

Research Article

Comparative analysis of acute appendicitis cases during and prior to the pandemic: A retrospective cohort study

Pandemi dönemi ve öncesinde akut apandisit olgularının karşılaştırmalı analizi: Retrospektif bir kohort çalışması

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Abstract

Aim: This study aimed to compare the clinical characteristics, morbidity, and diagnostic accuracy of imaging modalities in acute appendicitis cases during the COVID-19 pandemic and the pre-pandemic period.

Materials and Methods: We retrospectively analyzed the records of 898 patients who underwent surgery for acute appendicitis between April 2019 and April 2021. The study population was divided into two groups: pre-pandemic (n=508; April 2019 to April 2020) and pandemic (n=390; April 2020 to April 2021). We compared the socio-demographic characteristics, clinical features, morbidity rates, and the diagnostic accuracy of ultrasonography (USG) and computed tomography (CT) between the two periods.

Results: The prevalence of complicated cases was significantly higher during the pre-pandemic period (29.3%) compared to the pandemic period (15.6%). The morbidity rate was also significantly higher in the pre-pandemic period. ($p=0,004$) The sensitivity of USG in diagnosing appendicitis decreased during the pandemic period, while CT scans remained more sensitive than USG in both periods. (sensitivity = 0.93, specificity = 0,67) The prevalence of chronic diseases was significantly higher during the pandemic period.

Conclusion: Our study revealed that the prevalence of complicated appendicitis cases was significantly higher during the pre-pandemic period compared to the pandemic period. Additionally, the sensitivity of ultrasonography in diagnosing appendicitis decreased during the pandemic, while CT scans maintained their sensitivity across both periods. Based on our findings, we can confidently conclude that the pandemic does not exacerbate the severity of acute appendicitis cases.

Keywords: acute apendicitis, pandemic, radyology, morbidity,management

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Öz

Amaç: Bu çalışma, COVID-19 pandemisi sırasında ve pandemi öncesi dönemde akut apandisit vakalarında klinik özellikler, morbidite ve görüntüleme yöntemlerinin tanısal doğruluğunu karşılaştırmayı amaçlamıştır.

Gereç ve Yöntemler: Nisan 2019 ile Nisan 2021 arasında akut apandisit nedeniyle ameliyat olan 898 hastanın kayıtları retrospektif olarak analiz edilmiştir. Çalışma popülasyonu iki gruba ayrılmıştır: pandemi öncesi (n=508; Nisan 2019 - Nisan 2020) ve pandemi (n=390; Nisan 2020 - Nisan 2021). İki dönem arasında sosyodemografik özellikler, klinik özellikler, morbidite oranları ve ultrasonografi (USG) ile bilgisayarlı tomografi (BT) tanısal doğruluğu karşılaştırılmıştır.

Bulgular: Komplike vakaların prevalansı, pandemi öncesi dönemde (%29.3) pandemi dönemine (%15.6) göre anlamlı olarak daha yüksekti. Morbidite oranı da pandemi öncesi dönemde anlamlı olarak daha yüksekti. (p= 0,004) USG'nin apandisit teşhis etmedeki duyarlılığı pandemi döneminde azalmış, ancak BT taramaları her iki dönemde de USG'den daha duyarlı kalmıştır (sensitivite = 0.93, spesifite = 0,67) . Kronik hastalıkların prevalansı pandemi döneminde anlamlı olarak daha yüksekti.

Sonuç: Çalışmamız, komplike apandisit vakalarının prevalansının pandemi öncesi döneme göre pandemi döneminde anlamlı olarak daha düşük olduğunu ortaya koymuştur. Ayrıca, apandisit teşhis etmede ultrasonografinin duyarlılığı pandemi döneminde azalmış, ancak BT taramaları her iki dönemde de duyarlılıklarını korumuştur. Çalışmamızın sonuçlarına dayanarak, pandemi döneminde apandisit vakalarının daha komplike hale gelmediğini ifade edebiliriz.

Anahtar Kelimeler: akut apandisit, pandemi, radyoloji, morbidite, yönetim

Introduction

Appendicitis is a surgical condition that can affect individuals of any age, with incidence rates of 5.86% in men and 6.9% in women [1-3]. The appendectomy, a crucial component of emergency surgery, can be performed laparoscopically or openly. Due to the pandemic, it is not anticipated that the incidence of appendicitis will decrease, and there are numerous reports in the literature that cases of appendicitis become more complicated or less complicated during the pandemic period [4-9].

The COVID-19 infection, which originated in China-Wuhan in late 2019 and spread around the world in a period of weeks, has resulted in significant changes in order to protect the capacity of the health system for pandemic patients and patients with non-pandemic emergencies. Elective surgical procedures had been postponed in this situation, and conservative treatments were recommended wherever feasible [10-12].

In this study, we aim to perform a comparative analysis of acute appendicitis cases during and prior to the pandemic, to better understand its impact on patient outcomes and healthcare systems. We hope to identify potential changes in clinical practice and patient outcomes that may have resulted from the pandemic by comparing these two time periods. Our findings will be remarkable in informing future strategies for the management of acute appendicitis during times of crisis and guiding surgical care policy decisions.

Material and Methods

Ethics

This clinical study was approved by the Bursa Yüksek İhtisas Research and Training Hospital Ethics Committee with confirmation number 2011-KAEK-25 2022/05-03.

Data Collection and Patient Grouping

Acute appendicitis cases that underwent surgery one year before 20.04.2020, when the quarantine application started in our country due to the pandemic, and one year afterwards, were analysed as two separate groups. In a two-year period, the hospital data system revealed a total of 907 appendectomy cases, of which 9 patients were excluded because none of their parameters could be met. The study included patients for whom we had access to any pathological, radiological, laboratory, or clinical data. (Figure 1) After classifying patients as pre-pandemic or pandemic, demographic (age, gender, nation), pathological (based on reports), laboratory [White Blood Cell (wbc, 103/mm³), Lymphocyte (lym, 103/mm³), Neutrophil (neu, 103/mm³), Neutrophil/Lymphocyte Ratio (nlr), C reactive peptide (crp, mg/L), Total Bilirubin (mg/dl), Mid-platelet Volume (mpv, fL), Platelet (plt, 103/mm³)] and radiological parameters, as well as clinical course (symptom duration, length of the stay, morbidity, mortality) were compared.

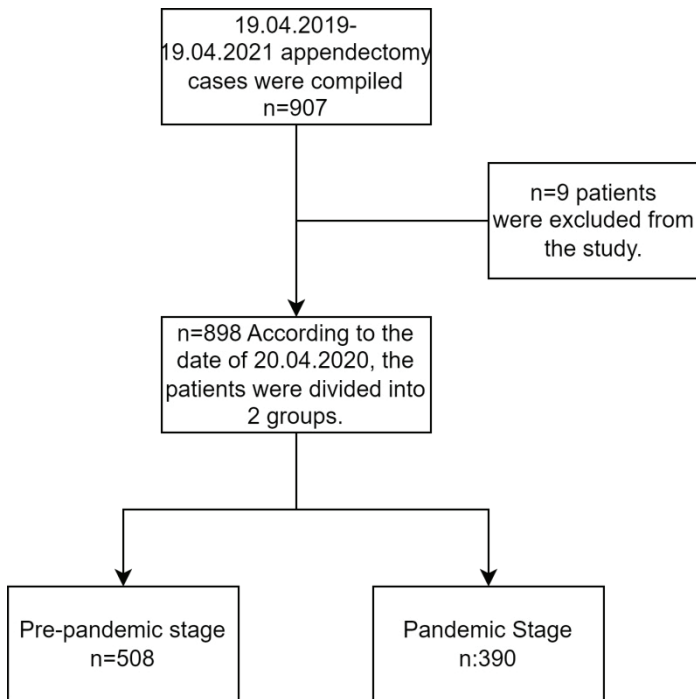


Figure 1. Study design flowchart

The primary outcome of the study was to determine whether complicated appendicitis cases were significantly higher during the pandemic. The secondary outcome was a cross-period assessment of the consistency of radiological and pathological data.

The Emergency Surgery Protocol under the COVID-19 Pandemic in Our Hospital

Each patient with a pre-diagnosis of acute appendicitis was evaluated by direct examination in the emergency department. After the diagnosis of acute appendicitis by clinical, laboratory and radiological evaluation, each patient evaluated in the emergency department was accepted as COVID+ and taken to the isolated-negative pressured operating room. Routine COVID PCR was not available in our hospital.

Surgical Method

The type of operation was determined according to the surgeon's own preference. At the beginning of the pandemic period, open operation was preferred due to the possibility of virus transmission through laparoscopic system-induced inhalation. Later, after the publication stated that there was no evidence about this in the literature, laparoscopic surgeries were continued in our clinic.

Definition of the Terms Used in This Study

The distinction between complicated and non-complicated appendicitis was determined according to the clinical course

of the patient and pathological result. Patients were classified as complicated if they required a stay in the hospital longer than two days, had surgical morbidity, or had perforated or malignant appendicitis (as a pathological result).

Statistics

Sociodemographic and clinical characteristics of individuals were calculated as frequencies and percentages for categorical data using descriptive statistical methods. Numerical data are expressed as mean \pm standard deviation values. To find out whether there was a relationship between in categorical variables, the Chi-square or Fisher's Exact Test was used. Normality distribution of numerical data was assessed using the Shapiro-Wilk test. Mean differences between two groups with normally distributed will be compared by Student's t-test, whereas the Mann-Whitney U test will be applied for comparisons of the not normally distributed data. Imaging devices equipment (USG and BT) were investigated by using the Kappa statistics. Weighted kappa statistics were used to determine the degree of agreement after correction for the agreement expected by chance. The kappa statistic was interpreted as follows: less than 0.00, poor agreement; 0.00-0.20, slight agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, substantial agreement; and 0.81-1.00, almost perfect agreement. The relationship between the parameters was evaluated at the spearman statistical significance. SPSS (Statistical Package for the Social Sciences, SPSS Inc., Chicago, IL, USA) version 25.0 package program was used for the data analysing. $p < 0.05$ were considered as statistically significant.

Results

The distribution of the cases' general characteristics is shown in Table 1. The average age of the patients was 35.25 ± 12.93 , the average length of hospitalization was 2.61 ± 1.89 days, and the average length of admission was 1.6 day. 577 (64.3%) of the patients were male, 799 (89%) were Turkish citizens and 711 (%81) underwent open surgery.

In Table 1, 13 patients could not be evaluated for the clinical course section due to lack of documentation. Due to the inaccessibility of the operation data for five patients, the total number of patients in the procedure type variable is 893. A total of 880 patients could be evaluated in the pathology report section because the pathology reports of 2 patients were malignant, 4 patients were low grade dysplasia, and 7 patients' pathology reports could not be accessed.

Table 1. Distribution of general and socio-demographic characteristics of the cases

	n(%) / mean±sd
Stage	
I. Pre-pandemic	508 (56,6)
II. Pandemic	390 (43,4)
Gender	
Male	577 (64,3)
Female	321 (35,7)
Age	35,25±12,93
Symptom duration (day)	1,68±1,41
Length of the stay (day)	2,61±1,89
Nation	
Turkish	799 (89)
Immigrant	99 (11)
Procedure type	
Open	711 (79,6)
Laparoscopic	182 (20,4)
Transition to open operation	
Yes	7 (3,7)
None	182 (96,3)
Ultrasonographic evaluation (usg)	
Normal	352 (64,8)
apandicitis	191 (35,2)
Computed Tomography Evaluation (ct)	
Normal	60 (8)
Apandicitis	692 (92)
Pathologic evaluation	
Lymphoid Hyperplasia	47 (5,3)
Apandicitis	833 (94,7)
Clinical classification	
Complicated	207 (23,4)
Non complicated	678 (76,6)
Morbidity of patients	
Hypertension	17 (1,9)
Diabetes Mellitus	16 (1,8)
Cardiac Morbidity	15 (1,7)
Others	41 (4,6)
None	800 (90)
Surgical Morbidity	
Exist	22 (6,3)
Absent	328 (93,7)
Surgical Mortality	
Exist	1 (0,1)
None	890 (99,9)

sd:standard deviation

The pre-pandemic and pandemic socio-demographic and clinical characteristics of the cases were compared (Table 2). The mean age, crp, mpv, symptom duration and length of hospital stay were significantly different in the two periods ($p < 0.05$). In the pre-pandemic period, the mean age of the admitted patients was 36.7 ± 13.18 ; the mean of the admission period was $1.84 \pm$

1.07; and the mean of the hospital stay was 2.80 ± 2.09 . During the pandemic period, it was determined that the Crp levels of the cases were 22.94 ± 48.51 and the average of the mpv values was 9.75 ± 1.38 higher. The prevalence of complicated appendicitis was 147 (29.3%) in the pre-pandemic period, significantly higher than the prevalence of complicated appendicitis in the pre-pandemic period compared to 60 (15.6%) ($p < 0.01$). During the pandemic period, there was a statistically significant increase in open appendectomy ($p < 0.01$).

The prevalence of chronic diseases in cases during the pandemic period was 50 (13.1%) and the pre-pandemic period was significantly higher than the pre-pandemic prevalence of chronic diseases of 39 (7.7%). In addition, the incidence of morbidity in cases during the pre-pandemic period was seen at a significantly higher value ($p < 0.004$).

Our clinic recorded 22 morbidities following appendectomy, including wound infection (7), collection at the surgical site (3), stump leakage (1), hypertensive attack (3), respiratory issues (4), evisceration (1), and subileus (3).

In two patients during the pre-epidemic period, the pathology report was malignant.

The patient who died was a 67-year-old diabetic with chronic renal failure and intra-abdominal abscess who underwent surgery. The patient died of multiorgan failure due to sepsis on the seventh day after surgery.

The sensitivity and specificity values of USG and CT imaging were examined, with pathology reports being the gold standard in the diagnosis of pre-pandemic and pandemic-period appendicitis (Table 3). The sensitivity and specificity of radiological methods were assessed by comparing them with the pathology report, which provides the main consequence, as well as the radiological reports. When the concordances of USG and CT diagnoses were examined in the pre-pandemic period, it was observed that the sensitivity value of USG was 0.38 and the specificity value was 0.75 in the diagnosis of appendicitis, while the sensitivity value of CT was 0.92 and the specificity value was 0.79. In the pre-pandemic period, CT diagnosis was seen as a more sensitive diagnosis compared to USG.

During the pandemic period, the sensitivity value of USG in the diagnosis of appendicitis was 0.29 and the specificity value was 0.83, while the sensitivity value of CT was 0.93 and the specificity value was 0.67. During the pandemic period, CT diagnosis was seen to be a more sensitive diagnosis compared to USG. During the pandemic period, a decrease in the sensitivity value of USG was observed.

Table 2. Comparison of the characteristics and clinical course of the cases in terms of periods

Variables		I. Pre-pandemic Stage	II. Pandemic Stage	p
Gender n (%)	Male	320 (63)	257 (65,9)	0,368
	Female	188 (37)	133 (34,1)	
Age (mean±sd)		36,70± 13,18	33,36 ± 12,37	<0,001
Symptom duration (mean±sd)		1,84± 1,07	1,41 ± 1,82	<0,001
Length of the stay (mean±sd)		2,80± 2,09	2,35 ± 1,56	<0,001
White blood cell (wbc) (mean±sd)		16,43± 9,21	13,74 ± 4,24	<0,001
Lymphocyte (lym) (mean±sd)		2,28± 4,29	3,44 ± 17,73	0,161
Neutrophil (neu) (mean±sd)		10,92± 4,74	10,71 ± 4,41	0,524
Neutrophil/Lymphocyte Ratio (nlr) (mean±sd)		7,07± 5,93	6,99 ± 5,69	0,841
C reactive peptide (crp) (mean±sd)		14,85±47,44	22,94±48,51	<0,001
Bilirubin (mean±sd)		0,73±1,05	0,71 ± 0,7	0,792
Mid-platelet Volume (mpv) (mean±sd)		9,38±1,90	9,75±1,38	0,004
Platelet (plt) (mean±sd)		258,52±84,78	256,70±72,79	0,739
Nation n (%)	Turkish	452 (89)	347 (89)	0,999
	Immigrant	56 (11)	43 (11)	
Pregnancy n (%)	Exist	4 (0,8)	4 (1)	0,733
	None	504 (99,2)	386 (99)	
Operation type n (%)	Open	380 (74,8)	331 (86)	<0,001
	Laparoscopic	128 (25,2)	54 (14)	
Clinical course n (%)	Complicated	147 (29,3)	60 (15,6)	<0,001
	Non complicated	354 (70,7)	324 (84,4)	
Chronic Disease n (%)	Exist	39 (7,7)	50 (13,1)	0,001
	Absent	468 (92,3)	332 (86,9)	
Morbidity n (%)	Exist	19 (5,5)	3 (0,8)	0,004
	None	328 (94,5)	387(99,2)	
Mortality n (%)	Exist	1 (0,2)	0 (0)	0,999
	None	506 (99,8)	384 (100)	

I. Stage :Pre-pandemic, II. Stage: Pandemic

Table 3. Examination of USG and CT diagnostic evaluation performances of the cases in periods

			Pathology			Sensitivity	Specificity
			Apandicitis n (%)	Normal n (%)	Total n (%)		
I	USG	Apandicitis	151 (38,1)	8 (25)	159 (37,1)	0,38	0,75
		normal	245 (61,9)	24 (75)	269 (62,9)		
		Total	396 (100)	32 (100)	428 (100)		
	CT	Apandicitis	322 (92)	6 (20,7)	348 (91,8)	0,92	0,79
		normal	28 (8)	23 (79,3)	31 (8,2)		
		Total	350 (100)	29 (100)	379 (100)		
II	USG	Apandicitis	29 (28,7)	1 (16,7)	30 (28)	0,29	0,83
		Normal	72 (71,3)	5 (83,3)	77 (72)		
		Total	101 (100)	6 (100)	107 (100)		
	CT	Apandicitis	330 (93,2)	3 (33,3)	336 (92,6)	0,93	0,67
		normal	24 (6,8)	6 (66,7)	27 (7,4)		
		Total	354 (100)	9 (100)	363 (100)		
Overall	USG	Apandicitis	180 (36,2)	9 (23,7)	189 (35,3)	0,36	0,76
		normal	317 (63,8)	29 (76,3)	346 (64,7)		
		Total	497 (100)	38 (100)	535 (100)		
	CT	Apandicitis	652 (92,6)	9 (23,7)	684 (92,2)	0,93	0,76
		Normal	52 (7,4)	29 (76,3)	58 (7,8)		
		Total	704 (100)	38 (100)	742 (100)		

Discussion

The significant decrease in the number of acute appendicitis cases during the pandemic period is consistent with the data of other studies in the literature [13-16]. As an explanation for this situation, we anticipate that the public was aware that our hospital served as a primary pandemic hospital, that those with mild symptoms self-medicated with antibiotics and analgesics, or that patients preferred private hospitals [13].

According to our data, the patient group with comorbidity was statistically significantly higher during the pandemic period which might be related to the challenges posed by the pandemic on healthcare systems and the potential changes in patient care-seeking behaviour. In some studies on the comorbidity variable, there are differences in the opposite direction of our findings that are not statistically significant [13, 17].

Our study found significant differences in the clinical characteristics, prevalence of complications, and morbidity rates in acute appendicitis cases during the COVID-19 pandemic compared to the pre-pandemic period. Interestingly, we observed a decrease in the prevalence of complicated cases during the pandemic period, which contrasts with some studies that reported increased complication rates during the pandemic [18-21]. In addition, some studies state that there is no statistically significant difference for complicated appendicitis cases when compared with the pandemic period [22, 23]. This discrepancy could be due to variations in healthcare resource allocation, patient management strategies, or regional differences in healthcare practices and systems. It is also possible that increased awareness and emphasis on timely diagnosis and treatment during the pandemic could have contributed to the lower prevalence of complicated cases. Due to the fact that our clinic is actively involved in the management of COVID patients during the pandemic, we anticipate that our case volume has decreased and that patients have no difficulties accessing the emergency service despite the quarantine policies.

In our study, it concluded that appendicitis patients in the pre-pandemic period had longer symptom duration and hospital stay. It is our opinion that early discharge can account for the patients' shorter length of stay during the pandemic. The patients' shorter average symptom duration during the pandemic period supports the hypothesis that they weren't affected by the quarantine restrictions implemented for emergency service applications during that time. Kupietzky et al. [18] and Başkent et al. [23] also found that the length of stay was no longer during the pandemic period. In accordance with the findings of our study,

Ocak et al.'s study reveals that hospital stays were shorter during the pandemic period [13]. On the other hand, there are articles in the literature stating that appendicitis patients have longer hospital stays during the pandemic [7, 24].

According to our data, CT was used more frequently as a diagnostic radiological modality during the pandemic, which is consistent with the literature. [25] Additionally our study found that there was a decrease in the sensitivity value of USG during the pandemic period. This could be related to the challenges in performing and interpreting USG examinations during the pandemic due to various factors such as limited resources, increased workload, and infection control measures. The preference for open appendectomy during the pandemic period is consistent with the literature. [13, 25, 26]

Several limitations should be acknowledged in our study, including its retrospective nature and the potential for selection bias. Moreover, the study was conducted in a single centre, which may limit the generalizability of our findings to other institutions or regions.

Conclusion

Our study revealed that the prevalence of complicated appendicitis cases was significantly higher during the pre-pandemic period compared to the pandemic period. The morbidity rate was also higher in the pre-pandemic period. Additionally, the sensitivity of ultrasonography in diagnosing appendicitis decreased during the pandemic, while CT scans maintained their sensitivity across both periods. The prevalence of chronic diseases was higher during the pandemic period. Our data opposes the expectations of the scientific community, which predicts more complicated cases during the pandemic period. In order to optimize patient outcomes, obtain maximum efficiency from hospital and human resources, and make accurate plans, health care providers must determine their priorities accurately, particularly in times of crisis. At this point, we propose an appendectomy can be performed safely during the COVID 19 period based on the results of our study.

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Conflicts of interest/Competing interests

None

Authors' contributions

All authors (OFA, MAU, MC, HH, BB) contributed to conceptualisation, data collection, statistical analysis, writing the manuscript. (OFA %50, MAU %20, MC, %10, HH %10, BB %10)

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