

## Research Article

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# The impact of management in the COVID-19 pandemic on acute diverticulitis severity

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### Abstract

**Objective:** The full impact of COVID-19 world-wide remains unknown. The aim of this study was to evaluate the diverticulitis severity and patient presentation during COVID lockdowns as public health concerns and to measure the impact of Emergency department avoidance on treatment.

**Methods:** A retrospective analysis of patients with simple or complicated diverticulitis admitted to the emergency department in a single tertiary center between 2020–2021 (COVID-19 outbreak), compared to a corresponding pre-pandemic period between 2019–2020, seem to be associated with more severe and complicated diverticulitis. Data were analyzed according to the ICD-9 in the electronic database.

**Results:** A total of 210 patients, all with left-sided (sigmoid colon) diverticulitis, were hospitalized during the study periods. While overall admissions for the diverticular disease were 3% lower during the COVID-19 period, there was a higher rate of surgical interventions ( $P < 0.001$ ). COVID-19 was prominent in the complicated group (82% vs 48%,  $p < 0.001$ ), resulting in higher inflammatory markers and higher disease severity. The distribution of Hinchey classification for the COVID-19 period was 44 (78.5%) patients with stage I, 3 (5.4%) patients with stage II, 8 (14%) patients with stage III, and 1 (1.8%) patients with stage IV. This was significantly different from the 55 (91.7%) patients with stage I and 5 (8.3%) patients with stage III (no class II or IV) in the control group ( $P < 0.001$ ). Multivariate logistic regression for symptoms and surgery as variables, revealed a linear relationship between recurrent attacks of complicated diverticulitis, with ORs of 1.78 (95% CI: 1.70-2.25) during the COVID-19 pandemic and 1.75 (95% CI: 1.1 to 2.1) for the duration of symptoms  $> 24$  h, respectively. Twelve patients (22%) required surgery, of whom, 9 (75%) were admitted through the emergency room and 3 (25%) were elective procedures.

**Conclusions:** Patient avoidance of Emergency department visits during the COVID-19 outbreak associated with more severe, complicated diverticulitis and the number of patients requiring urgent surgery.

## Introduction

Acute Diverticulitis (AD) is present in 10-25% of patients with diverticular disease, being most common in the sigmoid colon, with around 200.000 annual hospitalizations [1]. As many as 20% of patients are younger than 50 at diagnosis and around 5% are below the age of 40 [2]. Computed Tomography (CT), which is the gold standard imaging method for diagnosis of AD according to the American Society of Colon and Rectal Surgeons (ASCRS), has a sensitivity of 98% and a specificity of 99% [2,3].

COVID-19 is an infectious disease caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) [4]. The disease was first described in December 2019 in Wuhan, Hubei province, China, and has since spread worldwide [4]. The World Health Organization (WHO) declared the coronavirus outbreak a pandemic on 11 March 2020, with disease transmission in more than 200 countries [4].

In Israel, all schools and non-essential work facilities were closed on 12 March 2020 as part of the efforts to control the outbreak. Starting on 22 March 2020, all medical institutions initiated a strict emergency protocol by which all elective procedures, except certain oncological procedures, were postponed. During the study period, additional strict national preventative measures for social distancing were implemented [5]. We noticed that the public seemed to avoid Emergency Department (ED) visits due to fears of exposure to infected patients. Those who did come, appeared to be in a worse physical and medical condition than under normal circumstances. This study was designed to examine the effects and outcomes of the COVID-19 pandemic on patients with acute diverticulitis.

## Patients and methods

This was a retrospective study comprising all patients with diverticulitis who were admitted to the surgery department in a single tertiary center between 2020-2021 (COVID-19 outbreak), and the parallel year 2019-2020. The study was approved by the local IRB; with no informed consent needed because of the

retrospective non-interventional study design. Patients were identified according to the ICD-9 code and data were extracted from the central EMMS hospital archive section. Inclusion criteria were age above 18 years of age, a confirmed diagnosis of acute diverticulitis as assessed by CT scan, and results of a colonoscopy in the period in question. Exclusion criteria were, inflammatory bowel disease, collagenous colitis, microscopic colitis, eosinophilic colitis, oncological disease diagnosis, and treatment with immunosuppressive agents.

All patients underwent a CT with IV contrast after arrival at the ED. Blood samples were taken for CRP assessment and a complete blood count including leucocytes, neutrophils, and platelets, from which the values for the ratios of Neutrophils to Lymphocytes (NLR) and Platelets to Lymphocytes (PLR) were extracted. A classification of Simple Diverticulitis (SD) or Complicated Diverticulitis (CD) was based on analysis of the CT images by expert radiologists.

All patients were treated by the same protocol, which involved fluid resuscitation, antibiotic therapy, NPO, and hospitalization. Patient demographics including age, gender, and BMI, are presented in Table 1, together with a description of the symptoms, recurrence of attacks, and classification of imaging results by Hinchey stage traditionally been used in to distinguish four stages of perforated disease: I- pericolic, abscess or phlegmon, II pelvic, intraabdominal or retroperitoneal abscess, III purulent peritonitis and IV-fecal peritonitis. While simple diverticulitis by definition used to described mild clinical diverticulitis with lower abdominal pain, low grade fever, leukocytosis, and the diverticular inflammation and complications assessment (DICA) score, which measures severity. Laboratory parameters collected including CRP, WBC, NLR, and PLR are summarized in Table 2. While NLR, PLR WBC and CRP, Hinchey score, and DICA performance at optimal cutoff point values summarized in Table 5. Post-operative variables including hospitalization duration, onset of symptoms, and antibiotic usage, are summarized in Table 3, and treatment of the subset of patients with complicated diverticulitis is summarized in Table 4.

**Table 1:** Study population demographics.

	Covid-19 group (2020 - 2021) N = 102		P Value	Control group (2019 - 2020) N = 108		
	CD N = 56	SD N = 46		CD N = 60	SD N = 48	P Value
age						
Mean	70 ± 11	76 ± 9.2	0.001	70 ± 9.8	72.5 ± 8.9	0.505
Median	72	78		71.5	75	
Range	45 - 87	55 - 91		45 - 92	46 - 94	
Gender						
Male	30 (53%)	23 (50%)	0.280	32 (53%)	29 (72.5%)	0.002
Female	26 (47%)	23 (50%)		28 (47%)	19 (39.5%)	
BMI(kg\m <sup>2</sup> )						
Mean	37.6	37.8	0.605	37.6	37.5	0.320
Median	38	38		38	38	
Range	33 - 40	33 - 40		33 - 40	33 - 40	
Symptoms:	56(100%)	45(100%)	0.222	60(100%)	48(100%)	0.444
Abdominal pain	20(35%)	5(10%)	0.001	18(30%)	7(14.5%)	0.001
Fever	12(21.5%)	0(100%)	0.001	10(16%)	0(100%)	0.001
COVID-19+	46(82%)	22(48%)	0.001	0(0%)	0(0%)	N/A
Onset of symptoms \d	6.01 ± 2.2	3.52 ± 1.8	0.005	4 ± 1.6	1.5 ± 1.5	0.001
Recurrence >2 attacks	19(34%)	6(13%)	0.002	21(35%)	7(14.6%)	0.001

CT- Hinchey score (%)						
Stage I	44(78.5%)	0	<0.005	55(91.7%)	0	<0.005
Stage II	3(5.4%)	0		0	0	
Stage III	8(14%)	0		5(8.3%)	0	
Stage IV	1(1.8%)	0		0	0	
Colon- DICA score/%						
I	0	32(69.5%)	<0.005	0	25(52%)	0.001
II	37(66%)	14(30%)	<0.005	47(78.4%)	23(48%)	<0.005
III	19(34%)	0	0.001	13(21.6%)	0	0.001

**Table 2:** Laboratory data of the study population.

	COVID-19 group (2020 - 2021)			Control group (2019 - 2020)		
	CD group N = 56	SD group N = 46	P Value	CD group N = 60	SD group N = 48	P Value
Neutrophils to lymphocytes ratio						
Mean	11.1	7	0.001	10.2	6.04	0.001
Median	9.8	6.6		9	5.1	
Range	2.1 - 55	1.7 - 33		3.5 - 49	1.3 - 15	
Platelets to lymphocytes ratio						
Mean	202.5	171.6	0.001	200	161.8	0.001
Median	183.5	169		189.6	141.8	
Range	67.8 - 640	63 - 640		71 - 550	61 - 428	
CRP						
Mean	10.9	5.5	0.001	9.1	3.26	0.001
Median	11	5.2		3.9	1.1	
Range	0.1 - 38	1.1 - 15		1.1 - 22	0.1 - 15	
WBC (10*9/L)						
Mean	15 ± 6.9	11	0.001	13.3 ± 2.6	10.1	0.001
Median	14.45	12.5		12.9	9.1	
Range	5.7 - 29	6.6-19		6.1 - 19	6.3-15	

**Table 3:** Hospitalization characteristics.

	COVID-19 group (2020 - 2021)			Control group (2019 - 2020)		
	CD group N = 56	SD group N = 46	P Value	CD group N = 60	SD group N = 48	P Value
Length of Hospitalization (days)						
Mean	6.5	3.28	0.002	7.5	4.68	0.002
Median	6	3		7	4	
Range	3 - 9	2 - 6		5 - 10	3 - 9	
Onset of symptoms (days) prior to ED visit						
Mean	6	3.52	0.001	4	2	0.001
Median	7	4		4	2	
Range	4 - 10	2-4		2-4	1 - 2	
Treatment						
AB	+	+	ns	+	+	ns

**Table 4:** Surgical Treatment of Patients with Complicated Diverticulitis.

	COVID-19 group (2020 - 2021) Complicated group N = 56	Control group (2019 - 2020) Complicated group N = 60	P value
Location\CT sigma	56(100%)	60(100%)	ns
Percutaneous drainage	0(100%)	0(100%)	ns
Surgery	12(22%)	5(8.3%)	0.001
Elective	3 of the 12 (25%)	1 of the 5 (20%)	0.420
Emergency	9 of the 12 (75%)	4 of the 5 (80%)	0.220
Hartman	8 of the 12 (66%)	3 of the 5 (60%)	0.064
Lavage+drain	0(0%)	1 of the 5 (20%)	Ns
Anastomosis	4 of the 12 (33%)	0(0%)	ns
Onset of symptoms before admission\day	7(100%)	3.5(100%)	0.001

**Table 5:** NLR, PLR WBC and CRP, Hinchey score, and DICA performance at optimal cutoff point values.

	Optimal cutoff point	Sensitivity %	Specificity %	PPV%	NPV%
NLR	5	72	79	82	79
PLR	183	83	77	79	76
WBC	11	79	77	81	76
CRP	5	81	79	84	72
Hinchey score	2	77.6	79.4	86	78
DICA	2	79.6	77.4	78	76

Data were analyzed using SPSS version 25.0 software (IBM Corp, Armonk, NY, USA). All P values were two-sided, and significance was defined as  $P < 0.05$ . Statistical analyses included descriptive analysis (mean, median, and range) and standard deviation for continuous variables, with proportions for discrete variables, and comparative tests (chi-square for discrete variables and t-test for continuous variables). A multivariable logistic regression analysis adjusted for duration of symptoms longer than 24 h was used to assess the association between hospitalization during the COVID-19 pandemic and having complicated diverticulitis. A post hoc power analysis was conducted. Values of  $P < 0.05$  with 95% confidence interval (95% CI) and 5% margin of error were considered statistically significant.

## Results

A total of 210 patients with diverticulitis were hospitalized during the two study periods: 102 patients in the COVID-19 group and 108 in the control group in the previous year. Classifying patients according to Complicated or Simple Diverticulitis (CD and SD groups), 56 and 46 patients had CD and SD respectively in the COVID-19 group compared to 60 and 48 respectively in the control group. The total number of admissions for diverticular disease was 3% lower during the COVID-19 period than in the control period but the number of surgical interventions required was significantly higher,  $P < 0.001$ .

Classifying patients according to the type of diverticulitis (SD and CD), there were no significant differences in BMI between the groups or study periods. However, the mean age of patients admitted with CD in the COVID-19 group was significantly higher than in the appropriate control group ( $76 \pm 9.2$  y vs  $72.5 \pm 8.9$  y,  $P < 0.001$ ), and there were significantly more males in the SD group of the control arm (72.5% males,  $P = 0.002$ ).

The most frequently observed symptom in all patients was abdominal pain (100%). Fever were more prominent in the CD groups in both periods (arms), with a significant difference between the COVID-19 year and the control group. COVID+19 was prominent in the complicated group (82% vs 48%,  $p < 0.001$ ), resulting in higher inflammatory markers and higher disease severity.

The mean time interval between the initiation of symptoms and the ED visit was longer in the COVID-19 group compared to the control ( $6.01 \pm 2.2$  days compared to  $4 \pm 1.6$  days for CD, and  $3.52 \pm 1.8$  days compared to  $1.5 \pm 1.5$  days for SD). During the COVID-19 pandemic, patients presenting after  $> 24$  h from symptom onset were older than patients presenting within 24 h of onset of symptoms (mean age  $76 \pm 9.2$  y compared to  $72.5 \pm 8.9$  y,  $P < 0.001$ ). No age differences in time of presentation were seen in the control arm. In addition, a larger proportion of patients with an increased risk for a more severe course of COVID-19 (age  $\geq 76$  years) presented after  $>24$  h during the COVID-19 pandemic compared to the control 2019 cohort.

All cases were left sided (sigmoid colon) diverticulitis and all patients underwent endoscopic evaluation and were scored for diverticular inflammation and complication assessment (DICA) and Hinchey staging. The distribution of Hinchey classification for the COVID 19 period was 44 (78.5%) patients with stage I, 3 (5.4%) patients with stage II, 8 (14%) patients with stage III, and 1 (1.8%) patient with stage IV. This was significantly different to the 55 (91.7%) patients with stage I and 5 (8.3%) patients with stage III (no class II or IV) in the control group ( $p < 0.001$ ).

There was a significant difference in DICA scoring in the CD groups between the COVID-19 and control arms with a score of II for 37 (66%) and 47 (78.4%) patients respectively and III for 19 (34%) and 13 (21.6%) patients respectively,  $P < 0.001$ . The values for the SD group were a score of I for 32 (69.5%) and 25 (52%) patients in the COVID-19 and control arms respectively and II for 14 (30%) and 23 (48%) patients respectively.

Patients in the COVID-19 cohort presented with a higher level of leukocyte disturbances than in the control (mean  $15 \pm 6.9$  and  $13.3 \pm 2.6$  of CD group patients respectively,  $P = 0.001$ ), with higher values for NLR and PLR values (11.1 vs. 10.2, and 202.5 vs 202,  $P = 0.001$ ), and CRP (10.9 vs. 5.5, 9. vs 3.26 mg/L,  $P < 0.0001$ ). No differences were noted in temperature, creatinine, or hemoglobin.

The results of a univariate model analysis revealed that age, NLR, PLR, and DICA II and III correlated with advanced Hinchey classification ( $P < 0.001$ ) but there were no differences in the basic laboratory test (Hb, platelets, and kidney/liver function) between the groups.

A linear relationship was found between recurrent attacks in complicated diverticulitis. These associations persisted by multivariate logistic regression including both variables (symptoms and operation), with ORs of 1.78 (95% CI: 1.70–2.25) for presentation during the COVID-19 pandemic and 1.75 (95% CI: 1.1 to 2.1) for duration of symptoms  $> 24$  h, respectively. Similarly, there was a significant correlation between the NLR and PLR (odds ratio (OR) 1.1, 95% CI 1.0–1.2,  $P < 0.001$ , and OR 1.0, 95% CI 0.9–1.0,  $P < 0.001$ , respectively).

Not unexpectedly, there were more cases of recurrent diverticulitis in the CD than the SD group (34% and 35% vs 13% and 14.6% respectively,  $P < 0.002$ ).

A ROC curve analysis for the NLR, PLR, WBC, CRP, and DICA parameters, was used to define a threshold above the normal limit and predict diverticulitis severity. The AUCs for the NLR and PLR on univariate analysis were 0.68 and 0.72, and the values for WBC, CRP and DICA were 0.78, 0.77, and 0.79 respectively. The Youden index ( $J$ ) for several cutoff points for NLR and PLR demonstrated a correlation with advanced Hinchey classification, with values of  $>4.4$ ,  $<141.15$  respectively, corresponding to a sensitivity of 72%, 79% and a specificity of 79%, 77% respectively.

Similarly, the Youden index (*J*) values for CRP, WBC, and DICA were <0.5, <13, and <6 points corresponding to a sensitivity and specificity of 82%, 79%, and 79%, and 77%, 77%, and 78%, respectively.

Higher inflammatory parameters, were positively correlated with the need for surgical intervention and the mean NLR and PLR of patients who needed surgery during the hospitalization were 9.8 and 183 respectively,  $P < 0.001$ .

As might be expected, the duration of hospitalization was significantly longer for CD than for SD patients (6.5 days compared to 3.26 days in the COVID-19 group, and 7.5 days compared to 4.26 days in the control group),  $P < 0.001$ .

Another expected result was that the time from onset of symptoms to arrival at the ED for patients who did not require surgery, was longer in the COVID-19 year than in the control period, with values of 6 vs 4 days in the CD group 3.5 vs 2 in the SD group,  $P < 0.001$ , for all differences.

During the COVID-19 period, 12 patients (22%) with CD underwent surgery. Nine (75%) of these patients were admitted as emergency cases through the ED and 3 (25%) were elective procedures. Eight (66%) of the emergency cases in the COVID-19 year had a Hartman procedure and 4 (33%) underwent resection and anastomosis reconstruction. In contrast, only five (8.3%) patients in the control year required surgery, where four (80%) were emergency cases, (two Hartman procedures and the two laparoscopic lavage and drainage), and the fifth patient was an elective procedure.

## Discussion

COVID-19 has posed serious challenges to many healthcare systems across the world. The WHO has stated that education, isolation, prevention, controlling the transmission, and treatment of infected persons are the critical steps in controlling this contagious disease [6]. Regulations designed to decrease disease spread included recommendations to stay at home and minimize any unnecessary social connection. This caused the public and general practitioners to avoid or delay visits and referrals to EDs, even for patients experiencing acute abdominal complaints.

We hypothesized that the COVID-19 pandemic would indirectly affect patient's decision making concerning emergency admissions, especially in cases of acute diverticulitis. We therefore performed a retrospective, comparative study to compare acute diverticulitis admissions during the COVID-19 pandemic with the situation in the parallel prior year before the pandemic. The results indicated that during the pandemic, patients tended to wait and eventually arrived at the ED with an increased severity of acute diverticulitis, which required surgical intervention.

The demographic characteristics of the study populations in the two periods were almost identical, meaning that no change in age related disease appeared during the pandemic.

A minor decrease (3%) in overall diverticulitis admissions was observed during the Covid-19 pandemic, although of the distribution of CD and SD remained stable (55% CD and 45% SD). These results are supported by other studies [7], that reported a decrease in admission for simple diverticulitis but a higher rate of admission for complicated diverticulitis, with half the patients exhibiting an associated abscess (4.4% or 15 patients).

Treatment protocol was identical for all patients, however the rate of surgical interventions required was higher in the CD Covid-19 group with a value of 22% compared to 8.3% in the previous control year.

This may be because patients tended to delay their arrival after the onset of symptoms and arrived in a worse physical condition, thereby missing the option of conservative treatment.

Multivariable regression analysis revealed an association between complicated diverticulitis and presentation during the COVID-19 pandemic, independent of late presentation. In accordance with our results, another Israeli study [8] also reported a significant decrease in patients admitted with uncomplicated diverticulitis during the COVID-19 pandemic, compared to an antecedent period. It may be concluded that the COVID-19 pandemic and the Israeli lockdown discouraged patients from visiting an emergency department and thereby increased the chances of developing more severe disease. The observation that our study detected no significant differences in the number of diverticulitis admissions during the pandemic may be attributed to the low social economical state of the population the hospital serves.

Interestingly, the increased clinical severity of patients with complicated diverticulitis admitted during the COVID-19 period has not been reflected in higher mortality rates.

The length of hospital stay was significantly shorter during the COVID-19 period, which probably reflects patient and healthcare fund fears of in-hospital exposure to and infection with the virus, and the desire of medical teams to decrease the number of in-house patients. Although we anticipated that this trend towards the earliest possible discharge would result in increased readmissions, no such evidence was detected in our short study period compared to the parallel year.

Another important observation, is the significant increase in inflammatory markers during the COVID-19 periods. The worsening in the condition of patients arriving at the emergency room, was probably due to fear of infection with COVID-19. The study of Aviran E et al [8] show also reported higher inflammatory markers and leukocyte disturbances (leukocytosis or leukopenia), a higher CRP level, and decreased renal function. In this context, the NLR has previously been reported to be a reliable marker for detecting patients with sepsis at presentation to the emergency room [9], and the parameter has been associated with the requirement for surgical intervention in patients with acute diverticulitis [10]. Accordingly, the results of our study indicated that the NLR and PLR are independently associated with increased surgical intervention. This positive correlation is reflected by the correlation of the NLR and PLR with an advanced Hinchey classification, which indicates the presence of severe complicated acute diverticulitis that necessitates surgery.

To date, no studies have combined laboratory results with imaging and colonoscopy to report the prognostic role of the DICA score in acute diverticulitis. Our results and particularly in the COVID-19 period, demonstrated a strong correlation between the DICA score and the NLR\PLR and Hinchey stage as well as a need for surgical intervention. Moreover, the sensitivity and specificity of ROC cutoff points (DICA 2) generated represent a useful addition to patient evaluation and assessment of the severity of complicated diverticulitis.

Our study is limited by the retrospective design and because it is based on experiences within a single unit. However, al-

though these issues could represent a potential pitfall, all the data collected were available in the electronic medical records and no missing data points were noted. The strengths include the relatively larger cohort number and the presence of a CT scan that accurately evaluated the complications of diverticulitis. Further studies addressing regional or national registries may provide a more definite answer to the question of how COVID-19 has affected complicated diverticulitis, surgical interventions required, hospitalizations, and patient outcomes.

### Conclusion

Our study examined the implications of the COVID-19 pandemic for the presentation and outcomes of patients with both simple and complicated acute diverticulitis. The results indicated that fewer patients presented to the ED during the COVID-19 pandemic, and those who did arrive, often did so with a delay that worsened their clinical condition as demonstrated by deteriorations in clinical, laboratory, and surgical parameters. We therefore recommend healthcare systems to educate the general population and community healthcare providers about the importance of seeking required urgent medical or surgical attention in the ED in a timely fashion.

### Declarations

**Conflict of interest:** The author, and other co-authors declare that they have no conflict of interest.

Compliance with ethical standards.

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**Data Availability:** The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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