World J Surg
https://doi.org/10.1007/s00268-022-06814-4

ORIGINAL SCIENTIFIC REPORT

Timing is Everything: Surgical Outcomes for SARS-CoV-2 Positive Patients

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Accepted: 16 October 2022

Abstract

Background A debate remains on how long to postpone surgery after testing positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). We aimed to determine surgical outcomes at different time points after a positive SARS-CoV-2 test.

Methods This cohort study included non-preoperative critically ill adult surgical patients from 5/2020–5/2021 and a subset of SARS-CoV-2 positive patients 15–30 days before surgery from 5/2020–12/2021. Demographics, comorbidities, surgical variables, and outcomes were compared between SARS-CoV-2 positive patients within 50 days before surgery to SARS-CoV-2 negative surgical patients. Cases were stratified based on the timing of SARS-CoV-2 positivity before surgery in days (< 15, 15–30, > 30). Outcomes were compared between strata and against SARS-CoV-2 negative controls. A multivariable model was built to determine the association that the timing of SARS-CoV-2 positivity has on the odds of a major complication.

Results The SARS-CoV-2 positive cohort had 262 patients compared to 1,840 SARS-CoV-2 negative patients. Timing strata contained 145 (< 15 days), 53 (15–30 days), and 64 (> 30 days). The SARS-CoV-2 positive group had a higher incidence of comorbidities (87.4% vs. 57.2%) and underwent more emergent surgery (45.7% vs. 9.3%). The odds of major complications in patients positive for SARS-CoV-2 before surgery were 1.88 (1.13–3.15) (< 15 days), 0.43 (0.14–1.30) (15–30 days), and 0.98 (0.44–2.21) (31–50 days) times the odds in SARS-CoV-2 negative surgery patients when controlling for other variables.

Conclusion Timing of SARS-CoV-2 positivity before surgery has an impact on major complications. In certain cases, it may be appropriate to postpone surgery 14 days after SARS-CoV-2 positivity.

Introduction

The World Health Organization declared the Coronavirus Disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) a pandemic on March 11, 2020. Many hospitals were forced to cancel elective surgeries due to staffing and unclear guidance on how SARS-CoV-2 positivity would affect surgical patients. Studies demonstrated that patients with perioperative SARS-CoV-2 infection were at increased risk of pulmonary complications and death [1–3]. However, questions remain on how long surgery should be delayed when a patient tests positive for SARS-CoV-2 before surgery.

Multiple guidelines and preoperative protocols were released regarding perioperative management of SARS-CoV-2 positive surgical patients. Due to limited data available, there was significant heterogeneity on the

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Published online: 31 October 2022

optimal timing of surgery following SARS-CoV-2 infection. Guidelines relied on expert opinion or previous data from other viruses, so delay timeframes ranged from 2–8 weeks [4–7]. Few studies have addressed when surgery should be performed after SARS-CoV-2 infection. Each study examined different patient populations using inconsistent methodology. Baiocchi and colleagues found no increased risk of complications after a median delay of 25 days. The COVIDSurg Collaborative evaluated a robust population and noted an increased risk of complications up to six weeks after infection, and Deng et al. recommend delaying surgery for eight weeks after SARS-CoV-2 positivity for elective cases [8–10]. These studies did not include patients in the Omicron variant wave, which tended to produce a milder phenotype.

More studies are needed to add to the literature on this subject. There have been 80.4 million cases of COVID-19 reported in the USA. The optimal timing of surgery after testing positive for SARS-CoV-2 is still a relevant question. We aimed to evaluate how the timing of a SARS-CoV-2 positive test before surgery in non-critically ill patients affected surgical outcomes.

Methods

Overview/study population

This cohort study was approved by our Institutional Review Board (ID: STUDY00001466). Surgical patients from a single institution were included and compared by preoperative SARS-CoV-2 positivity. Inclusion criteria were adult patients, age $\geq$ 18 years, undergoing a wide range of inpatient surgeries from 5/2020–12/2021. Outpatient and endoscopic procedures were excluded from the analysis.

Exposure group

The exposure group included surgical patients who tested positive for SARS-CoV-2 using a PCR test 0–50 days before surgery. Variables for this group were actively abstracted from the electronic medical record. This group was stratified by how many days before surgery the patient tested positive. Patients with a SARS-CoV-2 positive test (0–14 days) and (30–50 days) before surgery were captured from 5/2020–5/2021. An additional cohort of patients with a SARS-CoV-2 positive test (15–30 days) before their operation was captured from 5/2020–12/2021 in order to capture the Omicron wave for this patient population. Since our current hospital protocol delays surgery 30 days post SARS-CoV-2 positivity, the (15–30 day) group was of particular interest, thus the additional capture of these patients. Patients who were preoperatively admitted to the ICU were excluded.

Control group

The control group consisted of surgical patients who were SARS-CoV-2 negative up to 50 days before their operation. This group was captured using the ACS-NSQIP platform and included patients from 5/2020–5/2021. Our institution's ACS-NSQIP report was cross-referenced against a list of preoperatively positive patients for SARS-CoV-2 to ensure the proper patients were excluded. Any patient with preoperative ventilator use $>$ 48 h was excluded. This period included surgeries performed during COVID-19 allocation protocols, which corresponds to time-sensitive operations which may inherently obtain more risk for complications.

Variables/outcomes

Baseline patient demographics and comorbidities were captured. The comorbidity category was defined as the presence of hypertension, diabetes, chronic obstructive pulmonary disease, or heart failure. Whether the operation was considered necessary due to sequelae of COVID-19 infection was captured and based on statements within the medical record. Intraoperative variables included case length, type of surgery, and wound class.

Standard ACS-NSQIP 30-day postoperative outcomes were captured for each group with consistent definitions. The outcome for logistic regression modeling was "major complication," which included the presence of one or more of the following outcome variables: reintubation, pneumonia, renal failure, myocardial infarction, pulmonary embolism, stroke, sepsis/septic shock, deep surgical site infection (SSI), organ space SSI, reoperation, or death [11].

Statistical analysis

Descriptive statistics were reported as frequencies (percentages) for categorical variables and means $\pm$ standard deviations or medians (interquartile ranges) for continuous variables. Demographics, comorbidities, and intraoperative variables were compared between exposure and control groups. Chi-square tests were used to compare categorical variables, while T test and Wilcoxon rank sum tests were used to compare continuous variables. All hypothesis testing was two-sided and conducted at a 0.05 level of significance. The same variables were compared between SARS-CoV-2 positive strata. Descriptive variables were displayed between groups with SARS-CoV-2 positivity ($\leq$ 14, 15–30, 31–50) days before surgery.

Postoperative 30-day outcomes were reported as frequencies (percentages) for categorical variables. Outcomes were compared by calculating the bivariate odds for each complication between SARS-CoV-2 negative surgery patients used as the referent group and preoperative SARS-CoV-2 positive patients stratified by timing categories ($\leq$ 14, 15–30, 31–50) days.

A logistic regression model was built using bivariate odds and clinical knowledge. The model included the entire population of patients. The outcome for the model was "major complication," and the main exposure of interest was the timing of SARS-CoV-2 positivity before surgery with SARS-CoV-2 negative patients as the reference group. SAS software (version 9.4, SAS Institute, Inc., Cary, NC) was used for all statistical analyses.

Results

The SARS-CoV-2 positive surgical patient group was comprised of 262 patients after excluding 97 patients for preoperative ICU admission status. When stratifying patients by the timing of SARS-CoV-2 positivity before surgery, the groups were as follows: 0–14 days: 145 patients, 15–30 days: 53 patients, and 31–50 days: 64 patients. Within the 15–30 day group, 14 patients were captured during the additional date range of 6/2021–12/2021. The SARS-CoV-2 negative surgery group had 1,840 patients.

Groups were similar in terms of sex and BMI. The SARS-CoV-2 positive group was younger with a mean of 55.7 vs. 59.3 years ($p < 0.001$), had more African American patients 53.1% vs. 36.6% ($p < 0.001$), and had a higher frequency of comorbidities 87.4% vs. 57.2% ($p < 0.001$). The SARS-CoV-2 positive group also had increased rates of preoperative acute kidney injury (AKI) 6.5% vs. 0.4% ($p < 0.001$). Control group surgeries were mostly elective (90.7%) and gastrointestinal surgeries (64.8%). Preoperative SARS-CoV-2 positive surgical patients had a high rate of emergency surgery (44.7%). Patients who were positive for SARS-CoV-2 0–14 days before surgery underwent emergent surgery at 64.8% compared to 32.1% and 12.5% in the 15–30 day group and 31–50 day group, respectively (Table 1).

Patients with at least one major postoperative complications among the groups were as follows ((%) odds ratio compared to negative patients (confidence interval)): SARS-CoV-2 positive patients before surgery, 0–14 days: (31%) 3.59 (2.45, 5.25), 15–30 days: (7.6%) 0.65 (0.23, 1.82), 30–50 days: (12.5%) 1.14 (0.54, 2.42), and the SARS-CoV-2 negative patients: (15.8%) REF. The most prevalent major complications among the 0–14 days stratum were reoperation (16.3%) 5.96 (3.55, 10.0), pneumonia (14.5%) 13.9 (7.47, 26.1), and sepsis (6.2%) 1.77 (0.87, 3.64) (Fig. 1). Other non-major complications in the 0–14 day group with increased odds compared to SARS-CoV-2 negative patients were ventilator > 48 h (7.12 (3.36, 17.3)) and postoperative acute kidney injury (52.8 (17.3, 161). Of note, there were eight deaths in this group (5.6%) 4.05 (1.80, 9.11) compared to no deaths in the SARS-CoV-2 positive patient groups after 14 days. All odds ratio confidence intervals crossed the null for complications within the 15–30 day SARS-CoV-2 positive group when compared to SARS-CoV-2 negative patients (Table 2).

The multivariable logistic regression model for "major complication" controlled for age, comorbidities, preoperative renal failure, surgery type, and emergency surgery. The odds of major complication for SARS-CoV-2 positive patients 0–14 days before surgery were 1.88 (1.13, 3.15) times the odds in SARS-CoV-2 negative patients. The odds of major complications for patients positive for SARS-CoV-2 15–30 days before surgery and 31–50 days before surgery were 0.43 (0.14, 1.30) and 0.98 (0.44, 2.21), respectively, times the odds in patients who tested negative for SARS-CoV-2 (Table 3).

Discussion

This project addresses how the timing of SARS-CoV-2 positivity before surgery affects outcomes. In our single-center study, we found increased rates of complications among patients who tested positive for SARS-CoV-2 0–14 days before surgery. Patients who tested positive for SARS-CoV-2 between 15–30 days and 31–50 days before surgery did not have increased odds of major complications compared to SARS-CoV-2 negative surgery patients. Our current hospital policy is to delay elective surgery for 30 days after a patient tests positive for SARS-CoV-2. These findings suggest that this interval could be reduced to 14 days for non-critically ill surgical patients with a positive SARS-CoV-2 test. Our policy implements a secondary anesthesia-based screening appointment for patients who test positive for SARS-CoV-2 before elective surgery. This appointment screens patients $\sim$ 14 days after a positive test for the presence of respiratory symptoms or sequelae of COVID-19 infection that may affect safe surgery.

Multiple expert consensus guidance documents exist for the surgical management of SARS-CoV-2-positive patients. Of note, there is heterogeneity between them

Table 1 Description between preoperatively SARS-CoV-2 positive patients and SARS-CoV-2 negative patients

Variables	Preop SARS-CoV-2 Test		*P* Value	SARS-CoV-2 (+) Prior to Surgery		
	Negative (−)*N* = 1,840	Positive(+)*N* = 262		≤ 14 (days) *N* = 145	15–30 (days) *N* = 53	31–50 (days) *N* = 64
Age, (years)	59.3 ± 15.4	55.7 ± 16.1	< .001*	57.0 ± 16.7	53.3 ± 14.5	54.9 ± 16.1
Sex						
Male	750 (40.8%)	120 (45.8%)	0.121	69 (47.6%)	23 (43.4%)	36 (56.3%)
Female	1090 (59.2%)	142 (54.2%)		76 (52.4%)	30 (56.6%)	28 (43.8%)
Race						
Black	631 (36.6%)	137 (53.1%)	< .001	77 (53.8%)	27 (51.9%)	33 (52.4%)
White	1022 (59.2%)	100 (38.8%)		54 (37.8%)	22 (42.3%)	24 (38.1%)
Other	73 (4.2%)	21 (8.1%)		12 (8.4%)	3 (5.8%)	6 (9.5%)
Body Mass Index	29.2 ± 7.5	29.3 ± 7.8	0.682*	29.7 ± 7.9	29.3 ± 7.8	28.7 ± 7.5
Comorbidities	1052 (57.2%)	228 (87.4%)	< 001	127 (88.2%)	45 (84.9%)	56 (87.5%)
Smoker	211 (11.5%)	52 (20.1%)	< 001	28 (19.7%)	8 (15.1%)	16 (25.0%)
Preop Dialysis	48 (2.6%)	34 (13.0%)	< 001	26 (18.1%)	2 (3.8%)	6 (9.4%)
Preop AKI	7 (0.4%)	17 (6.5%)	< 001	14 (9.7%)	1 (1.9%)	2 (3.1%)
Case Length, (mins)	159 (101–245)	111 (53–230)	< .001†	73 (42–159)	148 (56–262)	172 (109–262)
COVID-19 related op	0	11 (4.2%)	–	9 (6.2%)	1 (1.9%)	1 (1.6%)
Surgery Type						
Gastrointestinal	1190 (64.8%)	95 (36.3%)	–	40 (27.6%)	24 (45.3%)	31 (48.4%)
Orthopedics	211 (11.5%)	44 (16.8%)		28 (19.3%)	4 (7.6%)	12 (18.7%)
Vascular	89 (4.8%)	35 (13.4%)		26 (17.9%)	3 (5.7%)	6 (9.4%)
Soft Tissue	39 (2.1%)	36 (13.7%)		27 (18.6%)	5 (9.4%)	4 (6.3%)
Cardiothoracic	–	33 (12.6%)		15 (10.3%)	12 (22.6%)	6 (9.4%)
Neurosurgery	308 (16.8%)	19 (7.3%)		9 (6.2%)	5 (9.4%)	5 (7.8%)
Case type						
Emergent	169 (9.3%)	117 (44.7%)	< 001	94 (64.8%)	17 (32.1%)	8 (12.5%)
Elective	1654 (90.7%)	143 (54.6%)		51 (35.2%)	36 (67.9%)	56 (87.5%)
Wound Class						
Clean	477 (40.4%)	147 (57.0%)	< 001	83 (58.4%)	26 (50.0%)	38 (59.4%)
Clean/Contam	519 (43.9%)	63 (24.4%)		23 (16.2%)	16 (30.8%)	24 (37.5%)
Contaminated	66 (5.6%)	10 (3.9%)		6 (4.2%)	4 (7.7%)	0
Dirty	120 (10.2%)	38 (14.7%)		30 (21.1%)	6 (11.5%)	2 (3.1%)

Categorical Variables presented as Frequency (%), Continuous Variables presented as Mean ± SD or Median (Interquartile Range); *P* Values represent hypothesis testing between SARS-CoV-2 negative and (ALL) positive patients. *Designates Student T test, †Designates Wilcoxon Rank Sum Test, all other statistical testing was performed using Chi-Square Test; Abbreviations: (SARS-CoV-2)-Severe Acute Respiratory Syndrome Coronavirus 2, (Preop)-preoperative, (AKI)-Acute Kidney Injury, (mins)-Minutes, (COVID-19)-Coronavirus Disease 2019, (op)-Operation, (Contam)-Contaminated

regarding how long surgery should be delayed after a positive test. Some guidelines recommend only operating after complete recovery or the patient is no longer infectious. Other guidelines advise postponing surgery for at least 2–4 weeks, while others recommend delaying surgery for eight weeks [4–7]. This heterogeneity supports the question of how long to delay surgery after a positive SARS-CoV-2 test requires further study.

Baiocchi et al. studied surgical outcomes for 49 elective surgical oncology patients in Brazil. Surgery was delayed until a negative SARS-CoV-2 test, and the median delay before surgery was 25 (IQR 12–84) days. This group found no increased risk of postoperative complications compared to SARS-CoV-2 negative patients after delay [8]. The COVIDSurg Collaborative, a mostly European international multicenter collaboration of 1,674 hospitals from 116 countries, evaluated surgical outcomes of 3,127

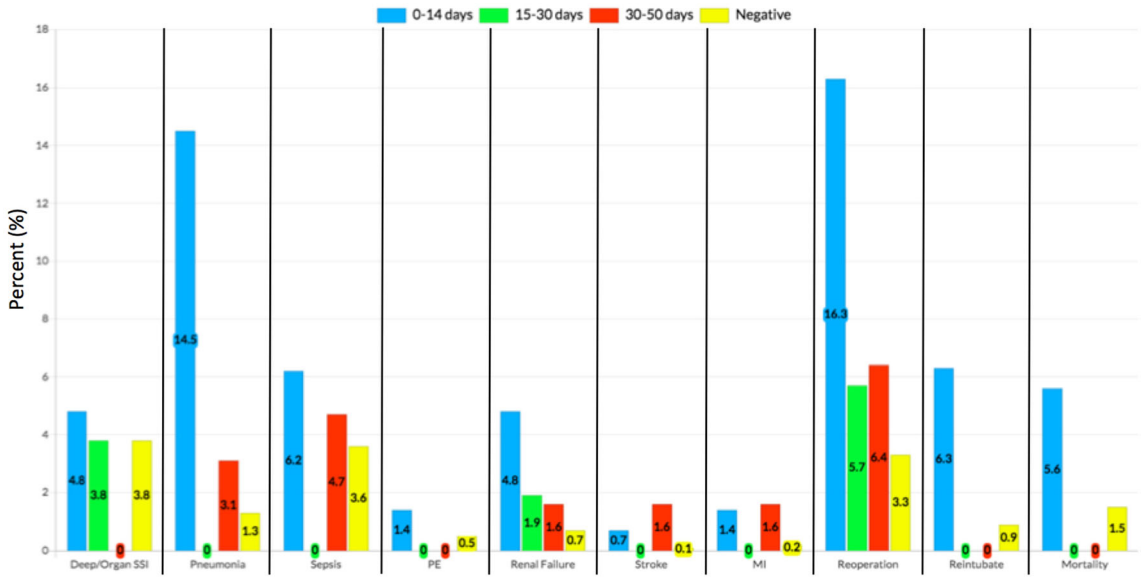

Fig. 1 Major complications stratified by timing of SARS-CoV-2 positivity before surgery compared to SARS-Cov-2 negative patients. Histogram showing percentage of major complications within SARS-CoV-2 positive patients stratified by timing of positivity before surgery and SARS-CoV-2 negative surgery patients. X-Axis: Major Complications. Y-Axis: Percentage (%). *SSI* Surgical Site Infection, *PE* Pulmonary Embolism, *MI* Myocardial Infarction

preoperative SARS-CoV-2 positive patients. Groups of patients were divided by the timing of positive tests between 0–2 weeks, 3–4 weeks, 5–6 weeks, and > 7 weeks. This study determined that the optimal timing of surgery following SARS-CoV-2 positivity was at least seven weeks since patients undergoing operations within six weeks of diagnosis had an increased risk of postoperative morbidity and mortality [9]. Deng et al. analyzed 2,858 elective non-vaccinated surgical patients who preoperatively tested positive for COVID-19. When comparing outcomes by the timing of SARS-CoV-2 before surgery, Deng et al. recommended delaying surgery for at least eight weeks after confirmed SARS-CoV-2 infection. Patients diagnosed with COVID-19 0–4 weeks before surgery had higher risks of sepsis, pneumonia, and respiratory failure, while positivity 4–8 weeks before surgery still was associated with an increased risk of postoperative pneumonia [10].

Our study evaluated abstracted data for 262 preoperative SARS-CoV-2 positive surgical patients. We excluded severely ill preoperative COVID-19 patients and evaluated elective and emergent cases. Our patients who had operations 15–30 days after testing positive for SARS-CoV-2 were included through the Omicron variant wave, and vaccination status is currently unknown for our patient population. By including all cases, surgeons can reference these data when counseling emergent surgical patients with preoperative SARS-CoV-2 positivity. This study shows no significant increased risk of major complications in preoperative SARS-CoV-2 positive patients after two weeks. This result contrasts with the previously mentioned studies that showed increased complications during this timeframe and recommended delays of up to 7–8 weeks [9, 10]. Our control group shows similar mortality (1.5%) to the comparison groups in the studies mentioned above. The etiology of this difference is unclear using current methods but may be related to our study group containing a portion of vaccinated patients and a subset of Omicron variant patients. These data can provide confidence to a surgeon who feels like an elective surgery is more urgent and waiting two weeks is appropriate.

This project is limited by not having vaccination status defined for each patient. Our early cohort from 5/2020 to 12/2020 was captured before vaccinations, and these patients are interspersed with vaccinated patients in the rest of our study cohort. Our models do not control for vaccination status, which limits interpretation. These data also represent multiple SARS-CoV-2 strains, including Alpha, Delta, and Omicron variants which have different severity profiles. To exclude patients severely ill with COVID-19 before surgery, we excluded any patients who were preoperatively admitted to the ICU. We excluded patients with preoperative ventilator status > 48 h for our control group. However, some patients in the control group may have been admitted to the ICU preoperatively, decreasing how well our exposure and control groups were matched. This cohort is limited by its smaller sample size, retrospective nature, and being a single-institution analysis. However,

Table 2 Postoperative outcomes between SARS-CoV-2 negative patients and preoperatively positive SARS-CoV-2 patients stratified by timing of positivity before surgery with bivariate odds of each complication compared to SARS-CoV-2 negative patients

Variables	SARS-CoV-2 Negative $N = 1840$	SARS-Cov-2 + Prior to Surgery		
		$\leq$ 14 (days) $N = 145$	15–30 (days) $N = 53$	31–50 (days) $N = 64$
LOS (days)	4 (2–7)	8 (4–15)	3 (1–5)	3.5 (2–6)
ICU postop	–	36 (25.9%)	8 (15.4%)	6 (9.7%)
Vent 48 h	25 (1.4%)	12 (8.3%)	1 (1.9%)	0
OR (CI)	REF	7.12 (3.46, 14.6)	1.52 (0.20, 11.4)	–
Reintubation	16 (0.9%)	9 (6.3%)	0	0
OR (CI)	REF	7.52 (3.26, 17.3)	–	–
Pneumonia	23 (1.3%)	21 (14.5%)	0	2 (3.1%)
OR (CI)	REF	13.9 (7.47, 26.1)	–	2.66 (0.61, 11.6)
UTI	21 (1.1%)	4 (2.8%)	0	3 (4.7%)
OR (CI)	REF	2.45 (0.83, 724)	–	4.25 (1.23, 14.6)
AKI	4 (0.2%)	15 (10.3%)	0	3 (4.7%)
OR (CI)	REF	52.8 (17.3, 161)	–	22.5 (4.93, 102)
Dialysis	13 (0.7%)	7 (4.8%)	1 (1.9%)	1 (1.6%)
OR (CI)	REF	8.41 (3.2, 22.0)	3.19 (0.40, 25.1)	2.63 (0.33, 20.7)
MI	3 (0.2%)	2 (1.4%)	0	1 (1.6%)
OR (CI)	REF	8.54 (1.42, 51.5)	–	9.69 (0.99, 94.5)
DVT	18 (1.0%)	3 (2.1%)	0	2 (3.1%)
OR (CI)	REF	2.40 (0.69, 8.34)	–	3.67 (0.82, 16.3)
PE	9 (0.5%)	2 (1.4%)	0	0
OR (CI)	REF	3.19 (0.67, 15.1)	–	–
Transfusion	209 (11.4%)	15 (10.3%)	2 (3.8%)	7 (10.9%)
OR (CI)	REF	0.90 (0.52, 1.57)	0.31 (0.07, 1.27)	0.96 (0.43, 2.13)
CVA	2 (0.1%)	1 (0.7%)	0	1 (1.6%)
OR (CI)	REF	12.7 (0.79, 204)	–	29.1 (1.8, 470)
Sepsis	67 (3.6%)	9 (6.2%)	0	3 (4.7%)
OR (CI)	REF	1.77 (0.87, 3.64)	–	1.32 (0.40, 4.31)
Superficial SSI	31 (1.7%)	4 (2.8%)	2 (3.8%)	0
OR (CI)	REF	1.67 (0.58, 4.81)	2.28 (0.53, 9.80)	–
Deep SSI	11 (0.6%)	5 (3.5%)	1 (1.9%)	0
OR (CI)	REF	6.01 (2.06, 17.5)	3.19 (0.40, 25.1)	–
Organ SSI	60 (3.3%)	2 (1.4%)	1 (1.9%)	0
OR (CI)	REF	0.44 (0.11, 1.80)	0.59 (0.08, 4.34)	–
Readmission	154 (8.4%)	23 (16.3%)	5 (9.4%)	6 (9.5%)
OR (CI)	REF	2.17 (1.35, 3.50)	1.16 (0.46, 2.96)	1.17 (0.50, 2.77)
Reoperation	60 (3.3%)	23 (16.3%)	3 (5.7%)	4 (6.4%)
OR (CI)	REF	5.96 (3.55, 10.0)	1.84 (0.56, 6.06)	2.07 (0.73, 5.90)
Mortality	27 (1.5%)	8 (5.6%)	0	0
OR (CI)	REF	4.05 (1.80, 9.11)	–	–
Major Complication	200 (10.9%)	45 (31.0%)	4 (7.6%)	8 (12.5%)
OR (CI)	REF	3.59 (2.45, 5.25)	0.65 (0.23, 1.82)	1.14 (0.54, 2.42)

Categorical Variables presented as Frequency (%), Continuous Variables presented as Median (Interquartile Range); Abbreviations: (SARS-CoV-2)-Severe Acute Respiratory Syndrome Coronavirus 2, (ICU)-Intensive Care Unit, (postop)-Postoperative, (Vent)-Ventilator, (hrs)-Hours, (OR)- Odds Ratio, (CI)-Confidence Interval, (REF)-Referent Group, (UTI)-Urinary Tract Infection, (AKI)-Acute Kidney Injury, (MI)-Myocardial Infarction, (DVT)-Deep Vein Thrombosis, (PE)-Pulmonary Embolism, (CVA)-Cerebrovascular Accident, (SSI)-Surgical Site Infection, (LOS)-Length of Stay

Table 3 Bivariate and multivariable odds of major complication

Variables	Crude OR (95% CI) $N = 2,102$	Multivariable OR (95% CI)
Age, (years)	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)
Sex		
Male	REF	–
Female	0.76 (0.58, 0.98)	–
Race		
Black	1.32 (1.00, 1.73)	–
White	REF	–
Other	0.71 (0.34, 1.50)	–
Body Mass Index	0.98 (0.96, 1.00)	–
Comorbidities		
Yes	1.44 (1.10, 1.91)	1.12 (0.82, 1.54)
No	REF	REF
Smoker		
Yes	1.30 (0.86, 1.96)	–
No	REF	–
Preop Dialysis		
Yes	3.96 (2.46, 6.37)	2.28 (1.31, 3.95)
No	REF	REF
Case Length, (mins)	1.00 (1.00, 1.00)	–
Surgery Type		
Gastrointestinal	REF	REF
Orthopedics	0.43 (0.25, 0.73)	0.35 (0.20, 0.61)
Vascular	1.96 (1.26, 3.06)	1.15 (0.69, 1.93)
Soft Tissue	1.61 (0.89, 2.89)	0.98 (0.50, 1.92)
Cardiothoracic	1.73 (0.74, 4.05)	1.11 (0.41, 3.05)
Neurosurgery	0.46 (0.29, 0.74)	0.46 (0.29, 0.75)
Case type		
Emergent	3.40 (2.51, 4.59)	2.45 (1.73, 3.48)
Elective	REF	REF
SARS-CoV-2 (+)Days prior to Surg		
Negative	REF	REF
0–14 days	3.59 (2.45, 5.25)	1.88 (1.13, 3.15)
15–30 days	0.65 (0.23, 1.82)	0.43 (0.14, 1.30)
31–50 days	1.14 (0.54, 2.42)	0.98 (0.44, 2.21)

Modeling the odds of Major Complication: reintubation, pneumonia, renal failure, myocardial infarction, pulmonary embolism, stroke, sepsis, deep surgical site infection (SSI), organ space SSI, reoperation, or death against the Referent group; Abbreviations: (OR)-Odds Ratio, (CI)-Confidence Interval, (REF)-Referent Group, (Preop)-preoperative, (mins)-Minutes, (SARS-CoV-2)-Severe Acute Respiratory Syndrome Coronavirus 2, (Surg)-Surgery

researchers or trained surgical clinical reviewers actively abstracted all the data.

In conclusion, this study adds to the limited literature on the appropriate length of time to wait to operate on a patient who preoperatively tests positive for SARS-CoV-2. Our study differs from the current literature, as we did not see increased odds of major complications for patients who were SARS-CoV-2 positive > 2 weeks before surgery. We recommend evaluating patients for surgery on an individual level. If the patient is not symptomatic and it's

been > 14 days since testing positive for SARS-CoV-2, it may be appropriate to perform an elective operation on good operative candidates.

Funding TL1TR002382, NIH/NCATS Georgia Clinical and Translational Science Alliance (Georgia CTSA) NSRA (TL1) Training Core.

Declarations

Conflict of interest The authors declare they have no conflict of interest.

Ethical approval This manuscript complies with the WJS ethical requirements.

Informed consent Informed consent was waived by this study's institutional review board.

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