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Cohort Study

Comparison of the prevalence of perforated appendicitis during and before COVID19 pandemic☆

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ABSTRACT

Objective: Coronavirus disease 2019 has significantly impacted the rate of emergency department visits among patients with the non-repository disease. Patients with acute appendicitis are also likely to delay their visit to the health care center, which can lead to complications including perforated appendicitis. The aim of this study was to compare the prevalence of perforated appendicitis during the COVID19 and pre-pandemic periods.
Methods: This retrospective study was performed on all appendectomies performed during COVID-19, Group A, and one year earlier, Group B. A questionnaire comprising demographic variables (age, gender, occupation, education), clinical variables (white blood cell count, fever), location and type of appendicitis, the status of appendectomy, and duration of hospitalization was completed for all the patients included in the study.
Results: The demographic variables were not significantly different among the two groups. The perforation appendicitis rate during the COVID19 pandemic increased compared to the previous year, The difference was not statistically significant. The number of negative appendectomy in group A was significantly less compared to group B. The mean time from the onset of pain to the time of referral was significantly lesser in group A. The mean length of hospital stay in group B was longer than in group A. In terms of fever, patients with perforated appendicitis in group B had a higher fever than in group A, which was statistically significant.
Conclusion: A non-significant increase in the number of perforated appendicitis cases during the pandemic period. Duration of hospitalization and fever was significantly greater in pre-pandemic perforated appendicitis cases.

1. Introduction

Acute appendicitis is associated with one of the common causes of emergency visits and abdominal surgery, appendectomy. It may worsen to perforated appendicitis in 20%–76% of cases, leading to additional complications and morbidities [1]. Mortality with perforated appendicitis is reported in up to 5% of cases [2]. Delayed management of acute appendicitis contributes chiefly to perforation, which is presented with prolonged symptoms [3]. Studies have indicated that non-surgical management of non-perforated appendicitis can be effective that includes intravenous and oral antibiotics [4].

The novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) causing coronavirus 2019 disease is an ongoing pandemic [5] that has affected more than 183 million people globally and more than 3.9 million people have died [6]. A global outbreak of the virus and its abrupt spread has made clinicians reconsider the management of a number of diseases. Additionally, patients' emergency department visits with non-respiratory presentations have significantly decreased [7]. The routine medical care system has been deferred, in order to reduce the spread of the virus [8]. Hospitals have maximized efforts to delay elective procedures, making room for COVID19 patients and minimizing the spread of the infection. Owing to the high rate of perioperative mortality during the incubation phase of COVID19 in patients, guidelines have stressed the practice of non-operative management, including for acute appendicitis [9]. In the United State, 98 per 100,000 individuals are projected to be presented with acute appendicitis [10]. A delay in the treatment of appendicitis by 36–48 following the onset of symptoms can lead to perforated appendicitis [11,12].

☆ This study was approved by the Research Ethics Board of Lorestan University of Medical Sciences (IR.LUMS.REC.1399.393).

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The aim of this study is to evaluate the incidence of perforated appendicitis during a pandemic and one year before the pandemic period and compare clinical outcomes in these two periods.

2. Methods

This descriptive-analytical cross-sectional study was performed in (XXX) to compare the rate of appendicitis perforation before and during the COVID19 pandemic among patients who underwent an appendectomy in this center.

The study population included all cases of appendectomy performed during COVID-19 (June 2020–June 2021), Group A and one year earlier (June 2018–June 2019), Group B.

A checklist containing demographic information (age, gender, education, and employment status) length of hospital stay, underlying diseases, COVID19 test, pain intensity, duration between onset and referral, white blood cell (WBC) count, fever, site of appendix, type of appendicitis and systemic involvement was completed after reviewing the selected files.

After collecting the data and entering it into SPSS v22 (IBM, IL, Chicago) central indicators and distribution of the outcomes were presented in the form of tables and graphs. Chi-square test was used to analyze the data and $p < 0.005$ was considered to be statistically significant.

This study was approved by the Research Ethics Board of (XXX).

Unique identifying number is: researchregistry8093.

The methods are stated in accordance with STROCSS 2021 guidelines [13].

3. Results

During the pandemic, 131 patients underwent appendectomy, and 353 patients underwent appendectomy a year before the pandemic. 10 files were excluded from the analysis due to incomplete information. In group A, 57 women (43.5%) and 74 (56.5%) men were included whereas, 141 (39.9%) women and 212 (60.1%) were men. The two groups were not significantly different in terms of gender, $p = 0.874$. The mean age in group A was 29.34 ± 15.41 years and in group, B was 27.16 ± 15.0. The two groups were not significantly different in terms of age distribution, $p = 0.264$.

In terms of education, the highest frequency of patients in the two groups were those with diplomas and less (58 patients (44.3%) in group A and (41.4%) 146 people in group B). The lowest frequency was that of bachelor's degree and above 12 patients (2.9% in group A and 33 patients (3.9%) in group B. The two groups were not significantly different in terms of education, $P = 0.262$.

The employment status in the two groups showed that in both groups, most of the patients were students 35 (26.7%) patients in group A and 110 patients (2.31%) in group B. In group A there were 34 housewives (26.0%), 31 self-employed (23.7%) 31, 15 unemployed (11.5%), 14 employees (10.7%) and 14 (5.2%) minors. In group B, the highest frequency after students were self-employed 77 (21.8%), housewives 65 (18.4%), unemployed 54 (15.3%), employees 39 (11.0%) 39, and minors (3.2%). However, the two groups were not significantly different in terms of employment status ($P = 0.551$).

The history of underlying disease showed that in group A, 19 (14.5%) had a history of surgery and in group B 11 (8.4%) had blood pressure. Also, the lowest rate of underlying disease in group A was that of psychiatric diseases and diabetes in 3 (3.2%) patients, respectively while in group B, the lowest rate was that of asthma 0 (0.0%) patients. The difference in the two groups was not statistically significant in terms of underlying disease, $p = 0.424$.

The mean weight of patients in group B was 97.77 kg and in a group, A was 86.44 kg. There was no significant difference in the two groups in terms of mean weight, $p = 0.116$. Group B has the greatest duration of onset of pain, 10 days. The mean pain onset duration in group B and group A was 1.85 and 1.63 days, respectively, which was also not significantly different, $p = 0.336$. The severity of pain was similar in the two groups, 0.58 ± 0.10.

The duration of hospitalization was 45.2 h in group A and 38.2 h in group B. The duration was not significantly different in the two groups, $p = 0.309$. The means WBC in group B was 74.12×10^9/L and in a group, A was 77.12×10^9/L, which was also not significantly different, $p = 0.564$.

The prevalence of perforation was 15 (11.5%) in Group A and 26 (7.4%) in group B. The difference was not statistically significant, $p = 0.197$. The frequency of negative appendectomy in groups A and B was 2 (1.15%) and 22 (6.2%), respectively. The two groups were significantly different in terms of negative appendectomy, $p = 0.034$(Table 1).

The most common position of appendix in groups A and B was normal, pelvic position, 109 (84.5%) and 264 (79.5%), respectively. In group A, the least common was sub-hepatic and paracecal 1 (0.8%), respectively, whereas in group B was sub-hepatic 4 (1.2%). The two groups were significantly different in terms of paracecal position of the appendix, $p = 0.02$.

The most common type of appendicitis in group B was catarrhal appendicitis 133 (40.2%) and purulent appendicitis in group A 67 (51.9%). The least common in group B was faecalis appendicitis 3 (0.9%) and in group A was faecalis appendicitis, gangrenous and perforated gangrene 2 (1.6%), respectively. The difference was not statistically significant, $p = 0.223$(Table 2).

Most of the cases in group A were reported in winter on January 19 (14.5%) whereas in group B it was on April 42 (11.9%). The difference was statistically significant in the two groups, $p = 0.002$(Table 3).

Despite the high number of men in group A, the prevalence of perforation was higher in women in this group 9 (0.60%), 9 *vs.* 6 (0.40%) while in group B, the prevalence of perforation was higher in men than in women 18 (2.69%) *vs.* 8 (8.30%), but there was no significant difference between the two groups, $p = 0.178$.

Based on educational status, most people who had perforated appendicitis in group A had a diploma and less than 7 (46.7%) and the lowest perforation rate was in illiterate patients 1 (6.7%). In group B, the highest perforation rate was in patients with a diploma and less than 10 (38.5%) and the lowest perforation rate was in people with a bachelor's degree and higher than 1 (3.8%). The correlation was not statistically significant, $p = 0.290$.

In group A, highest incidence of perforation was seen in housewives 5 (33.3%) and the lowest was in minor 0 (0.0%). In group B, highest incidence was in student 8 (30.8%) whereas lowest was in minor 2 (7.7%). The difference was not statistically significant, $p = 0.563$.

The highest perforation rate in group A was related to people with autoimmune disease 2 (3.13%) 2 and the lowest rate was that of hypertension and asthma 0 (0.0%). In group B, the highest perforation rate was in patients with hypertension 3 (11.5%) and the lowest rate was in patients with asthma and psychiatric illness 0 (0.0%). Underlying disease was not significantly correlated with perforation in the two groups, $p > 0.005$.

The incidence of ovarian cysts in women with perforated appendix was 1 in group A (1.11%) and 0 in group B (0.0%). However, the difference between the two groups was not significant, $p = 0.372$.

In group A, the highest rate of perforation was in appendices that

Table 1
Frequency and comparison of the prevalence of negative appendicitis in the two groups.

Variable		Frequency in group A	Frequency in group B	The cumulative frequency	p-value
Prevalence of negative appendicitis	Yes No	2(1.5%) 129(98.5%)	22(6.2%) 331(93.8%)	41(8.5%) 443(91.5%)	0.034

Table 2
Frequency and comparison of diagnostic and epidemiological information in the two groups.

Variables			Frequency in group A	Frequency in group B	Cumulative frequency	P-Value
Appendicitis location	Normal		109(84.5%)	264(79.5%)	373(80.9%)	0.134
	retrocecal		17(13.2%)	38(11.5%)	55(12%)	0.360
	Sub serosal		6(4.7%)	26(7.9%)	32(7%)	0.156
	Subhepatic		1(0.8%)	4(1.2%)	5(1.1%)	0.569
	paracaecal		1(0.8%)	17(5.1%)	18(3.9%)	0.020
Type of appendicitis	catarrhal		36(27.9%)	133(40.2%)	159(34.6%)	0.223
	Purulent		67(51.9%)	131(39.6%)	208(45.2%)	
	Gangrene		2(1.6%)	31(9.4%)	33(7.2%)	
	Perforation		13(10.1%)	11(3.3%)	24(5.2%)	
	Gangrene & Perforation		2(1.6%)	15(4.5%)	17(3.7%)	
	phlegmon		7(5.4%)	7(2.1%)	14(3%)	
	fecaloid		2(1.6%)	3(0.9%)	53(1.1%)	
Prevalence of appendicitis by season	Spring	March	2(1.5%)	42(11.9%)	118(24.4%)	0.002
		April	2(1.5%)	23(6.5$)		
		May	13(9.9%)	36(10.2%)		
	Summer	June	10(7.6%)	27(7.6%)	132(27.3%)	
		July	7(5.3%)	37(10.5%)		
		August	18(13.7%)	33(9.3%)		
	Autumn	September	9(6.9%)	27(7.6%)	117(24.2%)	
		October	19(14.5%)	29(8.2%)		
		November	10(7.6%)	23(6.5%)		
	Winter	December	19(14.5%)	33(9.3%)	117(24.2%)	
		January	13(9.9%)	17(4.8%)		
		February	9(6.9%)	28(7.9%)		

Table 3
Agreement table of perforation prevalence in two groups according to season and month.

Variable			Frequency in group A perforation		Frequency in group B perforation		p-value
			Positive incidence of perforation	Negative incidence of perforation	Positive incidence of perforation	Negative incidence of perforation	0.002
Prevalence of appendicitis by season	Spring	April	0(%0.0)	2(1.7%)	3(11.5%)	39(11.9%)	
		May	0(%0.0)	2(1.7%)	1(3.8%)	22(6.7%)	
		June	3(20.0%)	10(8.6%)	5(19.2%)	31(9.5%)	
	Summer	July	3(20.0%)	7(6.0%)	4(15.4%)	23(7.0%)	
		August	2(13.3%)	5(4.3%)	1(3.8%)	36(11.0%)	
		September	0(%0.0)	18(13.7%)	3(11.5%)	30(9.2%)	
	Autumn	October	0(%0.0)	9(7.8%)	1(3.8%)	26(8.0%)	
		November	2(13.3%)	17(14.7%)	4(15.4%)	25(7.6%)	
		December	1(6.7%)	9(7.8%)	1(3.8%)	22(6.7%)	
	Winter	January	0(%0.0)	19(16.4%)	1(3.8%)	30(9.2%)	
		February	3(20.0%)	10(8.6%)	1(3.8%)	176(4.9%)	
		March	1(6.7%)	8(6.9%)	1(3.8%)	27(8.3%)	

were in the normal position 11 (73.3%) and the lowest rate was in sub-hepatic and paracecal cases 0 (0.0%). In group B, most of the appendix that was in the normal position (23.58%) were perforated, and the lowest rate of perforation was in paracecal and sub-hepatic appendix. However, the difference was not significant ($P > 0.05$).

The mean weight of people with perforated appendicitis in group A (20.69) was higher than group B (46.66), but the difference was not significant ($P > 0.05$). The mean time from the onset of pain to the time of referral was 0.3 days in group A in perforated cases and 2.46 days in group B and the difference between the two groups was significant. ($P < 0.001$). The pain intensity in group A was from 0.7 to 0.9 while in group B the minimum pain was 0.4 and the maximum was 0.9. The difference was statistically significant, $P < 0.001$. The mean length of hospital stay in group B was longer than in group A (4 days vs. 4.19 days), which was also significantly different ($P < 0.001$). In terms of fever, patients with perforated appendicitis in group B had a higher fever than in group A, which was statistically significant, $p < 0.001$. The mean of group A (13.94×10^9/L) was higher than group B (13.38×10^9/L), and the difference between the two groups was not significant, $p = 0.138$.

In group A, highest incidence of perforated cases was reported in May, June and January 3 (20.0%), respectively. In group B, the highest incidence of perforated cases was reported in May 5 (19.2%). The difference was statistically significant, $p = 0.002$(Table 4).

4. Discussion

The aim of this study was to evaluate the data regarding perforated appendicitis before and during COVID19 period. Pandemic has caused to change trend in the management of a number of pathologies and diseases [14,15]. Following the increase in COVID19 cases, patients with acute illness such as myocardial infarctions, those requiring cardiac catheterization laboratory activations, and stroke have also reduced their visits to the hospital [16,17]. Due to reduction in non-emergent surgical procedures in COVID19 period, patients with acute appendicitis may have poor postoperative outcomes such as abscesses, prolonged hospitalization, and increased reoperations and readmissions [18,19]. Our study did not report any significant difference in the demographic variables of appendectomy patients before and during pandemic. Additionally, duration of hospitalization and WBC count were also not different in the two groups. Perforation of appendix was non-significantly more in pandemic period; however, the rate of negative appendectomy was more in pre-pandemic group. Similarly, this group had significantly more cases of paracecal position of appendix. Patients presented with perforated appendicitis in group B has longer pain onset to referral time, duration of hospitalization, and fever. The two groups also significantly differed in terms of time and the month of the year, in terms of perforation of appendicitis [20]. study showed that

Table 4
Agreement table on the prevalence of perforation in the two groups based on clinical information.

Variable	Group	perforation	Min	Max	SD ± Mean		p-value
Weight (Kg)	A	Yes	44	105	69.20 ± 19.360	41	0.329
		No	25	110	40.54 ± 10.28	90	
	B	Yes	20	110	66.46 ± 21.08	26	
		No	16	180	68.81 ± 19.86	327	
Time to start pain(day)	A	Yes	1	5	3.04 ± 1.26	41	<0.001
		No	1	5	1.50 ± 0.69	90	
	B	Yes	1	5	2.46 ± 0.98	26	
		No	1	10	1.66 ± 1.18	327	
Pain score(NRS)	A	Yes	0.7	0.9	0.8 ± 0.07	41	<0.001
		No	0.4	0.8	0.56 ± 0.06	90	
	B	Yes	0.6	0.9	0.82 ± 0.06	26	
		No	0.4	0.9	0.57 ± 0.08	327	
Duration of hospitalization(day)	A	Yes	3	5	4 ± 1.28	41	<0.001
		No	1	5	2.32 ± 1.11	90	
	B	Yes	2	9	4.19 ± 1.44	26	
		No	1	8	2.28 ± 1.00	327	
Fever rate(°C)	A	Yes	37.3	39	38.06 ± 0.43	41	<0.001
		No	38.6	36.9	37.59 ± 0.44	90	
	B	Yes	37.3	39	38.10 ± 0.49	26	
		No	36.8	39.9	37.52 ± 0.41	327	
WBC(X^{103})	A	Yes	9	27.6	13.94 ± 4.28	41	0.138
		No	6	22	13.02 ± 4.16	90	
	B	Yes	7.3	19.8	13.38 ± 3.60	26	
		No	3.6	25	12.39 ± 3.64	327	

the incidence of perforated appendicitis can be affected by seasonal variations. The study showed that the cases are more in summer, however, our study reported greatest frequency of cases in winter and spring [21]. conducted a study to determine the effect of COVID19 on perforated appendicitis in pediatric population in New York City. The study showed that within the 10 weeks of pandemic period, the perforated appendicitis rate was significantly higher relative to 5 years of pre-pandemic period along with prolonged symptoms. This could be due hesitance in seeking medical care during a pandemic [22]. also reported reduction in the incidence of reported acute appendicitis during pandemic period [23]. conducted a study to evaluate the incidence of complicated appendicitis before and during pandemic period. The study reported an increase in gangrenous and perforated appendicitis during the pandemic period along with abdominal abscesses. Furthermore, there was a decrease in the rate of acute appendicitis in this period. In another study by Ref. [24], on appendicitis in pediatric population during pandemic, relative to pre-pandemic data, reported that duration of symptoms during pandemic era is longer, with greater prevalence of fever, appendicitis complications (perforation and abscesses) and prolonged hospitalization. Additionally, non-operative treatment was significantly greater in pandemic period. Wang et al. [25], showed that in pre-pandemic and pandemic cohort, incidence of perforated appendicitis is significantly different, being higher during a pandemic. However, WBC count, duration of hospital stays, age, gender, and duration of symptoms do not differ significantly in these groups. Regarding increased incidence of perforated appendicitis, similar findings are reported by Wichmann et al. [26].

Our study is retrospective in nature and does not evaluate the impact of appendicitis and COVID19 positivity in these cohort. Furthermore, presentation of acute appendicitis and use of antibiotics is also not reported in our studies. We recommend that health care centers should take measures to provide possible emergency care to such patients and prevent the spread of infection. People should be more aware of time to seek medical help, particularly during COVID19 period. Patients who are at high risk of acute pathological presentations should be rightfully educated regarding the importance of seeking medical care. Further studies evaluating the impact on therapeutic intervention due to late referral in such cases are required.

5. Conclusion

Our study showed that following COVID19 pandemic, rate of perforated appendicitis is likely to increase. Due to variations in a sample size of two cohorts, these outcomes were not significantly different in our studies. Additionally, due to delays in the treatment of acute appendicitis, complications can lead to adverse health outcomes and prolonged hospitalization.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Sources of funding

No funding was secured for this study.

Author contributions

Dr.Morteza Azadbakht: conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript.

Dr. Saleh Azadbakht: Designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript.

Dr. Samira Daniali and Dr. Maryam Dehghani: Coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.

Registration of research studies

Name of the registry: Lorestan University of Medical Sciences, Khorramabad, Iran.

Unique Identifying number or registration ID: IR. LUMS. REC.1399.393.

Hyperlink to the registration (must be publicly accessible): https://ethics.research.ac.ir/ProposalCertificateEn.php?id=186808&Print=true&NoPrintHeader=true&NoPrintFooter=true&NoPrintPageBorder=true&LetterPrint=true.

Guarantor

Dr.Morteza Azadbakht.

Consent

Not applicable.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2022.104785.

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