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Research Article

Effect of the COVID-19 Pandemic in Jerusalem on Acute Care Surgery

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Abstract

Background: Concerns were raised about the effect of the COVID-19 pandemic on patient morbidity because of delayed presentation to the hospital. This study aimed to assess the effect of the pandemic on the timing and severity of presentation to acute surgical care.

Methods: We retrospectively reviewed the medical charts of patients hospitalized in the General Surgery Department at Hadassah University Medical Center from March to August 2020. We evaluated patients diagnosed with four acute surgical diseases, including acute appendicitis (AA), acute diverticulitis (AD), acute cholecystitis (AC), and bowel obstruction (BO). For the control group, we reviewed similar cases from March to August 2019. We compared patient demographics, time intervals from arrival to the Emergency Department (ED) to diagnosis and operation if needed, surgical and in-hospital course, and severity of the diseases.

Results: The study included 376 patients, 242 in the control cohort and 134 in the COVID-19 cohort. The number of referrals and hospitalizations to the surgical department was significantly smaller in the COVID-19 cohort ($p = 0.015$). In the COVID-19 cohort, the time intervals for physicians' examination, imaging, and surgery were shorter ($p = 0.010$), but the time intervals for hospitalization were longer ($p < 0.001$). Also, the percentage of BO cases was higher (34.3% vs. 23.4%, $p = 0.087$), and the length of operations was longer ($p = 0.058$) in this cohort. No differences were found in the duration of symptoms, length of intensive care unit hospitalization, the severity of cases, or the course of hospitalization.

Conclusion: COVID-19 led to a significant decrease in referrals and urgent surgical hospitalizations during the pandemic without worsening of the patient condition. According to our study, some of the common surgical diseases may be managed conservatively without hospitalization.

Introduction

In March 2020, the World Health Organization declared the coronavirus outbreak, caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), as a pandemic. In February 2020, the first patient in Israel was diagnosed. Following the spread of the virus, guidelines and restrictions were applied to daily activities in the country, including the imposition of a general lockdown [1]. In other countries that imposed a lockdown, changes were observed in the number and nature of referrals to the hospitals [2]. There is evidence of an indirect negative effect from the pandemic on morbidity that is not from the virus itself, following the avoidance or delay of medical treatment. For example, in Italy, a higher rate of morbidity was reported in surgical cases [3]. Historical pandemics have influenced surgical practices significantly. For instance, the SARS pandemic necessitated the postponement of elective surgeries and prompted the adoption of appropriate protective protocols [4]. Similarly, during the Ebola outbreak, there was a notable reduction of approximately 70% in elective surgical procedures [5,6]. Several studies have showed decrease in urgent surgeries and higher rates of delayed presentation to the hospital with higher severity and post-operative complications rates [7,8]. Our study aimed to assess the impact of the COVID-19 pandemic on acute care surgery workload and surgical acuity. We analyzed variations in referral rates to acute care surgery in the emergency department (ED), investigated shifts in the proportion of severe cases, and compared treatment durations across different periods. We hypothesized that during the pandemic, referral rates would decrease, the prevalence of severe cases would rise, and diagnostic and treatment time intervals would increase.

Methods

We retrospectively reviewed patient charts who were evaluated and treated in the surgical ED and were admitted to the general surgery department (GSD) of Hadassah University Medical Center, during the months of March-August in 2019 and 2020, with a diagnosis of acute appendicitis (AA), acute diverticulitis (AD), acute cholecystitis (AC), and bowel obstruction (BO). The criteria for inclusion were age 18 or older and a diagnosis of one of the above conditions according to clinical, laboratory, and imaging findings. Exclusion criteria were the lack of a clear diagnosis and recurrent admissions during the study period. This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Hadassah Medical Organization (No. 0500-20-HMO). Patient consent was waived due to the retrospective design of the study and patient anonymity.

Data collection

We retrieved data from the medical records. Collected data include demographics, main underlying diseases, and time intervals (TI) at the ED: from TI to physician's examination (TI-E), from TI to computer tomography (TI-I, CT), and from TI to decision for hospitalization (TI-H). Data were extracted regarding the TI between initiation of symptoms and arrival at the ED as reported in days (TI-S). A temperature (T) ≥38 ^{0}C was considered a fever. In addition, laboratory results were collected and include inflammatory markers, lactate, renal and liver enzymes, and imaging performed (type of imaging, findings, and severity of the disease). Polymerase chain reaction (PCR) test for SARS-CoV-2 results was done in patients suspected of COVID infection in the 2020 group. Urgent surgery was defined as one performed within the first 24 hours after arrival to the ED. TI to operation (TI-O), length of operation (LOO), findings during the operation, and pathological diagnosis were recorded in both groups. Finally, data collected about the post-operative course and/or hospitalization: length of hospitalization (LOH), length of stay in the intensive care unit (LOS-ICU), and post-operative complications (POC), including mortality.

Data analysis

For AA and BO, comparison of the cases' severity was made according to severity score criteria based on the severity grading of the American Association for the Surgery of Trauma Emergency General Surgery (ASST-EGS) [9]. The grading score included imaging, operative, and pathologic criteria. The degree of severity was defined as I (mild) to V (severe). In establishing the severity level of a patient, they must meet at least one criterion corresponding to that particular level. In instances where a patient satisfies multiple criteria from varying levels, the criterion associated with the highest level takes precedence in the determination. The Hinchey score was used to grade AD severity [10]. Regarding AC, it should be noted that in 2020, there was a change in our treatment policy, so that surgery was preferred during the initial hospitalization, in contrast to the former policy of conservative treatment and surgery after 6 weeks. Since there has been a fundamental change in the treatment approaches for AC, it was decided to collect information only about the severity of the disease. Therefore, we did not compare operative data between the cohorts.

Statistical analysis

Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 25 (SPSS, IBM Corp, Armonk, NY, USA). We used the chi-square test or Fisher's exact test to analyze categorical variables. Quantitative variable comparison was done using a t-test. All tests were two-sided, and a p -value ≤ 5% was considered statistically significant.

Results

41,835 and 35,748 patients were treated in Hadassah University Medical Center's ED during the study periods in the control cohort (2019) and the COVID-19 cohort (2020), respectively. Of them, 3,210 (7.7%) and 2,166 (6.1%), respectively, were referred to the surgical ED ($p < 0.001$). 1,814 (56.5%) and 1,151 (53.1%), respectively, were hospitalized ($p = 0.015$).

376 patients met the inclusion criteria and were included in the study: 242 from the control cohort and 134 from the COVID-19 cohort. In the COVID-19 cohort, only 14 (10.4%) patients were tested for SARS-CoV-2, and none were found to be positive.

General comparison between groups

There was no difference in any demographic characteristic between the cohorts (Table 1). There were 29 (7.7%) patients with fever, 21 (8.6%) in the control cohort, and 8 (5.9%) in the COVID-19 cohort. The average TI-E was 1.4 ± 1.6 hours and was shorter in the COVID-19 cohort ($p = 0.009$). The average TI-H was 4.9 ± 4.1 hours and was longer in the COVID-19 cohort ($p < 0.001$). The average TI-S was 2.2 ± 2.4 days ($p = 0.490$). The average TI-I was 4.8 ± 3.8 hours and was shorter in the COVID-19 cohort ($p = 0.006$). Tables 2,3 display the different TI. The average LOH was 6.1 ± 5.5 days ($p = 0.910$). The number of patients hospitalized in the ICU and the LOS-ICU were similar in both groups. 151 (40.2%) patients underwent urgent surgery, 97 (40%) in the control cohort, and 54 (40%) in the COVID-19 cohort (p = NS). Average TI-O was 10.9 ± 6.7 hours and was shorter in the COVID-19 cohort ($p = 0.010$), but the average LOO was slightly longer in the COVID-19 cohort ($p = 0.058$) (Table 2).

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Table 1: Patients' Demographics.

	Control cohort (242)	Covid cohort (134)	*p* - value
Age, Mean (SD)	50.4 (21.2)	52.2 (21.3)	0.434
Female, no. (%)	126 (52)	70 (52.2)	0.686
Pregnancy, no. (%)	6 (2.5)	0 (0)	0.091
HTN, no. (%)	66 (27.3)	38 (28.4)	0.956
IHD, no. (%)	25 (10.0)	12 (8.9)	0.606
CHF, no. (%)	10 (4.0)	2 (1.5)	0.224
S/p stroke/TIA, no. (%)	13 (5.4)	7 (5.4)	0.900
COPD, no. (%)	10 (4.0)	2 (1.5)	0.151
CKD, no. (%)	8 (3.3)	5 (3.7)	0.870
Immune deficiency, no. (%)	6 (2.5)	5 (3.7)	0.537
DM, no. (%)	33 (13.6)	15 (11.2)	0.436
Malignancy, no. (%)	9 (3.7)	7 (5.4)	0.528
Diagnosis			
AA, n (%)	89 (36.8)	45 (33.6)	0.087
AD, n (%)	36(14.8)	16 (11.9)	
AC, n (%)	60 (24.7)	27 (20.1)	
BO, n (%)	57 (23.4)	46 (34.3)	

SD - Standard Deviation; HTN – Hypertension; IHD – Ischemic Heart Disease; CHF – Chronic Heart Failure; S/p – Status post; TIA – Transient Ischemic Stroke; COPD – Chronic Obstructive Pulmonary Disease; CKD – Chronic Kidney Disease; Diabetes Mellitus.

Table 2: Treatment Time-Intervals (TI).

	All Diagnoses			AA			BO		
	Control cohort (242)	Covid cohort (134)	*p* - value	Control cohort (89)	Covid cohort (45)	*p* - value	Control cohort (57)	Covid cohort (46)	*p* - value
TI-S, mean (SD), days	2.2 (2.2)	2.4 (2.7)	0.490	1.9 (2.0)	2.2 (2.0)	0.276	1.5 (1.2)	1.7 (1.3)	0.316
TI-E, mean (SD), hours	1.5 (1.7)	1.1 (1.2)	0.009	1.5 (1.2)	1.1 (1.1)	0.009	1.4 (2.3)	0.9 (0.7)	0.520
TI-I, mean (SD), hours	5.0 (2.7)	4.5 (5.1)	0.006	4.8 (2.3)	3.8 (2.2)	0.004	6.4 (3.5)	4.2 (2.4)	$p < 0.001$
TI-H, mean (SD), hours	3.9 (3.7)	6.5 (4.2)	<0.001	4.0 (3.5)	4.9 (2.4)	<0.001	4.5 (5.4)	7.2 (4.1)	$p < 0.001$
LOH, mean (SD), days	6.1 (5.8)	6.2 (5.0)	0.910	3.4 (2.8)	3.6 (2.7)	0.615	9.2 (5.5)	8.6 (6.5)	0.321
LOH - ICU, mean (SD), days	4.0 (6.1)	3.0 (3.2)	0.735				4.0 (6.1)	3.0 (3.2)	0.329
Emergency surgeries	97 (40%)	54(40%)		79(32.6%)	38(28.4%)		18(7.4%)	15(11.2%)	
TI-O, mean (SD), hours	11.9 (6.6)	9.0 (6.4)	0.010	11.6 (5.8)	9.5 (6.8)	0.007	13.4 (9.4)	8.2 (5.8)	0.047
LOO, mean (SD), hours	1.8 (0.8)	2.1 (0.9)	0.058	1.6 (0.5)	1.7 (0.5)	0.381	2.8 (1.1)	3.0 (1.1)	0.588

AA- Acute Appendicitis; BO- Bowel Obstruction; TI-S – Time-interval Symptoms; TI-E Time-interval Examination; TI-I - Time-Interval Imaging; TI-H - Time-Interval Hospitalization; LOH – Length of Hospitalization; LOH-ICU - Length of Hospitalization Intensive Care Unit; TI-O - Time-Interval Operation; LOO – Length of Operation.

Table 3: Treatment Time-Intervals (TI).

	AD			AC		
	Control cohort (36)	Covid cohort (16)	*p* - value	Control cohort (60)	Covid cohort (27)	*p* - value
TI-S, mean (SD), days	3.5 (3.5)	3.9 (4.8)	0.703	2.5 (1.8)	2.8 (3.4)	0.382
TI-E, mean (SD), hours	1.6 (1.0)	1.8 (2.4)	0.343	1.7 (2.0)	1.2 (1.0)	0.226
TI-I, mean (SD), hours	4.8 (1.8)	4.4 (2.3)	0.148	3.9 (2.5)	6.6 (10.6)	0.145
TI-H, mean (SD), hours	4.0 (4.0)	6.8 (3.9)	0.001	3.3 (0.7)	8.0 (5.9)	$p < 0.001$
LOH, mean (SD), days	6.9 (8.9)	5.9 (3.7)	0.850	6.9 (5.2)	6.4 (2.9)	0.814

AD- Acute Diverticulitis; AC – Acute Cholecystitis; TI-S – Time-Interval Symptoms; TI-E Time-Interval Examination; TI-I - Time-Interval Imaging; TI-H - Time-Interval Hospitalization; LOH – Length of Hospitalization.

The frequency of diagnoses in descending order: AA (35.6%), BO (27.4%), AC (23.1%), and AD (13.8%) (Table 1). In the COVID-19 cohort, the percentage of BO cases was higher (34.3% *vs.* 23.4%, $p = 0.087$). Table 4 shows the distribution of the degrees of severity of the cases in each cohort. No differences were found between the cohorts ($p = 0.242$).

Acute appendicitis

89 (36.8%) patients were diagnosed with AA in the control cohort and 45 (33.6%) in the COVID-19 cohort during the study period. No differences were found in demographic characteristics, physical findings, laboratory, or imaging results. 117 (87.3%) underwent urgent surgery, 79 (88.7%) in the control cohort, and 38 (84.4%) in the COVID-19 cohort ($p = 0.55$). In most surgeries, the appearance of the appendix was inflamed (104 patients, 88.9%). After categorizing the appearance of the appendix according to non-complicated and complicated, no difference was found between the cohorts ($p = 0.203$). In the post-operative course, only three patients (two in the control cohort and one in the COVID-19 cohort) had surgical wound infection (SSI). The most common pathological results (78, 66.7%) were non-complicated AA ($p = 0.895$). After categorizing the pathological results according to non-complicated and complicated, no difference was found between the cohorts ($p = 0.919$). 17 (12.6%) patients

did not undergo surgery, 10 (11.2%) in the control cohort, and 7 (15.5%) in the COVID-19 cohort ($p = 0.634$). Of these, 13 (76.5%) had advanced inflammation that did not allow operation ($p = 1.000$). Only one patient in the COVID-19 cohort underwent drainage of an abscess.

Bowel obstruction

57 (23.4%) patients were diagnosed with BO in the control cohort and 46 (34.3%) in the COVID-19 cohort during the study period. Most of the patients (82, 79.6%) had previous abdominal surgery ($p = 0.987$). No differences were found in demographic characteristics, physical findings, laboratory results, or imaging. The main type of obstruction (82, 79.6%) was small bowel obstruction ($p = 0.646$). The imaging diagnosis was made using CT in 96 (93.2%) patients. 47 (45.6%) patients required surgery during the hospitalization, 26 (45.6%) in the control cohort, and 21 (45.6%) in the COVID-19 cohort ($p = 0.768$). 33 (70.2%) patients, 18 (69.2%) in the control cohort, and 15 (71.4%) in the COVID-19 cohort, underwent surgery at admission ($p = 0$ .870), most of them due to incarcerated hernia. There was no difference in the LOO ($p = 0$ .833). The rate of necrotic bowel was similar between the groups ($p = 1.000$). 12 (11.7%) patients had a complication ($p = 0.429$), eight in the control cohort (5 SSI and 3 pneumonia), and four in the COVID-19 cohort (2 SSI, 1 Pneumonia, and 1 pulmonary embolism). Five (4.8%) patients died, three (5.3%) in the control cohort and two (4.3%) in the COVID-19 cohort ($p = 1.000$).

Acute diverticulitis

36 (14.8%) patients were diagnosed with AD in the control cohort and 16 (11.9%) in the COVID-19 cohort during the study period. No differences were found in demographic characteristics, physical examination, and laboratory results between the two cohorts. Most of the patients had simple inflammation (HS = 0), and there was no difference in the distribution of HS between the cohorts ($p = 0.501$) (Table 4). Only one patient in the COVID-19 cohort underwent urgent surgery. None of the patients underwent abscess drainage. Two (3.8%) patients had bacteremia, one from each cohort ($p = 0.544$).

Acute cholecystitis

60 (24.1%) patients were diagnosed with AC in the control cohort and 27 (19.0%) in the COVID-19 cohort during the study period. No statistical differences were found in demographic characteristic and, physical examination, and laboratory results between cohorts. For most patients, the imaging diagnosis was performed using US - 60 (69.0%) patients ($p = 0.110$). Three (3.4%) patients were also diagnosed with cholangitis and three (3.4%) with pancreatitis ($p = 0$ .266 and p=1.000, respectively). In addition, 12 (13.8%) patients, 6 in each group, underwent endoscopic retrograde cholangio-pancreatography ($p = 0$ .18). More

Table 4: Severity Grade Distribution.

Severity Grade	Control cohort	Covid cohort	*p* - value
Acute Appendicitis	89	45	
I, n (%)	53 (59.6)	23 (51.1)	0.477
II, n (%)	13 (14.6)	6 (13.3)	
III, n (%)	4 (4.5)	5 (11.1)	
IV, n (%)	1 8(20.2)	10 (22.2)	
V, n (%)	1(1.1)	1(2.2)	
Acute Diverticulitis*	36	16	
0, n (%)	28 (77.8)	14 (87.5)	0.501
I, n (%)	5 (13.9)	1 (6.3)	
II, n (%)	2 (5.6)	0 (0)	
III, n (%)	0 (0)	1 (6.3)	
IV, n (%)	1 (2.8)	0 (0)	
Bowel Obstruction	57	46	
I, n (%)	10 (17.5)	5 (10.9)	0.776
II, n (%)	35 (61.4)	31 (67.4)	
III, n (%)	5 (8.8)	3 (6.5)	
IV, n (%)	5 (8.8)	6 (13)	
V, n (%)	2(3.5)	1(2.2)	

* Based on Hinchey score.

patients required cholecystostomy in the COVID-19 cohort (9, 33.3%) compared to the control cohort (9, 15.0%), but this did not reach statistical significance ($p = 0$ .08).

Discussion

The study aimed to evaluate the impact of the COVID-19 pandemic on common acute surgical pathologies. The findings give rise to several points for discussion. Initially, there appears to be a marked decrease in the volume of referrals to both general and surgical EDs, as well as hospitalizations to the GSD during the year 2020. This observation aligns with our initial hypotheses and is consistent with findings reported globally. However, there was a notable increase in the percentage of patients requiring hospitalization relative to the total number of referrals. This trend suggests that individuals with less severe illness may have opted to refrain from seeking referral to the ED [11]. The same trend was observed with trauma-related admissions [12]. Second, in comparing the observed time intervals of all patients in 2019 versus 2020, the TI-E, TI-I, and TI-O were shorter in 2020. This is contrary to our assumptions that the duration of the diagnosis process will be extended in 2020. A possible explanation for this is that the low number of referrals in 2020 reduced the burden on the treating staff. On the other hand, TI-H was longer in 2020. It is possible that the regulations and policies during the pandemic led to the delay of the administrative processes and thus extended the TI-H. Due to a low number of patients with high fever, we could not assess whether it affected the treatment process during the pandemic. Some studies suggest that the pandemic prolonged the TI-S [13-15]. Contrary to our expectations, there appeared to be no difference in the TI-S between the study cohorts. The discrepancy may be because the previous studies included only the beginning of the pandemic, when a lockdown was imposed, which may suggest that the effect of avoiding seeking medical treatment is only relevant at the early stages of the pandemic.

In this study, we focused on four main diseases in ACS. The results demonstrate a difference in the distribution of diagnoses between the periods. In 2020, the percentage of BO cases was higher than the corresponding period in 2019, as was seen in previous studies [15]. In contrast, the percentage of AA, AD, and AC cases was slightly lower in 2020, also in line with previous studies [16-18]. These results may correspond with the natural course of these diseases. It can be assumed that there are surgical diagnoses that cannot be managed in an outpatient way, as observed in BO. The results of this study can strengthen the recommendation of the World Society of Emergency Surgery for AD, in which patients with an uncomplicated disease and no significant underlying diseases can be treated as outpatients, as is customary in the USA [19,20]. In all the examined diagnoses, no difference was found in LOH and the LOS-ICU, and the number of POC between the cohorts. Reinke, et al. also showed that there were no changes in the number of ICU hospitalizations during an extended follow-up period of one year [21]. Most of the patients in the study were from the AA cohort. Several studies published so far have shown that COVID led to an increased number of complicated AA cases [22-24]. Chrysos, et al. have even shown more advanced histological findings in the pandemic group [25].

Contrary to our hypothesis and evidence from previous studies, no differences were found in the severity of the cases defined by the AAST-EGS score. This difference can be explained again by the assumption that patients continued to seek medical care as they did in the period before the pandemic. No statistically significant differences were found in the severity of the cases. However, there are results that did not reach statistical significance that could suggest a higher severity of cases during the pandemic, such as a longer LOO in all operated and a higher percentage of gallbladder drains in 2020. It is possible that in a larger sample, statistical significance could have been reached.

The purpose of comparing the severity of the cases was to investigate any potential indirect impact of the pandemic. Notably, no noticeable effect on morbidity was observed, as was seen in other studies, which included a longer follow-up period and at a later stage of the pandemic [21,26,27].

This study has several advantages. First, the study included several surgical diagnoses and did not focus on one diagnosis, as was done in other studies. Thus, a broader picture of the surgical workload was obtained, and we were able to learn which diseases may be managed in a community setting. Second, we collected a large amount of data, which made it possible to create a more accurate picture of reality and establish the reliability of the research conclusions. There are several limitations to this study, most of which are due to the retrospective nature of data collection at a single institution. Possible variations in the number of acute surgical presentations at the ED may also affect our results.

In conclusion, we observed a significant decrease in the number of referrals to the ED and hospitalizations during the pandemic. Shorter TI also could be explained by this lower workload for surgical teams compared to the "regular" pre-COVID situation. The severity of cases treated during the pandemic did not increase, nor did patients' outcomes, which can indicate that the effect of the pandemic on severity was mainly during the lockdown periods. Additionally, treatment modalities, especially in simple cases of AC and AD, could be adopted as an outpatient care.

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Authors' contributions: R.O., Y.F., Y.F., and D.JA designed the study, acquired and analyzed the data, and wrote the initial draft of the article. R.O contributed to the analysis and interpretation of data. A.N analyzed and interpreted the patient data regarding the Emergency department. S.A.S, O.CA., and B.M assisted in the preparation of the article. P.A, A.G supervised the project. All authors have critically reviewed the manuscript and approved the final version.

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