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COVID-19: From resource restriction to surgical services – How we waived off the waves

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ABSTRACT

Objectives: In India, more than 43 million people were infected with the novel coronavirus (CoV), and more than 0.5 million deaths occurred in 2020–2022. This severely affected the surgical services as well as the management of non-CoV disease (COVID) patients, especially in a transformed tertiary COVID care center.

Materials and Methods: This cohort study was conducted at the Department of Surgical Gastroenterology, Medical College Hospital, Kolkata, India, from March 12, 2020, to May 31, 2022. The study included patients hospitalized for gastrointestinal surgeries matched with those having the same pathology and treated before February 29, 2020, (pre-pandemic) in a 1:1 ratio. Patients treated primarily in other departments and those who died undiagnosed were excluded from the study.

Results: In total, 344 patients were operated on. A comparison of 30-day mortality did not show any significant difference ($P = 0.74$, odds ratio [OR]: 0.093, 95% confidence interval [CI]: 0.021–2.458). Time to admission ($P = 0.003$, OR: 1.512, 95% CI: 0.124–3.587) and time to surgery ($P < 0.001$, OR: 2.031, 95% CI: 0.023–6.738) were significantly high. Only pulmonary complications ($P = 0.002$, OR: 1.958, 95% CI: 1.021–3.968) were significantly high in the COVID-19 era. Patients infected with CoV in the perioperative period had a significantly higher morbidity ($n = 50$, OR: 2.58, 95% CI: 1.74–14.62).

Conclusion: When scientifically managed, improved outcomes may be expected in the pandemic, even though many stones of epidemiology remain unturned.

Keywords: Coronavirus disease 2019, Surgical outcome, Complications

INTRODUCTION

For centuries, zoonotic diseases have affected human lives. Zoonotic spillover represents a global health burden and is poorly understood. Coronaviruses (CoVs), first reported in 2002–2003 in Guangdong Province, China, were known to cause severe acute respiratory syndrome (SARS-CoV).[1] A decade after SARS, the Middle East Respiratory Syndrome Coronavirus emerged in the Middle East, and again after a decade, novel CoV 2019 marked its footprints in Wuhan, China in December 2019.[1] India recorded the first case of CoV Disease 2019 (COVID-19) on January 27, 2020, and was certainly the country suffering the most from the COVID-19 outbreak.[2] On March 11, 2020, the World Health Organization declared a public health emergency of international concern.[3] In India, the number of COVID-19 cases started increasing in March 2020. In total, 103 new cases were reported on March 23, 2020. A nationwide lockdown was imposed on March 24, 2020. This lockdown completely halted the movement of the 138-crore Indian population, marking the onset of the first wave in India.

With the exponential rise in COVID-19 cases, the healthcare system was severely stretched, as there was an urgent requirement for extra beds for isolation and critical care, extra manpower for effective delivery of healthcare services, and extra measures for infection containment and boosting research to overcome the pandemic.[4,5] Surgery was only restricted to emergency procedures and oncology care.[5,6] With restrictions on the movement of the public transport system, patients were facing difficulty in affording a private patient transport vehicle. Hospital beds were mostly reserved for COVID-19 patients. This problem intensified when Medical College Hospital, Kolkata, India was declared a tertiary-level COVID-19 hospital on May 07, 2020, with reservation and diversion of all resources to COVID-19 care. Non-COVID-19 non-emergency surgeries were resumed on

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June 16, 2020, with restricted healthcare personnel, operating rooms, and intensive care beds.

The Department of Surgical Gastroenterology at the Medical College Hospital provided uninterrupted services to both COVID-19 as well as non-COVID-19 patients, strictly following the guidelines laid down from time to time by state health policy, Indian Council of Medical Research, and various international consensuses. Amid the waves of COVID-19, the department gradually evolved with a new normal protocol, taking precautions to prevent the transmission of infection and managing COVID-19 patients requiring our specialist services and non-COVID cancer patients. This study assesses how COVID-19 affected the patients and surgical services, formulations of new normal protocols, outcome assessment of patients in the COVID-19 and non-COVID-19 era, and outcome of patients having COVID-19 and requiring surgical care.

MATERIALS AND METHODS

Study population

This retrospective study was conducted in the Department of Surgical Gastroenterology, Medical College Hospital, Kolkata, India. Patients hospitalized in the said department from March 12, 2020, to May 31, 2022, (COVID-19 era) were included in the study. Patient data were collected from the prospectively maintained departmental database, the institutional COVID-19 registry, the operating room registry, and the intensive care unit registry. Patients primarily managed in departments other than the Department of Surgical Gastroenterology; those who died undiagnosed; and those requiring minor surgical care such as wound care, removal of a feeding tube, or an abdominal drain were excluded from the study. Patients who attended the said department until February 29, 2020, and underwent identical treatment for the same disease were matched in a 1:1 ratio with those treated during the study period and included in the control group.

Systematic screening for COVID-19 patients requiring intervention began after March 15, 2020. Both nasopharyngeal and oropharyngeal swabs were tested for SARS-CoV-2 through reverse transcriptase-polymerase chain reaction (RT-PCR). Chest computed tomography was performed to detect lung abnormalities. The results of at least one of the aforementioned tests should be positive for a COVID-19 diagnosis.

The study was approved by the institute's ethics committee (MC/KOL/IEC/NON-SPON/1317/05/2022 dated May 18, 2022) and is registered with CTRI (CTRI/2022/08/044722).

Outcomes

The primary endpoint includes the evaluation of 30-day postsurgical morbidity and mortality in patients managed during the COVID-19 era compared with those managed during the pre-COVID-19 era. The secondary endpoint includes the assessment of risk factors influencing the outcome of patients in the COVID-19 era.

Data collection

The following data were collected for all included patients: Age, sex, body mass index (BMI), comorbid conditions, and American Society of Anesthesiologists (ASA) class. Perioperative factors analyzed were a complete hemogram, renal function tests, liver function tests, C-reactive protein, chest radiography, electrocardiogram, and echocardiogram. Types of surgery and complications were evaluated using the Clavien-Dindo classification system and comprehensive complication index (CCI).[7-10] Delays in admission, readmission, delay in operative intervention, and hospital stay, including requirements for high dependency and intensive care units, were also recorded.

Evaluation of patients during the COVID-19 era

All patients were evaluated with standard pre-operative investigations as in the pre-COVID-19 era. COVID-19-positive patients were only eligible after a waiting period of 4 weeks from the first positive test and had no complications. All patients were admitted to the isolation ward and their nasopharyngeal and oropharyngeal swabs were collected for RT-PCR for COVID-19 detection. If the results were negative, the patients were shifted to the general ward. This negative report was valid for surgery only if surgery was conducted within 7 days of receipt of this report. A high-resolution CT scan of the thorax was also conducted in COVID-19-affected patients, as any pulmonary sequelae of COVID-19 would have a severe impact on surgical outcomes. Our department continues to implement enhanced recovery after surgery as in the pre-COVID-19 era.

Statistical analysis

All baseline characteristics were represented as numbers and percentages, the mean and standard deviation, or the median and range, as applicable. Qualitative data were analyzed using the Chi-square or Fisher exact test. Quantitative data were analyzed using the Student's *t*-test or the Mann–Whitney test, as applicable. $P \leq 0.05$ was considered statistically significant. Statistical analysis was performed using SPSS software (version 28.0.1. 1, IBM Corp, Armonk, NY).

RESULTS

Baseline matching

Of the 3168 patients attending the Outpatient Department of Surgical Gastroenterology, 344 were admitted and operated

on during the study period. This cohort had a female preponderance (n = 197, 57.26%). The median patient age was 42 years, and the mean BMI was 22.55. Most patients had ASA Class I (56.39%), followed by II (41.86%) and III (1.74%) [Table 1]. Among the 344 patients, 50 (14.53%) were positive for SARS-CoV-2 in the perioperative period.

Patients operated on during the study period were matched with historical controls who had the same surgical pathology and were operated on by the same surgical team but before the onset of the COVID-19 pandemic. Except for hypothyroidism and chronic renal disease, no significant differences were evident between the two groups [Table 1].

COVID-19 and surgery

The median time to admission (number of days between enlistment for admission and admission) was 18 days, which was significantly more than that required in the pre-COVID era [Table 2]. Emergency surgery was performed in <1% of cases. Among the 344 patients operated on during the COVID-19 pandemic, 84 (24.33%) underwent surgery for colorectal diseases, while the remaining patients underwent surgery for the pancreas (28.35%), biliary tract (17.15%), stomach (16.28%), esophagus (8.42%), hepatic system (3.48%), and portal hypertension (1.16%). The median time to surgery (number of days from admission to the day of surgery) was significantly higher in the COVID-19 era than in the pre-COVID-19 era. However, no significant difference was observed in the time to discharge (number of days from surgery to discharge) between the patients operated on in the COVID-19 period and those operated on in the pre-COVID-19 era.

Intensive care and high-dependency unit stays and complications

Although no significant difference was observed in patients requiring a stay in the intensive care unit between the two eras, the stay in the high-dependency unit was significantly longer in controls than in cases. The decreased availability of intensive care during the pandemic resulted in the management of patients in high-dependency units, which explains this disparity. Because of the SARS-CoV-2 pathology affecting the respiratory, cardiac, and renal systems and thromboembolism, we specifically monitored complications involving these systems.

Pulmonary complications (n = 47, 13.66%) were the most frequent complications and were significantly higher in those operated on in the COVID-19 era. Pulmonary complications were also significantly higher in patients with prior exposure to the COVID-19 virus (n = 39, odds ratio [OR]: 4.36, 95% confidence interval [CI]: 1.58–14.36). Pulmonary complications

Table 1: Baseline characters used for matching.

Variable	Case (n=344)	Control (n=344)	Total (n=688)	P-value
Age (Median)	42	44	86	0.24
(IQR)	(31–54)	(31–56)	(31–56)	
Sex				
Male	147 (42.73)	136 (39.54)	283 (41.33)	0.57
Female	197 (57.27)	208 (60.46)	405 (58.86)	
BMI	22.55	24.36	23.78	0.14
Emergency cases				
Yes	3 (0.87)	7 (2.03)	10 (2.9)	0.99
No	341 (99.12)	337 (97.96)	678 (98.54)	
ASA[1] class				
I	194 (56.29)	181 (52.59)	375 (54.51)	0.36
II	144 (41.74)	144 (42.21)	288 (41.86)	
III	6 (1.97)	13 (3.72)	19 (2.76)	
IV	0	6 (1.48)	6 (0.87)	
V	0	0	0	
Comorbid conditions				
Hypertension	65 (18.90)	59 (17.15)	124 (18.02)	0.75
Diabetes	51 (14.82)	48 (13.95)	99 (14.39)	0.58
COPD[2]	16 (4.65)	14 (4.07)	30 (4.36)	0.12
Hypothyroidism	56 (16.27)	50 (14.53)	106 (15.40)	0.03
Chronic renal disease	12 (3.49)	11 (3.19)	23 (3.34)	0.01
Neoadjuvant therapy				
Yes	57 (24.15)	53 (22.45)	110 (23.31)	0.29
No	179 (75.85)	183 (77.55)	362 (76.69)	

[1]American society of anesthesiologists, [2]Chronic obstructive pulmonary disease, BMI: Body mass index, IQR: Interquartile range

Table 2: Statistical analysis of perioperative factors and outcomes of patients.

Variable	Cases (*n*=344)	Control (*n*=344)	*P*-value	OR	95% CI
Type of surgery			0.99	1.286	0.925–2.347
Elective	341 (99.12)	337 (97.96)			
Emergency	3 (0.87)	7 (2.03)			
Type of operation					
Esophagus					
Benign	21 (6.1)	21 (6.1)			
Malignant	08 (2.32)	08 (2.32)			
Stomach					
Benign	14 (4.07)	14 (4.07)			
Malignant	42 (12.21)	42 (12.21)			
Colorectal					
Benign	08 (2.32)	08 (2.32)			
Malignant	76 (22.1)	76 (22.1)			
Hepatic					
Benign	08 (2.32)	08 (2.32)			
Malignant	04 (1.16)	04 (1.16)			
Biliary					
Benign	28 (8.14)	28 (8.14)			
Malignant	31 (9.01)	31 (9.01)			
Pancreatic					
Benign	25 (7.27)	25 (7.27)			
Malignant	75 (21.8)	75 (21.8)			
PTHN[1]	04 (1.16)	04 (1.16)			
Duration of Surgery (minutes) (mean, SD)			0.074	1.082	0.582–4.104
Esophagus					
Benign	314.21 (45.66)	298.57 (47.41)			
Malignant	329.54 (57.12)	347.23 (45.68)			
Stomach					
Benign	54.12 (24.25)	62.57 (37.58)			
Malignant	229.48 (57.85)	204.34 (64.89)			
Colorectal					
Benign	136.45 (79.32)	121.14 (68.56)			
Malignant	159.45 (67.24)	148.57 (44.58)			
Hepatic					
Benign	94.28 (24.11)	102 (28.45)			
Malignant	228.38 (45.58)	245.36 (48.45)			
Biliary					
Benign	154.54 (24.28)	136.48 (27.35)			
Malignant	294.58 (54.75)	308.32 (41.52)			
Pancreatic					
Benign	116.34 (35.27)	102.53 (43.52)			
Malignant	382.42 (57.84)	374.21 (63.85)			
PTHN[1]	227.54 (54.58)	245.52 (64.21)			
Time to admission (days)			0.003	1.512	0.124–3.587
Mean (SD)	19.85 (2.54)	11.31 (3.89)			
Median (IQR)	18 (8–25)	10 (7–13)			
Time to surgery (days)					
Median (IQR)	14 (10–18)	8 (6–11)	<0.001	2.031	0.023–6.738
Time to discharge (days)					
Median (IQR)	10 (6–16)	10 (7–14)	0.47	4.685	1.256–7.295
Complications					
Respiratory	47 (13.66)	39 (11.33)	0.002	1.958	1.021–3.968
Cardiac	8 (2.32)	7 (2.03)	0.74	3.658	0.035–8.254
Renal	16 (4.64)	21 (6.1)	0.08	8.354	4.321–16.876

(Contd...)

Table 2: *(Continued)*

Variable	Cases (*n*=344)	Control (*n*=344)	*P*-value	OR	95% CI
Thromboembolic	2 (0.58)	3 (0.87)	0.34	0.785	0.381–6.873
ICU[2] Stay					
Median (IQR)	0.00 (0.00–8.00)	1 (0.00–7.00)	0.85	4.865	1.961–7.261
HDU[3] stay					
Median (IQR)	4 (0.00–12)	7 (0.00–14)	0.002	2.234	0.876–6.387
Clavien Dindo					
None	84	90	0.15	1.623	1.014–4.857
I	226	219			
II	22	21			
III	2	3			
IV	4	6			
V	6	5			
CCI[4]					
Mean (SD)	10.13 (13.50)	9.86 (11.74)	0.07	1.983	1.011–5.232
Mortality	6 (1.74)	5 (1.45)	0.74	0.093	0.021–2.458
Total duration of stay (days)					
Median (IQR)	19 (13–25)	17 (12–26)	0.99	0.857	0.065–5.326

[1]Portal hypertension, [2]Intensive care unit, [3]High dependency unit, [4]Comprehensive complication index, SD: Standard deviation, IQR: Interquartile range, OR: Odds ratio, CI: Confidence interval

included pneumonia (n = 32) and pleural effusion (n = 15). Twelve patients required high-flow oxygen, one patient acquired a COV infection in the postoperative period, and two patients required invasive mechanical ventilation.

Renal complications (n = 16, 4.64%) were the second most common post-operative adverse event. Twelve patients had oliguria, four had urinary tract infections, and four required re-insertion of the urinary catheter. Eight patients (2.32%) had cardiac complications, required inotropic support (n = 4), and had arrhythmias (n = 4). Deep vein thrombosis was noted in two patients. None of the complications, except pulmonary complications, were clinically significant in the COVID-19 era. Wound complications were rare and insignificant. Classifying complications according to the Clavien-Dindo system, we found that most patients had Grade I (n = 226, 65.69%), followed by Grade II (n = 22, 6.39%), Grade V (n = 6, 1.74%), Grade IV (n = 4, 1.16%), and Grade III (n = 2, 0.58%) complications. 84 patients (24.41%) had no complications. The CCI, which was the sum of all complications that are weighted for their severity (multiplication of the median reference values from patients and physicians), did not differ between the groups. Six patients died after the operation during the COVID-19 period. One patient had acquired a COVID-19 infection and could not be salvaged; four patients died due to postoperative septicemia; and one patient died due to secondary bleeding after surgery [Table 2].

Risk factor analysis

Because the mortality rate (1.74%) and discharge rate (98.26%) are unbalanced in the analysis, we used pulmonary complications as the outcome variable for the risk factor analysis. In the univariate analysis, diabetes mellitus, chronic obstructive pulmonary disease, chronic kidney disease (CKD), ASA Grades III and IV, pre-operative COVID-19 infection, and use of steroids during the COVID-19 infection were considered significant risk factors for pulmonary complications. However, major risk factors in the multivariate analysis include diabetes mellitus, CKD, ASA Grade IV, pre-operative COVID-19 infection, and steroid use.

Compared with patients who received the surgical intervention and did not acquire COVID-19 infection in the COVID-19 era, patients who received the surgical intervention and acquired COVID-19 infection were found to have significantly increased morbidity (n = 50, OR: 2.58, 95% CI: 1.74–14.62) [Table 3].

DISCUSSION

CoV is an enveloped positive-strand ribonucleic acid (RNA) virus that derives its name from its characteristic crown-like appearance and has the largest known viral RNA genome.[11-13] SARS-CoV-2 marked its deep impact across the globe in all sectors, including medical sciences. Although lockdown was imposed in our country and treatment was diverted toward CoV management, considering that the complications of delay in the treatment of oncologic care might be grievous, other departments were allowed to resume patient care.

When analyzing morbidity and mortality throughout the COVID-19 era, the epidemiological triad of CoV (agent), mankind (host), and socioeconomic condition (environment) all left footprints on the outcome. The virus keeps on

Table 3: Analysis of complication of patients acquiring COVID-19 infection in perioperative period.

Acquiring COVID-19 infection	Number of patients	CCI Mean (SD)	Mortality
Before attending OPD	22	11.42 (9.27)	0
After attending OPD and before admission	14	9.42 (6.23)	0
After attending admission and before surgery	12	12.8 (6.74)	0
After surgery and before discharge	2	56.1 (4.08)	1
Total	50	22.43 (19.47)	1
P-value		0.02	0.54

CCI: Comprehensive complication index, SD: Standard deviation, COVID-19: Coronavirus disease 2019, OPD: Outpatient department

mutating and producing new (and sometimes less virulent) strains and waves; the innate and acquired immunity of the host, the vaccination drive and the economy, health budget allocation, and restricted movement, all together resulted in a progressive improvement of health-care services and their outcomes. One of the studies in the early part of the pandemic by Doglietto *et al*. compared factors associated with surgical mortality and complications in patients with and without COVID-19 in Italy. The authors reported mortalities of 2.44% and 19.51% in patients without and with COVID-19 infection, respectively.[14] Our study, in comparison, reported a mortality rate of 1.74% in patients without COVID-19 but operated in the COVID-19 era. When comparing patients with COVID-19 in the perioperative period, the 30-day mortality rate was 2%. Another study conducted in Brazil by Baiocchi *et al*. analyzed 1253 patients who underwent surgical procedures during the COVID-19 era. They reported that patients with pre-operative SARS-CoV-2 were not at an increased risk of post-operative complications and had zero mortality within 30 days after surgery.[15] De Luca *et al*. analyzed the outcome of 68 patients who underwent emergency or oncological surgery from March 5, 2020, to May 26, 2020 and reported a mortality rate of 14.7%.[16]

Recent studies analyzing morbidity associated with patients with COVID-19 have reported a significant increase in pulmonary, thromboembolic, renal, cardiac, and septic complications.[17-21] Pulmonary complications were the most frequent in our cohort of patients, similar to other studies, and these complications were significantly higher than those in patients operated on in the pre-COVID-19 era.[22,23] By contrast, COVID Surg Collaborative and Baiocchi *et al*. reported no difference.[15,24] Although a safe 4-week interval between a positive test and surgery was suggested by the authors, we followed a safe period of 3 weeks, which might be a cause of disparity in outcome.

To the best of our knowledge, the literature on factors predicting post-operative complications is limited. Shao *et al*. described the association of increased age, increased BMI, and medical comorbidities with post-operative pulmonary complications.[25] In addition, De Luca *et al*. suggested that smoking, cardiovascular diseases, and malignancy are associated with post-operative pulmonary complications.[16] Our study described diabetes, CKD, ASA Grade IV, pre-operative COVID-19, and steroid use during the COVID-19 infection as statistically significant factors for post-operative pulmonary complications.

Studies conducted early in the COVID-19 era, including those conducted in or after the first wave, reported high mortality and morbidity rates, whereas those conducted late after the second wave had improved mortality and morbidity rates. A better understanding of viral pathology and its sequel, mutation toward the less virulent strains, mass vaccination, early diagnosis and management of complications, and target-oriented research all played a role in such improvement, although some factors remain unturned.

Pre-operative screening for COVID-19, stratifying and triaging patients for surgery, screening for potential complications after CoV infection, and therapeutic precautions (anticoagulants for patients who had CoV complications) are the cornerstones of our management. Although our study reported a significant delay in admission and surgery, there was no delay in time to discharge when comparing patients operated on in the COVID-19 era to those operated on in the pre-COVID-19 era. Triage for admission, comparing outcomes of patients operated on in the pre-COVID-19 era with those operated on in the COVID-19 era, comparing perioperative CoV-positive to those CoV-negative patients, and predicting its association with increased morbidity are the backbone of the study and will help in future preparedness for a medical disaster. Missing data and a short follow-up period are the main study limitations. The squeal of CoV infection and its long-term implications on physiology and pathology remain unknown. Although the risk factors assessed in this study add data to the pool, they are not sufficient for a discrete formulation.

CONCLUSION

CoV is rapidly spreading as a highly infectious disease with multi-organ involvement. It affects the outcome of patients both directly and indirectly through complex immune-mediated mechanisms. Proper screening, streamlining the admission process, a structured treatment protocol, and early recognition and prompt management of complications helped us to wade off the waves of COVID-19.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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