period had LA, whereas 73.2% (n=30) in the pandemic had OA (P<0.001) (Table 3).

Out of the conservatively treated patients during the pandemic, only two patients (5.5%) had recurrence in the 6 months that followed the treatment. More specifically, one recurred in 13 days, and the other in 29 days. Both patients were treated conservatively again.

The occurrence rate of any of the evaluated pathologies, namely, perforated appendicitis (P=0.818), obliterated appendicitis or fecaloid (P=0.13), and diameter of appendix (P=0.925) were similar between the two periods. The pathology results by period are shown in Table 3 (Figure 1).

Figure 1: Surgical and pathological results of operated patients by period

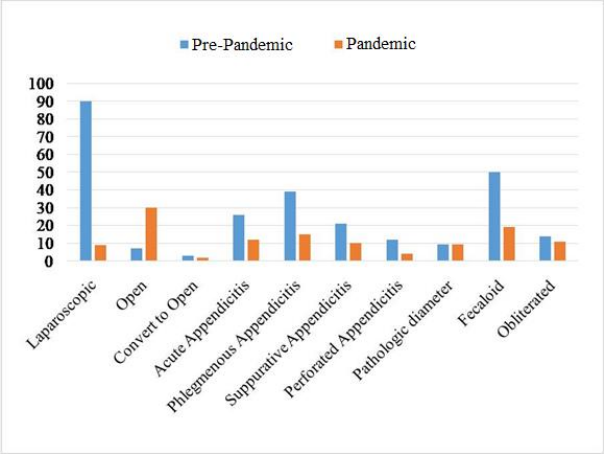

Table 3: The results of operated patients by period

Parameters	Pre-Pandemic		Pandemic		*P*-value
Type of operation	n	%	n	%	<0.001
Laparoscopic	90	91.8	9	22	
Open	7	7.1	30	73.2	
Laparoscopic convert open	3	3.1	2	4.8	
Pathology	n	%	n	%	0.818
Acute appendicitis	26	26.5	12	29.3	
Phlegmonous appendicitis	39	39.8	15	36.6	
Suppurative appendicitis	21	21.4	10	24.4	
Perforated appendicitis	12	12.2	4	9.8	
Pathologic diameter *	9.4 (2.3)		9.5 (3)		0.925
Luminal pathology	n	%	n	%	0.13
Fecaloid	50	51	19	46.3	
Obliterated	14	14.3	11	26.8	
Added pathology	n	%	n	%	0.004
Neuroma	0	0	1	2.4	
Serrated adenoma	1	1	2	4.9	
Diverticulum	0	0	4	9.8	
Neuroendocrine tumor	1	1	0	0	

* Mean (Standard Derivation)

Discussion

Appendicitis occurs with luminal obstruction of the appendix by lymphoid hyperplasia (related to viral illnesses, upper respiratory infection, mononucleosis, and gastroenteritis), appendicoliths, parasites, foreign bodies, Crohn's disease, cancers or carcinoid syndrome [6]. Appendicitis which occurs by lymphoid hyperplasia or spontaneous passage of appendicolith can heal without an appendectomy [7]. However, phlegmonous, suppurative, or complicated appendicitis (gangrenous, perforated or with abscess) require appendectomy [8].

The most common emergency surgical disease was AA with 31.84%, followed by anal abscess with 13.8%, and acute cholecystitis with 9.45% during the first wave of the Cov19 pandemic [9]. Tankel et al. [10] reported a decreasing incidence of AA during Cov19. During the Cov19 pandemic, the ratio of AA patients to the total number of patients admitted to the emergency department increased (1.35% (77/5707) vs. 1.16% (100/8624)) in our hospital.

Romero et al. [11] and Finkelstein et al. [12] reported the mean age as 38.2 and 41 years, respectively, in the pre-pandemic period, and as 36.6 and 44 years, respectively, during the pandemic. They stated that female was the most common gender with 52% and 73%, respectively, before the pandemic, and 56% and 61.8%, respectively, during the pandemic. There was no significant difference in terms of age and gender in the comparative studies about AA during the Cov19 pandemic. Also, there was no difference in the mean age of acute care surgery patients between the pre-pandemic and pandemic periods; however, there was a significant change in the most common gender between the periods with female being the most common

gender with 50.9% before the pandemic, but male being the most common gender with 66.6% during pandemic [9]. There was no difference in terms of age and gender (higher male ratio) between the conservatively treated or operated patients by period [13, 14]. The rate of noncitizen AA patients our previous study was 15.1% (95/628) from 2014 to 2018 [15].

In our study the mean age was 34.4 (13.9) in the pre-pandemic, and 34.7 (15.7) in the pandemic period. There was no difference in age between conservatively treated and operated patients during the pandemic; however, conservatively treated patients were older before the pandemic. Eighteen percent (n=18) and 6.5% (n=5) of the patients were non-citizens during the pre-pandemic and pandemic periods, respectively. Third decade and male gender were the risk groups of AA during the pandemic for both conservatively treated and operated patients. Travel bans significantly decreased the rate of noncitizen AA patients during the pandemic.

Lower length of hospital stay is desired and favored during the pandemic to decrease the contamination of Cov19 and to empty the beds for a new outbreak. Some studies reported no differences in LOS between these periods [16-17]; however, Kvasnovsky et al. [18] reported a significantly higher LOS for AA during the pandemic. Conservatively treated AA patients had longer LOS than the operated patients in both periods [14, 19]. In our study, LOS was significantly higher among all AA patients during the pandemic. Conservatively treated patients in both periods had insignificantly longer LOS. During the pandemic, the number of conservatively treated patients was higher than the surgically treated, hence, a longer LOS was expected.

History and physical examination are the essential parameters for diagnosing and differential diagnosing acute abdominal pain (AAP) as well as AA with 43-59% accuracy. Plain radiographies have limited indication for diagnosing AAP, USG is the initial imaging with advantages of ease of accessibility, cheaper cost, and safety. The correct diagnosis rates of AAP in USG and CT were 53-83%, and 61.6-96%, respectively. The sensitivity and specificity of diagnosing AA by USG were 76% and 95%, respectively, and 99% and 84%, respectively, for CT imaging [20, 21]. Cov19 has gastrointestinal symptoms which mimic AAP such as AA, and CT becomes more useful and important for diagnosing AA during the Cov19 outbreak [22]. Somers et al. [23] reported that the rate of imaging used for AA was 70.27% in the pre-pandemic, and 89.9% in the pandemic periods. CT was the most common imaging method used for AA with 54.05% during the pre-pandemic, and 69.64% during the pandemic periods; however, USG was used in 10.8% before the pandemic, in 12.5% during the pandemic. Antakia et al. [16] reported a significant decrease in USG use (16.5% vs 24.1%); however, a significant increase was observed in CT use (87.5% vs 69.8%) during the pandemic for AA imaging. The diameter of the appendix being ≥ 7mm was a sign of AA. In our study, USG was performed to all AA patients during the pre-pandemic period but was performed to 92.2% of AA patients in the pandemic with a higher false negativity rate (27% vs 40.3%). CT was performed more frequently during the pandemic (72.3% vs 43%), with higher false negativity rates (12.5% vs 7%). The performance and false negativity rates of USG were similar for the conservatively treated and operated patients in both periods, but CT was preferred more frequently, especially for conservatively treated patients during the pandemic. The diameter of the appendix at both USG and CT during both periods was not a predictor for surgery.

WBC and CRP are the most common inflammatory markers for diagnosis, and also a part of scoring system which is used to diagnose and predict the severity of AA. WBC ≥ $14x10^6$u/l, and CRP > 5mg/dl supports the diagnosis of AA [24]. In previous studies, there is contradicting results for differences in WBC and CRP levels between the two periods. Gannesh et al. [25] reported lower levels of WBC (12.9 vs 13.2 $x10^9$/L), and higher levels of CRP (82 vs 69 mg/dl), but Mai et al. [26] reported higher levels of WBC (14 vs 12.2 $x10^9$/L), and lower levels of CRP (43 vs 56 mg/dl) in AA during the pandemic. Lower WBC and CRP were reported for conservatively treated AA both in the pre-pandemic (14.2 vs 15.3 $x10^9$/L, and 25.9 vs 64.8 mg/dl respectively), and the pandemic periods (12.5 vs 15.9 $x10^9$/L, and 24.5 vs 50 mg/dl respectively) [13, 14]. In our study, overall WBC levels were insignificantly lower during the pandemic, while overall CRP levels were higher. CRP levels were also higher independently for both the conservatively treated and operated patient groups during the pandemic. Another observation was that while in the pre-pandemic period, the mean CRP levels of the operated patients were higher than those of conservatively treated patients, it was the opposite in the pandemic period. However, since the number of conservatively treated patients was only 2 in the pre-pandemic period, no statistical analysis was performed on this observation.

Nonoperative treatment for uncomplicated and selected AA is recommended and have been a part of guidelines, with 27.4% recurrence rate in one year. Hansson et al. [27] reported that AA patients with CRP <60 g/L, WBC <12 × 10^9/L, and age <60 years could be treated conservatively with 89% accuracy [21]. The management algorithms of emergency disease have changed during Cov19 [28, 29]. The management of acute appendicitis involves, if possible, conservative treatment as an outpatient, short hospitalization, operation with an open technique and under regional anesthesia [16]. AA was managed conservatively in 5.4-22.2% of the patients during the pre-pandemic period, which increased to 7.8-100% during the pandemic [30]. In our study, conservative treatment was performed in 46.8% (36/77) of the AA patients with 5.5% (n=2) recurrence rate during the pandemic.

Phlegmonous, suppurative, and complicated AA were treated surgically. LA was performed more frequently than OA for AA recently, with lower postoperative pain, LOS, wound infection, and higher intraabdominal abscess rate. Sixty to eighty percent of the appendectomies were performed laparoscopically in tertiary centers with 1-2 days LOS, and 1-3% complication rate [31]. Javanmard-Emamghissi et al. [32] reported the OA rate as 56.1%, and conversion to open surgery rate as 10.7%; however, Lotfallah et al. [14] reported the OA rate as 35.5% and conversion to open surgery rate as 3.2% during the pandemic. In our study, while 91.2% of the AA underwent LA in the pre-pandemic with 3.1% conversion rate, OA was performed in 72% of the AA patients during the pandemic.

Gao et al. [33] reported an increased rate of complicated appendicitis due to delayed admission or surgery and decreased

intention to seek treatment at Cov19. Fonseca et al. [17] reported the rate of complicated AA as 15.2% in the pre-pandemic period, and as 33.3% during the pandemic. In our study, the lower rate of complicated AA and luminal pathology implied the accurate indication and timing of appendectomy during the pandemic.

Limitation

The main limitation of this study was the fact that it was not a prospective randomized controlled trial. The number of conservatively treated patients during the pre-pandemic was only two, therefore, conservatively treated patients could not be evaluated statistically. Also, the differences in the management of AA patients during the initial and later stages of the Cov19 pandemic should be evaluated.

Conclusion

During the first wave of the Cov19 pandemic, the ratio of AA patients to the total number of patients admitted to the emergency department was larger compared to the pre-pandemic period. The mean LOS was longer, and a higher ratio of male to female AA patients was seen in our department. USG had no effect on choosing conservative or surgical treatment; however, CT was particularly useful for the diagnosis of AA and choosing suitable patients for conservative treatment, and it was performed more frequently during the Cov19 pandemic. CRP levels of conservatively treated AA patients increased in the Cov19 pandemic. We saw more patients being treated with no surgery with lower recurrence rates for selected uncomplicated cases during the pandemic. The open surgical technique was performed more often. As a result, even though surgery is the widely accepted method for treating AA for centuries, this study, albeit limited, suggests that in conditions where the resources of a hospital may be limited, the treatment of uncomplicated AA can be managed conservatively with a low recurrence rate.

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