Acute surgical abdomen during the COVID-19 pandemic: a retrospective study on clinical and therapeutic challenges

Moatasem A. Erfan, Ibrahim N. Alwardany

Department of General Surgery, Misr University for Science & Technology, Giza, Egypt

Correspondence to Moatasem A. Erfan, Department of General Surgery, Misr University for Science & Technology, Giza, Egypt. Tel: 01223478555; e-mail: moatasem.erfan@must.edu.eg

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Background
As with other medical specialties throughout the epidemic, general surgical clinics' treatment protocols have changed because of the COVID-19 pandemic, which has become a serious danger to healthcare systems. The presence of severe COVID-19 in young individuals and among medical workers has exacerbated the psychological burden on clinicians treating patients suspected of having or being infected with SARS-CoV-2, even if comorbidities and older age are statistically linked to higher death rates.

Patients and methods
A retrospective comparative study included patients who were admitted to the emergency room (ER), surgical, or managing conservatory for acute surgical abdomen. All subjects were divided into three groups. 1186 patients; out of them, 490 cases were examined before the pandemic, 334 cases were examined during the pandemic, and 362 cases were examined after vaccination.

Results
Before the pandemic, the commonest cause of acute abdomen was appendicitis (21.8%), strangulated hernia (21%), and cholecystectomy (17.8%). During the pandemic, the commonest cause of acute abdomen was appendicitis (21.8%), cholecystectomy (16.8%), and Mesenteric venous occlusion (MVO)/Mesenteric Artial occlusion (MAO) (13.8%). After the pandemic, the commonest causes of acute abdomen were cholecystectomy (25.4%), appendicitis (24.6%), and exploration abdomen (11.9%). The time of management differed significantly among the studied groups. The highest requirement for immediate intervention was attributed to the before pandemic group, while during the pandemic group was associated with conservative management, and after conservative management.

Conclusion
The Sars-Cov-2 pandemic highly affected the clinical presentation, aetiology, diagnostic and paraclinical investigations, and therapeutic management, as well as the changes in emergency practice procedures.

Keywords:
acute abdomen, appendicitis, cholecystectomy, MVO/MAO, pandemic, Sars-Cov-2, strangulated hernia

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Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) first showed up in Wuhan at the end of 2019 and spread quickly around the world [1]. On January 30, 2020, the World Health Organisation (WHO) announced that coronavirus disease 2019 (COVID-19) was a worldwide public health emergency [2]. They demonstrated that a familial cluster of pneumonia is associated with the novel coronavirus, and they indicated person-to-person transmission [3]. Egypt reported the first case of COVID-19 on February 14, 2020, and within 3 months, 10,000 cases had been recorded [4].

Acute abdomen is defined as the acute onset of abdominal pain, which requires accurate diagnosis and treatment within a particular time limit to prevent mortality and morbidity [5]. During outbreaks, some patients with COVID-19 pneumonia experienced acute abdomen, necessitating immediate intervention. Studies have shown that having pneumonia before surgery is a major risk factor for bad results after surgery [6]. Also, it has to be taken into consideration that the surgeon and the medical staff operating are exposed to the hazards of infection [7,8]. The surgery may also cause the patient to have more inflammation, which can make their COVID-19 pneumonia worse [9]. As a result, research into the effects of emergency surgery on patients with both acute abdomen and COVID-19 is urgently needed.

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Multiple vaccines against COVID-19 have been developed and are being used in vaccination campaigns around the world. Anti-COVID-19 vaccines from companies like Sinopharm, AstraZeneca, and Sputnik V have started arriving in Egypt for healthcare workers in isolation, fever, and chest hospitals; patients with cancer, kidney, or immunity problems; patients with chronic diseases; and finally, all citizens over the age of 18. In March 2021, Egypt began administering the vaccine against COVID-19 [10].

The current study aimed to compare the incidence, diagnosis, and management challenges of acute surgical abdomen cases pre-COVID, during the pandemic, and after the vaccine.

Patients and methods

We did a retrospective comparison study on people with acute surgical abdomen at Souad Kafafi University Hospital, Misr University of Science and Technology. The pre-pandemic group was between March 2019 and February 2020; the pandemic group was between April 2020 and March 2021; and the vaccinated group was between April 2021 and March 2022.

All patients who went to the emergency room (ER), surgery, or conservatory for an acute surgical abdomen with appendicitis, bowel obstruction, peritonitis, superior or inferior digestive haemorrhage, or acute mesenteric ischemia were included in the study. Patients who refused to stay in the hospital, participate in the study, or didn't have enough information were left out.

We analysed the clinical presentation, aetiology, diagnostic, para-clinical, and therapeutic management, vaccination history, and changes in emergency practice procedures imposed by the COVID-19 pandemic.

Data analysis

The collected data was revised, coded, tabulated, and introduced to a PC using the Statistical Package for Social Science (IBM Corp., released 2017). IBM SPSS Statistics for Windows, Version 25.0 Armonk, NY: IBM Corp. The Kolmogorov-Smirnov test was used as a test of normality; if the significance level is greater than 0.05, then normality is assumed. For the comparison of more than two groups' means, one-way analysis of variance (ANOVA) was used, followed by a post hoc test, which allows exploring the difference between multiple group means. The Kruskal-Wallis test was used to assess the statistical significance of the difference between more than two study group non-parametric variables, followed by pairwise comparison. χ^2 test was used to examine the relationship between two qualitative variables. All tests were 2-sided, and a P value < 0.05 was considered statistically significant.

Results

The present study was conducted on 1186 patients; out of them, 490 cases were examined before the pandemic, 334 cases were examined during the pandemic, and 362 cases were examined after vaccination.

Regarding the median age of pre-pandemic, pandemic, and vaccinated groups (39, 41, and 41 years, respectively), there was a male predominance among pre-pandemic, pandemic, and vaccinated groups (52.9%, 60.2%, and 56.6%, respectively). No significant differences were found between the studied groups regarding age or gender (Table 1).

As illustrated in Table 2, appendicitis (21.8%), strangulated hernia (21%), and cholecystectomy (17.8%) were the most common causes of acute abdomen prior to the pandemic. Appendicitis (21.8%), cholecystectomy (16.8%), and Mesenteric venous occlusion (MVO)/Mesenteric Artial occlusion (MAO) (13.8%) were the most common causes of acute abdomen during the pandemic. In the vaccinated group, the commonest causes of acute abdomen were cholecystectomy (25.4%), appendicitis (24.6%), and exploration of the abdomen (11.9%). We observed that mesenteric vein occlusion or superior mesenteric artery occlusion was significantly increased in pandemic patients and the vaccinated group compared to pre-pandemic.

Table 1 Comparison of demographics and comorbidities among the studied groups

	Before pandemic *N*=490	During Pandemic *N*=334	After vaccination *N*=362	*P*
Age (years)	40.3±16.2 (39 (10-88))	42.7±16.9 (41(10-88))	42.2±16.9 (41(10-88))	0.182
Males	259 (52.9%)	201 (60.2%)	205 (56.6%)	0.111
Females	231 (47.1%)	133 (39.8%)	157 (43.4%)	
HTN	63 (12.9%)	40 (12.0%)	43 (11.9%)	0.890
DM	55 (11.2%)	40 (12.0%)	37 (10.2%)	0.759

Table 2 Comparison of the main reported causes of acute abdomen among studied groups

	Before pandemic		During pandemic		After vaccination		*P*1	*P*2	*P*3	*P*4
Appendicitis	107	21.8%	100	29.9%	89	24.6%	0.032	0.008	0.346	0.113
Cholecystectomy	87	17.8%	56	16.8%	92	25.4%	0.006	0.713	0.007	0.005
Exploration Abdomen	39	8.0%	21	6.3%	43	11.9%	0.027	0.365	0.055	0.011
MVO / MAO	19	3.9%	46	13.8%	23	6.4%	<0.001	<0.001	0.099	0.001
perforation diverticulitis	8	1.6%	3	0.9%	0	0.0%	0.012	0.539	0.024	0.110
Strangulated hernia	103	21.0%	18	5.4%	22	6.1%	<0.001	<0.001	<0.001	0.697
Torsion testis	21	4.3%	2	0.6%	4	1.1%	<0.001	0.002	0.007	0.688

Categorical data are expressed as counts or percent. *P*1, comparison between all studied groups. *P*2, comparison between before and during the pandemic. *P*3, comparison between before the pandemic and after vaccination. *P*4, comparison between during the pandemic and after vaccination.

Table 3 Comparison of COVID-19-related clinical presentations among studied groups

	Before pandemic		During pandemic		After vaccination		*P*1	*P*2	*P*3	*P*4
Fever	37	7.6%	55	16.5%	54	14.9%	<0.001	<0.001	0.001	0.574
Cough	0	0%	30	9.0%	21	5.8%	<0.001	<0.001	<0.001	0.108
Diarrhea	7	1.4%	22	6.6%	14	3.9%	<0.001	<0.001	0.023	0.106
Nausea and vomiting	51	10.4%	55	16.5%	48	13.3%	<0.001	0.011	0.199	0.234

Categorical data are expressed as counts or percent. *P*1, comparison between all studied groups. *P*2, comparison between before and during the pandemic. *P*3, comparison between before the pandemic and after vaccination. *P*4, comparison between during the pandemic and after vaccination.

Patients reporting fever (16.5%), nausea and vomiting (16.5%), cough (9%), and diarrhea (6.6%) during the COVID-19 pandemic experienced significantly higher rates of these symptoms compared to the pre-pandemic group, but no statistically significant difference was found between the pandemic and vaccinated groups (Table 3).

Laboratory parameters were Laboratory parameters were assessed among the studied groups: pre-pandemic, In pandemic, and in vaccinated group, Lymphocyte (4.1±1.2,3.3±1.3and3.5±1.3) respectively, CRP (1.8±1.1,3.1±2.3 and 2.5±1.8) respectively, ALT(32.9±14.5, 46.7±23.6 and40.9 ±21.5) respectively AST(28.5±12.7,44.8±23.5and 38.9±21.2) respectively, d-dimer (0.7±0.8,1.1 ±1.3and0.8±0.9) respectively. When compared to other groups, ALC was significantly lower during the pandemic, as were CRP, ALT, AST, and d-dimer, and after vaccination, ALC increased significantly, while CRP, ALT, AST, and d-dimer decreased significantly, but did not reach pre-pandemic levels (Table 4).

Surgery management was observed to be much more common in the pre-pandemic group (62.7%, 55.4%, and 49.2%, respectively) than in the pandemic and post-vaccinated groups. Laparoscopic treatment, however, was considerably more common in the groups that had received vaccinations, were

Table 4 Comparison of laboratory parameters among the studied groups

	Before pandemic		During pandemic		After vaccination		*P* value *P*4			
	N=490		*N*=334		*N*=362		*P*1	*P*2	*P*3	*P*4
WBC (×109 /l)	7.3±2.7	6.87 (4-25.4)	7.5±3	6.9 (4-21.01)	7.4±2.9	6.9 (4-21.1)	0.670			
Lymphocyte (×109 /l)	4.1±1.2	4.1 (2-6.54)	3.3±1.3	2.98 (1.5-6.54)	3.5±1.3	3 (1.5-6.54)	<0.001	<0.001	<0.001	0.008
HGB (g/dl)	11.5±0.8	11.53 (10.01-12.99)	11.6±0.9	11.76 (10-12.99)	11.5±0.9	11.55 (10.02-13)	0.312			
CRP (mg/l)	1.8±1.1	1.9 (0.4-8.2)	3.1±2.3	2.7 (0.4-10)	2.5±1.8	2.4 (0.4-9)	<0.001	<0.001	<0.001	0.001
ALT (U/l)	32.9 ±14.5	33.57 (7.1-91.6)	46.7 ±23.6	45.89 (7.04-121.1)	40.9 ±21.5	39.86 (7.28-121.1)	<0.001	<0.001	<0.001	0.001
AST (U/l)	28.5 ±12.7	28.19 (8.04-88)	44.8 ±23.5	41.76 (8.14-121.1)	38.9 ±21.2	36.68 (8.13-121.1)	<0.001	<0.001	<0.001	0.001
D-Dimer (mg/l)	0.7±0.8	0.59 (0-7.1)	1.1±1.3	0.74 (0-8.55)	0.8±0.9	0.68 (0-8.2)	<0.001	<0.001	0.007	<0.001

Numerical data are expressed as mean±SD, median (min-max). *P*1, comparison between all studied groups. *P*2, comparison between before and during the pandemic. *P*3, comparison between before the pandemic and after vaccination. *P*4, comparison between during the pandemic and after vaccination.

Table 5 Comparison of management among studied groups

	Before pandemic		During pandemic		After vaccination		*P* value *P*3 *P*4			
	N=490		*N*=334		*N*=362		*P*1	*P*2	*P*3	*P*4
No surgery	17	3.5%	32	9.6%	20	5.5%	0.001	<0.001	0.146	0.042
Surgery	307	62.7%	185	55.4%	178	49.2%	<0.001	0.037	<0.001	0.101
Lap	166	33.9%	117	35.0%	164	45.3%	0.002	0.732	0.001	0.006

Categorical data are expressed as counts or percent. *P*1, comparison between all studied groups. *P*2, comparison between before and during the pandemic. *P*3, comparison between before the pandemic and after vaccination. *P*4, comparison between during the pandemic and after vaccination.

experiencing a pandemic, and were not experiencing one (45.3%, 35.0%, and 33.9%, respectively) (*P* 0.05) (Table 5).

Management time differed significantly between the studied groups. Immediate management was done among 94.3% of patients before the pandemic, which decreased significantly in the pandemic and vaccinated groups (82.3% and 89.8%, respectively). However, conservative management was significantly higher among pandemic and vaccinated people than before the pandemic (9.6%, 5.5%, and 3.5%), respectively ($P<0.05$), as well as after the pandemic, where conservative management was significantly higher among pandemic and vaccinated people than before the pandemic (8.1%, 4.7%, and 2.2%), respectively ($P<0.05$) (Table 6).

Hospital stay, days, and postoperative complications did not differ significantly between the studied groups ($P>0.05$) (Table 7).

Discussion

In this paper, we aim to compare the incidence, diagnosis, and management challenges of acute surgical abdomen cases prior to the COVID pandemic, during the pandemic, and after the vaccine. We enrolled 1186 patients with complaints of acute abdomen who came to the ER; out of them, 490 cases were examined before the pandemic, 334 cases were examined during the pandemic, and 362 cases were examined after vaccination. Among our cases; Appendicitis was the main diagnosis in pre-pandemic (21.8%) and pandemic cases, with significantly higher incidence in the pandemic period (29.9%); the association between COVID and appendicitis was mentioned previously [11,12].

SARS-CoV-2 may infect the intestinal wall because of the high expression of the viral receptor ACE2 in the gut wall, resulting in a reduction in barrier function and an increase in microbial translocation [13]. The observation of the unusual histological features of appendicular tissue, including rare microthrombi, fibrinoid necrosis of blood vessels, and perivascular lymphocytic inflammatory infiltration, supports the hypothesis that SARS-CoV-2 infection and acute appendicitis are related. Lymphocytic infiltration and fibrinous microthrombi have been seen in lung tissues from COVID-19 patients [14,15]. In addition, viral infections have been connected to mucosal ulcerations, which allow bacteria to penetrate, and lymphoid hyperplasia, which results in appendix blockage [12].

Table 6 Comparison of the time of surgery among the studied groups

	Before pandemic		During pandemic		After vaccination		*P*1	*P*2	*P*3	*P*4
Immediate	462	94.3%	275	82.3%	325	89.8%	<0.001	<0.001	0.014	0.004
Conservative	17	3.5%	32	9.6%	20	5.5%	0.001	<0.001	0.146	0.042
after conservative	11	2.2%	27	8.1%	17	4.7%	<0.001	<0.001	0.047	0.067

Table 7 Comparison of outcomes among study groups

	Before pandemic		During pandemic		After vaccination		*P*
hospital stay / days	2.4±1.7	2 (1-7)	2.7±2.1	1 (1-7)	2.3±1.8	1 (1-7)	0.129
post operative complication							
No	477	97.3%	323	96.7%	348	96.1%	0.607
wound seroma	13	2.7%	11	3.3%	14	3.9%	

Categorical data are expressed as counts or percent.

Another interesting finding in our study is that mesenteric vein occlusion or superior mesenteric artery occlusion was significantly higher in pandemic patients (13.8%) and the vaccinated (6.4%) group than in the pre-pandemic (3.9%). A study done on 184 ICU patients with proven COVID-19 pneumonia showed a high incidence of thrombotic complications [16]. The specific mechanism of COVID-19 thrombosis is uncertain. The suggested procedures are hypoxia, inflammatory mediators, thrombocythemia, immobility, and liver injury due to ACE2 receptor expression. Pre-existing cardiac illness, peripheral artery disease, advanced age, severe injury, and low cardiac output situations are all major risk factors for acute cardiac failure [16,17].

Regarding the clinical picture, we found that fever, diarrhoea, nausea, vomiting, and mostly cough were significantly higher in the COVID-19 and vaccinated groups than in the pre-pandemic group; According to recent clinical data, fever is a common symptom in both COVID-19 patients and those with acute abdomen; Five patients (17.9%) in a retrospective study done by Zhao *et al.*, they reported high body temperatures prior to emergency surgery. It is very challenging to determine the origin of a fever and positively identify COVID-19 in a timely manner [18].

Laboratory tests have shown elevated white blood cell counts in the majority of cases with acute abdomen, particularly appendicitis [11,19–21], whereas lymphopenia, considered a feature of COVID-19 infection [21], has been observed in some cases as mentioned in Ngaserin *et al.* and Malbul *et al.* studies [11,22], and Georgakopoulou *et al.* study [23]. Similarly to our study, we found that lymphopenia was significantly more prevalent in the pandemic and vaccinated groups than in the pre-pandemic.

Cytotoxic lymphocytes, such as cytotoxic T lymphocytes, and natural killer cells are well known for their importance in controlling viral infections by regulating the immune system and the inflammatory response. Previous research has linked viral infection progression to cytotoxic lymphocyte apoptosis or functional exhaustion [24].

In addition, our study revealed significantly elevated levels of CRP, d-dimer, and liver function. Since the onset of the COVID-19 pandemic, D-dimer has been identified as a potential prognostic indicator for COVID-19 patients [25]. Using data from 34 patients with acute abdomen who required emergency surgery, Zhao *et al.*, 2020 [18], determined that COVID-19 pneumonia is associated with poor liver function and coagulation function in patients with acute abdomen. All of these results demonstrated that COVID-19 likely interferes with the accurate diagnosis and clinical assessment of acute abdomen.

During the COVID-19 epidemic, it is very important that the criteria for emergency surgery are strictly followed. The following are some of the reasons why surgery may not be the best way to treat an acute abdomen with COVID-19 pneumonia: When COVID-19 patients undergo surgical procedures, the risk of SARS-CoV-2 transmission and the rate of COVID-19 pneumonia both increase [8,26]. Furthermore, oxidative stress [27] and immunosuppression [28] caused by surgery may make it more difficult to eradicate SARS-CoV-2 and hasten the spread of COVID-19 pneumonia. The issue is that this theory has a very fragile scientific basis.

In some circumstances, the use of intravenous antibiotics in conjunction with conservative therapy can result in outcomes that are equivalent [29]. It is challenging to perform an appendectomy on a patient with acute appendicitis who also has COVID-19 because it entails high surgical risks for both the patient and for healthcare personnel who have been exposed to SARS-CoV-2. The risk of treatment failure, which can lead to perforation, peritonitis, and even death, increases even while medical therapy lowers the morbidity and mortality linked to surgery [30].

In our study, conservative management was significantly higher among pandemic and vaccinated people than before the pandemic. Furthermore, studies have shown that during the pandemic, the management of acute appendicitis has shifted to more conservative interventions. In the UK, the COVID-19 outbreak has changed the treatment of appendicitis to a conservative method that has proven to be effective [31,32]. Also, Köhler *et al.*'s systematic review and meta-analysis that was done on 46 studies revealed that throughout the pandemic, significantly more patients (adults and children) got antibiotic therapy rather than surgical appendix resection [33].

During the current COVID-19 pandemic, there has also been some debate about whether to perform laparoscopic or open appendectomy on patients with acute abdominal problems. In our study, surgery

management was significantly higher in the pre-pandemic group than in the pandemic and post-vaccinated groups; however, laparoscopic management was more common in the vaccinated and pandemic groups than in the pre-pandemic groups. Even though about 60% of all appendectomies in Chang *et al.*'s study that was done on 307 appendicitis cases [34], during the pandemic, were done laparoscopically.

However, as seen in the English *et al.* study, 26 of 28 appendectomies were carried out using an open approach during the pandemic, while this number was only 3 of 52 before the pandemic [35].

Later, it was discussed whether laparoscopy was the safer choice because it put a barrier between the surgeon and the fluids in the abdomen. However, laparoscopic surgeries take longer, which means there may be a higher risk of transmission. Filtering surgical smoke appeared to reduce the risk of transmission and was thus advised [36]. According to the literature, abdominal fluid samples from patients with severe COVID-19 pneumonia tested negative for the virus [37], implying that laparoscopic or open surgery has no effect on the risk of infection for surgical staff [33].

According to a survey of 744 surgeons (from 66 countries), only one-third changed their approach from laparoscopic to open surgery as a result of popular (but evidence-free) advice from expert groups [38]. During the pandemic, there were clearly disparities in global attitudes towards laparoscopic appendectomy techniques.

This study had certain limitations that should be discussed. Due to the lack of definite practical guidance for patients with both acute abdomen and COVID-19 pneumonia, the indication and timing of the surgical treatment were decided empirically instead of based on evidence.

Conclusion

In conclusion, COVID-19 has significantly altered worldwide healthcare infrastructure, procedures, and availability. Lymphopenia was found to be an important parameter in COVID-19 diagnosis, with an increase in conservative management and laparoscopic intervention in cases of acute abdomen during the COVID-19 and vaccinated eras.

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Abbreviations: ACE 2, Angiotensin Converting Enzyme 2; ALT, Alanine Aminotransferase Test; AST, Asparate Aminotransferase Test; COVID-19, Coronavirus Disease of 2019; CRP, C-reactive protein; DM, Diabetes Mellitus; ER, Emergency Room; HGB, Hemoglobin; HTN, Hypertension; MAO, mesenteric Arterial occlusion; MVO, mesenteric venous occlusion; P value, probability value; SARS-CoV-2, Severe acute respiratory syndrome coronavirus 2; SD, Standard deviation; WBC, white blood cells; WHO, World Health Organization.

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Authors' contributions: Moatasem A. Erfan and Ibrahim Alwardany.

Authors' information: Lecturer of General Surgery.

Author details: Department of General Surgery, Misr University for Science & Technology, Giza, Egypt.

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Conflicts of interest

There are no conflicts of interest.

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