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Surgical Outcomes During COVID-19 Pandemic

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Background. In December 2019, an outbreak of a novel coronavirus (COVID-19) occurred in China and became pandemic in March 2020. Patients undergoing surgery are a vulnerable risk of COVID-19 exposure/infection. The aim of the study was to determine the characteristics and outcomes of patients undergoing surgery during the COVID-19 pandemic in a third level reference hospital in Mexico.

Method. IRB approved observational study (prospectively collected database) of general and surgical oncology procedures from 04/20–08/20. Patients preoperative data and surgical cases registered. COVID-19 detection was a combination of polymerase chain reaction swab and chest computed tomography. Primary endpoints were: 30 d surgical mortality and complications, including COVID-19 infection during hospitalization.

Results. 193 patients were included (mean age: 53.9 years, 63.7% female). 52.8% procedures were performed by surgical oncology. 42.4% developed a complication with 8.3% mortality. COVID-19 infection was 11.3% ($n=22$). Postoperative morbidity (81.3 vs. 37.4%, $p=0.0001$) and mortality (27.3 vs. 5.8%, $p=0.0001$) was higher in COVID-19 (+) patients. Factors associated with COVID-19 infections were sex, functional status, preoperative sepsis and ventilation, renal failure and dialysis (univariate analysis) and sepsis and renal failure (multivariate analysis). COVID-19 infection was associated with respiratory complications (54.5 vs. 2.9%), surgical site infection (27.3 vs. 10.5%), postoperative transfusions (59.1 vs. 31.6%), renal failure (54.5 vs. 8.2%), sepsis (68.2 vs. 22.2%), reintervention (22.7 vs. 7.6%), readmission (18.2 vs. 4.1%), and death (27.3 vs. 5.8%) ($p < 0.05$).

Conclusion. Postoperative morbidity and mortality in COVID-19 patients is high. Surgical procedures should be thoughtfully reviewed with a plan to minimize scheduled operations. © 2021 Instituto Mexicano del Seguro Social (IMSS). Published by Elsevier Inc. All rights reserved.

Key Words: SARS-CoV-2, Coronavirus, COVID-19, Surgery, Outcomes, Complications, Morbidity, Mortality.

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Introduction

In December 2019, an outbreak of the 2019 novel coronavirus (COVID-19) caused by SARS coronavirus 2 (SARS-CoV-2) occurred in Wuhan, China (1,2); spreading worldwide (3), with WHO declaring a COVID-19 pandemic on March 11, 2020. The symptoms of SARS-CoV-2 infection are varied, ranging from asymptomatic disease to pneumonia and life-threatening complications, including acute respiratory distress syndrome (ARDS), multisystem organ failure and death (2). Hypertension, cardiovascular disease, diabetes mellitus, smoking, chronic pulmonary obstructive disease (COPD), chronic kidney disease and malignancy have been shown to be prevalent underlying diseases among hospitalized COVID-19 patients (4).

Patients undergoing surgery are at risk of SARS-CoV-2 exposure in the hospital. They are particularly susceptible to pulmonary complications, due to pro-inflammatory cytokines, immunosuppressive response to surgery and mechanical ventilation (5,6). Certain guidelines have been published for the management of surgical patients during SARS-CoV-2 pandemic (7,8). In addition to guidance on staffing, infection control and prevention, guidelines recommended postponing elective surgeries and procedures. Even with these procedures postponed, urgent and emergent surgeries are still performed in COVID-19 positive and negative patients as well. Data on management and outcomes of surgical patients operated during this pandemic is scarce and urgently needed (9–15).

In Mexico, the first COVID-19 case was reported on February 27th, 2020 (16). By the end of August, Mexico had 599,560 confirmed cases and 54,414 deaths. The state of Veracruz ranks fifth in the number of cases and the city of Veracruz ranks first in the state's number of cases (17). Mexican health system comprises two sectors: private and public. Social security institutions, hospitals, institutes, and programs for patients without social security are included amongst the public sectors. Formal economy workers, either active or retired are entitled to social security institutions. Mexican Institute of Social Security (IMSS) covers 80% of this population (18). In the city of Veracruz, there is a third level reference hospital (UMAE Hospital de Especialidades 14, Adolfo Ruiz Cortines). Except from oncologic procedures, all elective general surgery procedures were postponed from March 31st, 2020 until now, where only urgent and emergency general surgery operations were performed. Therefore, the objective of this study is to determine the clinical characteristics and the outcomes of patients who were operated during the COVID-19 pandemic with or without perioperative SARS-CoV-2 infection in the largest social security hospital of Veracruz, Mexico.

Methods

Patient and Study Design

This observational study consisted of a prospectively collected database of general and oncologic procedures performed by the departments of general surgery and surgical oncology between April 1st, 2020–August 30th, 2020 performed at UMAE Hospital de Especialidades 14, Adolfo Ruiz Cortines. Procedures related to COVID-19 care during hospital stay such as tracheostomies, gastrostomies, chest tube insertion and central venous catheter insertion were excluded from the study. The research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The study was approved by the local ethics committee (R-2020-3001-45).

The data recorded for all patients was according to the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) surgical risk calculator (19) with entry of the following variables: age, sex, functional status, emergency case, American Society of Anesthesiologists (ASA) classification, steroid use, ascites, sepsis within 48 h prior to surgery (any of the following occurring within 48 h prior to surgery: Systemic Inflammatory Response Syndrome (SIRS), Sepsis, Septic Shock), ventilator status, disseminated cancer, diabetes mellitus (insulin and non-insulin-dependent), hypertension, congestive heart failure, dyspnea, current smoker, severe COPD, dialysis, acute renal failure, height and weight for body mass index determination (19,20). Surgical cases were identified and grouped based on the primary procedure coded by the Current Procedural Terminology (CPT) codes (21).

SARS-CoV-2 Procedures

Screening for COVID-19 infection on acute surgical admission and elective surgical oncology procedures varied on the presence of symptomatology as well as a combination of oropharyngeal swabs analyzed by real time polymerase chain reaction (RT-PCR) and un-contrasted computed tomography (CT) of the chest. Radiological COVID-19 diagnosis based on chest CT was in accordance with CO-RADS classification (22).

All patients that underwent an emergency surgery had a full chest CT. Patients who had a CO-RADS chest CT classification 4 and 5 (COVID-19 probable or highly likely) were considered COVID-19 positive (+) and had a subsequently confirmatory positive RT-PCR. Elective surgical oncology patients underwent a clinical respiratory triage investigating highly indicative symptoms of SARS-CoV-2 infection (2,23), such as cough, fever, headache, myalgia, arthralgia, sore throat, nasal drip, conjunctivitis, chest pain and dyspnea. A chest CT was performed as well. Patients underwent surgery if they were asymptomatic and were classified as CO-RADS 1 on radiological

examination. Postoperative patients who developed respiratory symptoms and/or complications underwent RT-PCR and a chest CT.

Outcomes

The primary endpoints of the study were: 30 d surgical mortality and complications, including COVID-19 infection during hospitalization. Secondary objectives included comparisons of primary outcomes between COVID-19 (–) and COVID-19 (+) patients, and how COVID-19 interacted as a risk factor for morbidity and mortality.

Complications were defined by the Clavien-Dindo classification of surgical complications (24) and by the ACS-NSQIP (19,20) as follow: any complication, pneumonia, cardiac complication, surgical site infection, urinary tract infection, venous thromboembolism, renal failure, readmission, reoperation, death, and sepsis. COVID-19 pulmonary complications in addition to pneumonia were: ARDS and unexpected postoperative mechanical ventilation.

Statistical Analysis

Data are expressed as mean \pm standard deviation and range for continuous variables if distribution was normal and median if non-normal distribution. Categorical variables are expressed in frequency and percentage. Student *t*-test and Mann-Whitney *U* test was used to assess differences between continuous variables with normal and non-normal distribution, respectively. Categorical variables were compared using χ^2 and Fisher's exact. Binary logistic regression analysis was used for analysis of risk factors for demographic and preoperative variables and COVID-19 infection. Multivariate analysis of risk factors for demographic and preoperative variables and COVID-19 infection (logistic regression analysis) was performed using variables that were statistically significant in the univariate analysis. Logistic regression analysis was performed to determine risk factors between COVID-19 infection and postoperative outcomes. A *p* value <0.05 was considered statistically significant. Data were analyzed using SPSS software version 26 (Chicago, IL, USA).

Results

One hundred and ninety-three patients ($n=193$) were included in the study with a mean age of 53.9 ± 14.5 years (16–86 range). Most of the patients were female (63.7%, $n=123$) with a mean body mass index of 27.1 ± 5.1 kg/m² (15.4–43 range) Forty-eight patients (24.9%) were obese (>30 kg/m² body mass index) Ninety-seven patients (50.3%) had hypertension and 12.4% ($n=24$) were on dialysis. None of the patients had ascites and/or dyspnea 30 d prior to surgery. Table 1 shows all the preoperative characteristics of the patients.

Procedures and Outcomes

During the period of the study, there was a substantial decrease in the number of procedures performed by each department. In comparison to the previous year (2019), during the study period, 931 procedures were performed. The surgical oncology department performed 315 procedures (33.8%) and general surgery department 616 procedures (66.2%) respectively. There was a 79.3% decrease ($n=738$) in the total surgical activity in both departments. Each department decrease their surgical activity by 67.6% (surgical oncology) and 85.2% (general surgery) respectively.

Procedures included in the study were: one hundred and two procedures (52.8%) were performed by the surgical oncology department and 91 (47.2%) by the general surgery department. The most common procedures performed during the study were coded as abdomen, peritoneum and omentum (20.6%), followed by intestines except rectum (16.1%) and breast (11.9%). A description of the procedures is displayed in Table 2.

Table 3 shows postoperative surgical outcomes. Eighty-two patients (42.4%) developed at least one complication. The most common complication was a postoperative blood transfusion ($n=67$, 34.7%) followed by sepsis ($n=53$, 27.5%). Pneumonia and unexpected postoperative mechanical ventilation accounted for 6.2% and 5.2% of the morbidity, respectively. 30 d mortality was 8.3% ($n=16$). Hospital readmission was 5.7% ($n=11$). Readmission causes were: sepsis in 72.7% ($n=8$) and electrolyte imbalance (27.3%, $n=3$). Readmitted patients underwent the following procedures: Intestines except rectum (36.3%, $n=4$), biliary (18.8%, $n=2$), and abdomen and peritoneum, anus, stomach, ovary and skin and subcutaneous tissue ($n=1$ 9.1% each respectively).

COVID-19 Outcomes

Figure 1 summarizes COVID-19 outcomes. COVID-19 infection was present in 22 patients (11.3%), mostly in male patients ($n=13$, 59.1%). COVID-19 (+) mean age was 50.9 ± 14.1 years with a mean body mass index of 26.2 ± 4.6 kg/m². Table 1 compares demographic and preoperative characteristics between COVID-19 (+) and COVID-19 (–) patients. COVID-19 (+) were mostly males, less functional and had a higher preoperative ASA classification. These differences were statistically significant. In addition, more COVID-19 (+) patients underwent surgery having preoperative sepsis and assisted ventilation than COVID-19 (–) patients, and these differences were also statistically significant. Preoperative renal status was significantly deteriorated in COVID-19 (+) patients (either preoperative renal failure and/or dialysis) than COVID-19 (–) patients. No other differences were noted. Fifty percent of the COVID-19 (+) patients ($n=11$) were diagnosed

Table 1. Demographic and preoperative characteristics of patients ($n=193$).

Variable	Total patients $n=193$ (100%)	COVID-19 (+) $n=22$ (11.4%)	COVID-19 (-) $n=171$ (88.6%)	<i>p</i>
Age, years (mean \pm std dev.)	53.9 \pm 14.5	50.9 \pm 15.1	54.3 \pm 14.4	0.2
Age group				
<65 years	140 (72.5%)	17 (77.3%)	123 (71.9)	
65–74 years	43 (22.3%)	4 (18.2%)	39 (22.8%)	
75–84 years	9 (4.7%)	1 (4.5%)	8 (4.7%)	
>85 years	1 (0.5%)	0	1 (0.6%)	0.9
Sex				
Female	123 (63.7%)	9 (40.9%)	114 (66.7%)	
Male	70 (36.3%)	13 (59.1%)	57 (33.3%)	0.018*
Functional Status				
Independent	140 (72.5%)	12 (54.5%)	128 (74.9%)	
Partially dependent	53 (27.5%)	10 (45.5%)	43 (25.1%)	0.045*
ASA class				
Healthy patient (I)	9 (4.7%)	9 (5.3%)	0	
Mild systemic disease (II)	99 (51.3%)	93 (54.4%)	6 (27.3%)	
Severe systemic disease (III)	75 (38.9%)	61 (33.7%)	14 (63.6%)	
Severe systemic disease/constant threat to life (IV)	10 (5.2%)	8 (4.7%)	2 (9.1%)	0.035*
Steroid use for chronic condition				
Yes	1 (0.5%)	1 (100%)	0	0.1
Sepsis within 48 h prior to surgery				
Yes	53 (27.5)	15 (68.2%)	38 (22.7%)	0.001*
Ventilator Dependent				
Yes	19 (9.8%)	6 (27.3%)	13 (7.6%)	0.01*
Disseminated Cancer				
Yes	19 (9.8%)	0	19 (9.8%)	0.1
Diabetes				
Yes (Oral Medication)	62 (32.1%)	10 (45.5%)	52 (30.4%)	0.1
Hypertension				
Yes	97 (50.3%)	11 (50%)	86 (50.3%)	0.9
Congestive Heart Failure in 30 d prior to surgery				
Yes	8 (4.1%)	1 (4.5%)	7 (4.1%)	0.9
Current Smoker within 1 Year				
Yes	24 (12.4%)	1 (4.5%)	23 (13.5%)	0.2
History of Severe COPD				
Yes	4 (2.1%)	0	4 (2.3%)	0.4
Dialysis				
Yes	24 (12.4%)	6 (27.3%)	18 (10.5%)	0.03**
Acute Renal Failure				
Yes	38 (19.8%)	15 (68.2%)	23 (13.5%)	0.0001*
Body Mass Index (kg/m ²) (mean \pm std dev.)	27.1 \pm 5.1	26.2 \pm 4.6	27.2 \pm 5.2	0.3
Body mass index category				
Normal (20–25 kg/m ²)	73 (37.8%)	7 (31.8%)	66 (38.6%)	
Overweight (25–30 kg/m ²)	72 (37.3%)	10 (45.5%)	62 (36.3%)	
Obesity (>30 kg/m ²)	48 (24.9%)	5 (22.7%)	43 (25.1%)	0.6

ASA: American Society of Anesthesiologists; COPD: Chronic Obstructive Pulmonary Disease.

*Statistically significant by χ^2 .

**Statistically significant by Fisher's exact.

preoperatively. The most common CO-RADS chest CT classification was CO-RADS V ($n=9$, 40.9%), followed by CO-RADS VI ($n=8$, 36.3%); CO-RADS IV ($n=4$, 18.1%) and CO-RADS III ($n=1$, 4.5%).

Regarding surgical procedures, the department of general surgery performed more operations on COVID-19 (+) patients ($n=20$, 90.9%) than the department of surgical oncology ($n=2$, 9.1%) ($p=0.001$, χ^2). Emergency surgery accounted for 29.5% of the procedures ($n=57$). Emergency surgery was more common in COVID-19

(+) patients and this difference was statistically significant. 30 d postoperative morbidity was significantly higher in COVID-19 (+) (81.3%) than COVID-19 (-) patients (37.4%) ($p=0.0001$) (Odds Ratio: 0.13, 95% Confidence Interval 0.043–0.4, $p=0.0001$). Similarly; 30 d postoperative mortality was higher in COVID-19 (+) (27.3%) against COVID-19 (-) (5.8%) ($p=0.0001$) (Odds Ratio: 0.16, 95% Confidence Interval 0.05–0.5, $p=0.002$). COVID-19 (+) had more aggressive complications than COVID-19 (-) according to Clavien-Dindo classification

Table 2. Principal procedures performed by CPT coding.

Procedure	Total <i>n</i> = 193 (100%)
Procedure (CPT code)	
Skin, Subcutaneous tissue (10030–11646)	3 (1.6%)
Under Incision and Drainage Procedures on the Skin, Subcutaneous and Accessory Structures	3 (100%)
Breast (19000–19499)	23 (11.9%)
Mastectomy, modified radical, including axillary lymph nodes with or without pectoralis minor muscle, but excluding pectoralis major muscle	18 (78.2%)
Musculoskeletal (20100–29999)	11 (5.7%)
Amputation, thigh, through femur, any level; open, circular (guillotine)	5 (45.4%)
Respiratory system (30000–32999)	4 (2.1%)
Decortication, pulmonary	2 (50%)
Hemic and Lymphatic System (38204–38232)	9 (4.7%)
Cervical lymphadenectomy	6 (66.6%)
Mediastinum and Diaphragm (39000–39599)	2 (1%)
Salivary Gland and Ducts (42300–42699)	2 (1%)
Stomach (43500–43999)	7 (3.6%)
Gastrectomy, partial, distal	4 (57.1%)
Intestines except Rectum (44005–44979)	31 (16.1%)
Enterectomy, resection of small intestine; single resection and anastomosis	7 (22.5%)
Rectum (45000–45915)	5 (2.6%)
Proctectomy, combined abdominoperineal	2 (40%)
Anus (46020–46699)	4 (2.1%)
Incision and drainage of ischiorectal or intramural abscess with fistulectomy or fistulotomy, submuscular, with or without placement of seton	3 (75%)
Liver and Biliary tract (47000–47999)	16 (8.3%)
Cholecystectomy	5 (31.2%)
Pancreas (48000–48999)	5 (2.6%)
Pancreatectomy, proximal subtotal with near-total duodenectomy choledochoenterostomy and duodenojejunostomy (pylorus-sparing, Whipple-type procedure)	3 (60%)
Abdomen, Peritoneum and Omentum (49000–49999)	39 (20.6%)
Removal of tunneled intraperitoneal catheter	17 (43.5%)
Urinary system (50010–53899)	2 (1%)
Uterus (Corpus) (58100–58579)	13 (6.7%)
Total abdominal hysterectomy (corpus and cervix), with or without removal of tube(s), with or without removal of ovary(s);	10 (76–9%)
Ovary (58800–58960)	9 (4.7%)
Laparotomy, for staging or restaging of ovarian, tubal, or primary peritoneal malignancy (second look), with or without omentectomy, peritoneal washing, biopsy of abdominal and pelvic peritoneum, diaphragmatic assessment with pelvic and limited para-aortic lymphadenectomy	3 (33%)
Thyroid (60000–60300)	8 (4.1%)
Thyroidectomy, total or complete	5 (62.5%)

CPT: Current Procedural Terminology.

of surgical complications. Surgical site infections, postoperative blood transfusions, postoperative renal failure, reoperations and postoperative sepsis were more present in COVID-19 (+), and these differences were statistically significant. The most common surgical procedures in COVID-19 (+) patients who developed postoperative sepsis were: Intestines except rectum ($n=6$, 40%), biliary tract and musculoskeletal (13.3%, $n=2$ each), and stomach, pancreas, anus, ovary and respiratory system ($n=1$, 6.7% each, respectively). Postoperative sepsis source in these patients were: intraabdominal ($n=12$, 80%) followed by soft tissue/musculoskeletal ($n=2$, 13.3%) and respiratory ($n=1$, 6.7%).

Hospital readmissions were also more common in COVID-19 (+) patients (18.2 vs. 4.1%, $p=0.02$). Pulmonary complications in COVID-19 (+) were 54.5%

against a pulmonary complication rate of 2.9% in COVID-19 (–) ($p=0.0001$). Unexpected ventilatory mechanical ventilation occurred in 10 patients. The majority of them were COVID-19 (+) (80%, $n=8$, vs. 20%, $n=2$, $p=0.001$ by χ^2). Half of the COVID-19 (+) patients ($n=4$) who suffered unexpected ventilatory mechanical ventilation were preoperatively diagnosed with COVID-19. [Table 3](#) details differences in surgical outcomes between COVID-19 (+) and COVID-19 (–) patients including detailed pulmonary complications.

Factors associated with COVID-19 infection in univariate analysis were sex (male), functional status (partially dependent), sepsis within 48 h prior to surgery, ventilator, dialysis and acute renal failure ($p < 0.05$). Multivariate analysis confirmed that sepsis within 48 h prior to surgery (Odds ratio: 0.23, 95% Confidence Interval 0.07–0.7,

Table 3. Surgical outcomes in all patients (n = 193).

Outcome	Total n = 193 (100%)	COVID-19 (+) n = 22 (11.4%)	COVID-19 (-) n = 171 (88.6%)	p
Emergency surgery	57 (29.5%)	14 (63.6%)	43 (25.1%)	0.0001*
Length of stay, days (mean ± std dev)	6.8 ± 7.9	10.8 ± 13.4	6.2 ± 6.8	0.4 (Mann-Whitney)
Clavien-Dindo classification of complications				
No complications	111 (57.5%)	4 (18.2%)	107 (62.6%)	
Grade I	3 (1.6%)	0	3 (1.8%)	
Grade II	19 (9.8%)	2 (9.1%)	17 (9.9%)	
Grade IIIa	6 (3.1%)	2 (9.1%)	4 (2.3%)	
Grade IIIb	13 (6.7%)	2 (9.1%)	11 (6.4%)	
Grade IVa	18 (9.3%)	3 (13.6%)	15 (8.8%)	
Grade IVb	7 (3.6%)	3 (13.6%)	4 (2.3%)	
Grade V (Death)	16 (8.3%)	6 (27.3%)	10 (5.8%)	0.004*
ACS NSQIP complication				
Any complication	82 (42.4%)	18 (81.8%)	64 (37.4%)	0.0001*
Surgical site infection	24 (12.4%)	6 (27.3%)	18 (10.5%)	0.037**
Postoperative blood transfusion	67 (34.7%)	13 (59.1%)	54 (31.6%)	0.01*
Cardiac complication	2 (1%)	1 (4.5%)	1 (0.6%)	0.2
Urinary tract infection	5 (2.6%)	1 (4.5%)	4 (2.3%)	0.5
Venous thromboembolism	1 (0.5%)	0	1 (0.6%)	0.1
Renal failure	26 (13.5%)	12 (54.5%)	14 (8.2%)	0.0001*
Sepsis	53 (27.5%)	15 (68.2%)	38 (22.2%)	0.0001*
Reintervention	18 (9.3%)	5 (22.7%)	12 (7.6%)	0.03**
Readmission	11 (5.7%)	4 (18.2%)	7 (4.1%)	0.02**
Respiratory complications	17 (8.8%)	12 (54.5%)	5 (2.9%)	0.0001*
Pneumonia	12 (6.2%)	7 (31.8%)	5 (2.9%)	0.0001*
ARDS	8 (4.1%)	8 (100%)	0	0.0001*
Unexpected postoperative mechanical ventilation	10 (5.2%)	8 (36.4%)	2 (1.2%)	0.001*
Death	16 (8.3%)	6 (27.3%)	10 (5.8%)	0.004**

ACS: American College of Surgeons; NSQIP: National Surgical Quality Improvement Program.

*Statistically significant by χ^2 .

**Statically significant by Fisher's exact.

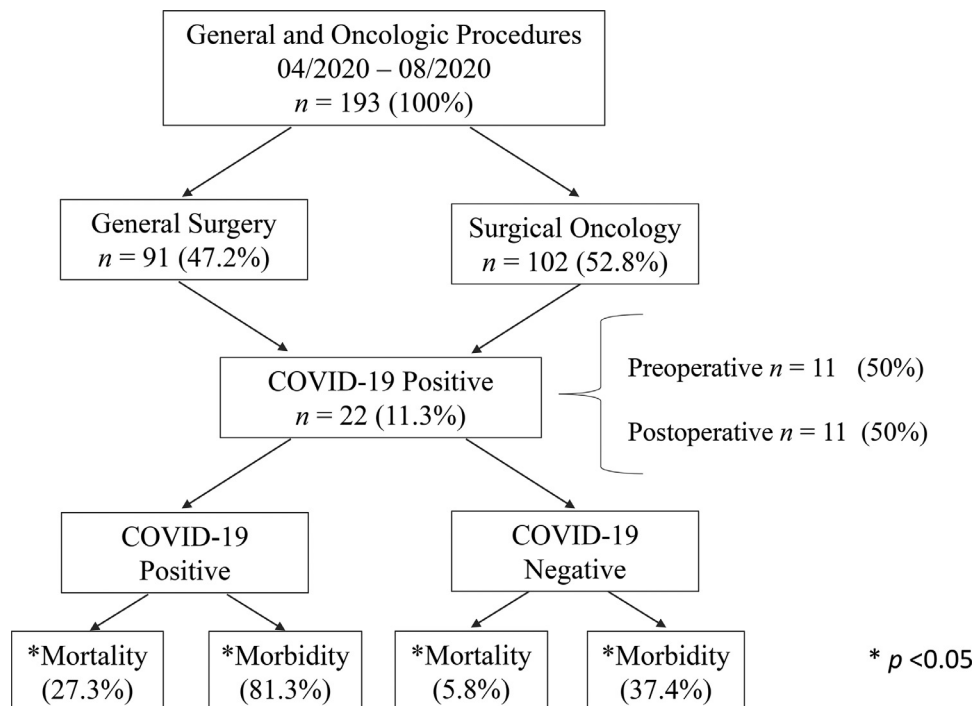
**Figure 1.** COVID-19 Outcomes Summary.

Table 4. Preoperative risk factors for COVID-19 (+) infection ($n=193$) (Logistic regression).

Variable	COVID-19 (+) patients					
	Univariate analysis			Multivariate analysis**		
	Odds ratio	95% CI	<i>p</i>	Odds ratio	95% CI	<i>p</i>
Age, years	0.98	0.95–1.01	0.2			
Male Sex	0.34	0.14–0.85	0.02*	0.5	0.1–1.4	0.2
Functional Status Partially dependent	2.4	1–6.1	0.05	0.8	0.2–2.6	0.8
ASA class	0.9	0.1–4.8	0.092			
Steroid use for chronic condition	0	0	1			
Sepsis within 48 h prior to surgery	0.13	0.05–0.35	0.0001*	0.23	0.07–0.7	0.012*
Ventilator Dependent	0.21	0.07–0.65	0.007*	0.93	0.2–3.96	0.92
Disseminated Cancer	23.3 × 10(6)	0	0.99			
Diabetes	0.52	0.21–1.2	0.16			
Hypertension	1.01	0.4–2.4	0.99			
Congestive Heart Failure in 30 d prior to surgery	0.8	0.1–7.6	0.92			
Current Smoker within 1 Year	3.2	0.4–25.4	0.25			
History of Severe COPD	25.2 × 10(6)	0	0.99			
Dialysis	0.31	0.1–0.9	0.003*	0.6	0.1–2.4	0.5
Acute Renal Failure	0.07	0.02–0.19	0.0001*	0.88	0.2–2.6	0.001*
Body Mass Index (kg/m2) (mean ± std dev.)	0.96	0.8–1.05	0.38			
Body mass index category	1.3	0.4–4.3	0.6			

ASA: American Society of Anesthesiologists; COPD: Chronic Obstructive Pulmonary Disease; CI: Confidence Interval.

*Statistically significant.

**Statistically significant variables in univariate analysis that were included in multivariate analysis.

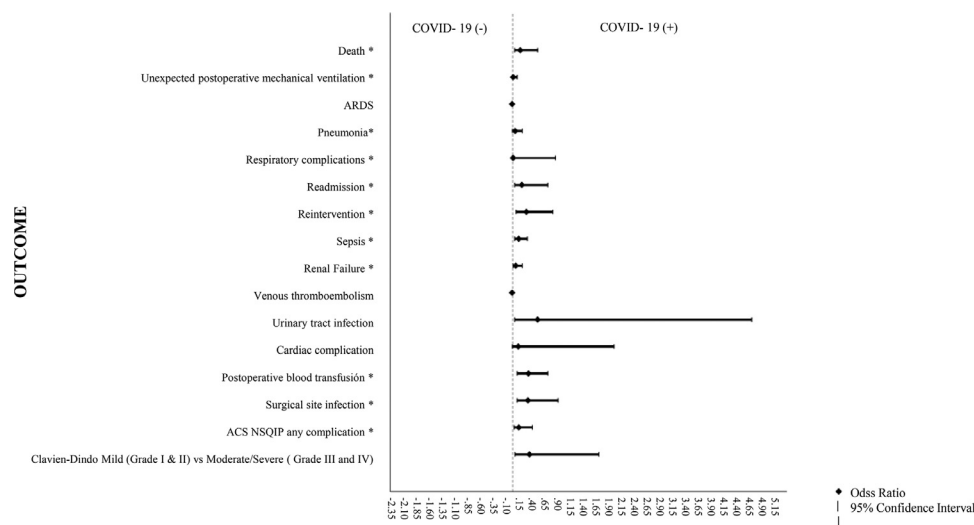


Figure 2. COVID-19 and surgical complications (Logistic regression) ARDS: Acute Respiratory Distress Syndrome ACS NSQIP American College of Surgeons National Quality Improvement Program. *Statistically significant ($p < 0.05$).

$p=0.012$) and acute renal failure (Odds ratio: 0.88, 95% Confidence Interval 0.2–2.6, $p=0.001$) were risk factors for COVID-19 infection ($p < 0.05$) (Table 4). COVID-19 infection was significantly associated with most of the postoperative morbidity according to the ACS NSQIP complication chart (any complication: Odds ratio 0.13, 95% Confidence Interval 0.04–0.4) and mortality as well (Odds ratio: 0.16, Confidence Interval 0.05–0.5) ($p < 0.05$) (Figure 2).

Discussion

The results of this study evidenced that the surgical activity during the COVID-19 pandemic drastically decreased. It also demonstrates that the 30 d morbidity and mortality of surgical procedures performed during the COVID-19 pandemic is high, especially in COVID-19 (+) and specifically pulmonary complications in COVID-19 (+) patients. In addition, the results of this study also corroborate certain underlying conditions prevalent to COVID-19 infection.

Along the pandemic development, hospitalized COVID-19 patient information has been characterized. In-hospital COVID-19 (+) patients are males predominantly, within 40–60 years of age, with a 30–70% prevalence of comorbid conditions, such as hypertension, diabetes mellitus, COPD and cardiovascular disease (2,4,6,23). Distinctively, a meta-analysis of the prevalence of underlying diseases in hospitalized patients with COVID-19 estimated an approximately 1% pooled prevalence of acute and chronic kidney diseases (4). Our study found similarities to what has been previously described, since there were significant differences favoring male population, and comorbid conditions such as physical status, higher ASA preoperative classification and specifically renal failure (with or without dialysis). End-stage renal disease constitutes a major public health problem in Mexico. IMSS attends approximately 73% of the Mexican population requiring dialysis or transplant (25). In addition, Mexican clinical practice guidelines advocate peritoneal dialysis use primarily (26). Our hospital has the largest nephrology department in our state; hence we did have a significant renal inpatient population that might have acquired COVID-19 infection either as nosocomial or community-based transmission. This also explains why one of the most common procedures performed were removals of intraperitoneal dialysis catheters.

There are few studies dealing with surgical morbidity and mortality in COVID-19 patients (9–14),27) and almost none from Latin America. The earliest report was made by Aminian A, et al. (10) describing 4 surgical patients who developed perioperative complications in the first few weeks of COVID-19 outbreak in Iran during 02/2020.

Lei S, et al. (9) identified patients in Wuhan, China who had elective surgery in the early phases of the COVID-19 outbreak, who were unknowingly COVID-19 (+) prior to surgery. Their median age was 55 years and 50% had comorbidities. All patients developed postoperative pneumonia with a 20.5% mortality rate. Studies from Spain from February–May 2020 (12,13,27) estimated a COVID-19 infection rate around 7% and a complication rate up to 80% (30% severe complication rate) and a 2–20% mortality rate with mainly pulmonary causes. Doglietto F, et al. (14) found a 12.3% COVID (19) infection rate and a 19.5% mortality rate in a third level specialty hospital in Lombardy (epicenter of the Italian pandemic). 30 d mortality was significantly higher in COVID-19 (+) patients (9.5 odds ratio) and complications as well (4.9 odds ratio). Pulmonary complications were the most common found in their study. The COVIDSurg international (Europe and North America), multicenter cohort study in COVID-19 (+) patients had 51.2% pulmonary complications and a 23.8% 30 d mortality rate. Mortality was associated with male sex over 70 years of age, high ASA grades, malignant disease and emergency surgery (11). Considering these results, we encountered a similar high morbidity (81%) and mortality rate (27%) in our COVID-19 (+)

patients particularly in respiratory complications (54.5%). Complications in COVID-19 (+) were high-graded based on Clavien-Dindo classification as well. Interestingly, a careful preoperative screening methodology in elective surgical oncology patients resulted in a low COVID-19 infection in our series (2.1%, $n=2$). Some other authors have justified our strategy having similar results (28,29).

There was a significant decrease in the surgical activity in our hospital during the study period (79%), resembling what occurred in places where COVID-19 outbreak hit first, where surgical activity decreased closely to a 90% in almost every hospital (14,15,27). Therefore, a special consideration is necessary to be address before full surgical activities in our hospital is re-started: Fifty percent of our COVID-19 (+) patients were diagnosed postoperatively. Unfortunately, our study design does not allow to determine how they became infected; either by patient visitors or by their attending health care professionals. Thus, we need to be aware that an aggressive preoperative screening for COVID-19 baseline status and detection of asymptomatic surgical candidates is mandatory, facilitating preoperative risk and benefits of each individual surgical procedure.

There are some shortcomings in our study: It is a small series number of cases coming from a single center. In order to speed up and facilitate information, our study is based on key outcomes such as morbidity and mortality, missing some other data. Nevertheless, our study brings an additional light of the surgical practice challenge in the COVID-19 pandemic, especially in low- and middle-income countries in Latin America and Mexico as well. The future trajectory of the pandemic is still uncertain, and the evidence provided by our study is relevant to further preparation, development and guidance of preoperative COVID-19 screening and postoperative care.

In conclusion, postoperative morbidity and mortality in COVID-19 patients is high. Surgical procedures should be thoughtfully reviewed with a plan to minimize scheduled operations.

Declaration of Competing Interest

The authors declare that they have no competing interest.

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