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SARS-CoV-2–related outcomes after surgical procedures on SARS-CoV-2–positive patients in a large, urban, safety net medical center☆

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ABSTRACT

Background: Beginning on March 16, 2020, nonurgent scheduled operations at a large, urban, safety net medical center were canceled. The purpose of this study was to determine complications associated with severe acute respiratory syndrome coronavirus 2 infection for all operations done from March 16 to June 30, 2020.
Study Design: This study was a single-institution, retrospective observational analysis of data for all surgical procedures and all severe acute respiratory syndrome coronavirus 2 tests done in the medical center from March 16 to June 30, 2020. The charts of all severe acute respiratory syndrome coronavirus 2–positive patients who had a surgical procedure during the study time period were retrospectively reviewed to assess the outcomes.
Results: Of 2,208 operations during that time, 29 (1.3%) patients were severe acute respiratory syndrome coronavirus 2–positive and were asymptomatic at the time of their operations. Twenty-four (82.7%) of the 29 required urgent or emergent procedures. The median time between availability of test results and operations for these patients was 0.63 ± 1.94 days. With median follow-up of 89 days, none of the 29 patients died from severe acute respiratory syndrome coronavirus 2–related causes, and none developed clinically evident thromboembolism or required reintubation secondary to severe acute respiratory syndrome coronavirus 2–related pneumonia.
Conclusion: By operating on carefully screened, asymptomatic severe acute respiratory syndrome coronavirus 2–positive patients, it was possible to eliminate major complications and mortality due to severe acute respiratory syndrome coronavirus 2 infection.

INTRODUCTION

On March 11, 2020, the World Health Organization declared COVID-19 a pandemic, with close to 120,000 cases of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in over 110 countries and territories around the world [1]. A statement from the American College of Surgeons was issued on March 13, 2020, recommending the interim cancellation of elective surgical procedures, limiting the use of essential items such as intensive care unit (ICU) beds, and redirecting personal protective equipment (PPE) in anticipation of a significant influx of SARS-CoV-2–positive patients [2]. On March 16, the Los Angeles County Department of Health Services began canceling nonurgent scheduled operative procedures in the 4 public, safety net hospitals.

As operating room managers and hospital administrators struggled over the next several weeks with decisions regarding how to safely provide urgent surgical services to patients and PPE to staff, a report was published on April 5, 2020, from Wuhan, Hubei, China, describing the outcomes of 34 patients who were unintentionally scheduled for elective operations during the incubation period of their SARS-CoV-2 infections [3]. All patients developed pneumonia shortly after their operations, 15 (44.1%) required admission to an ICU, and 7 (20.5%) died. This report highlighted the urgent need to identify SARS-CoV-2–positive surgical candidates and to carefully weigh the risks of delaying an operation versus those related to the acuity of the SARS-CoV-2 infection.

Abbreviations: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; COVID-19, coronavirus disease-19; ICU, intensive care unit; PPE, personal protective equipment; PUI, person under investigation; MeNTS, Medically Necessary Time-Sensitive; ASA, American Society of Anesthesiologists; RT-PCR, real-time polymerase chain reaction.

☆ Precis: It was possible to limit the risk of postoperative complications due to SARS-CoV-2 infection by operating on carefully screened, asymptomatic SARS-CoV-2–positive patients.

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At LAC + USC Medical Center, operating time was restricted to urgent or emergent surgical procedures, dedicated "COVID operating rooms" were created with appropriate staffing models and PPE, and patients were tested for SARS-CoV-2 prior to their operations. The purpose of this study was to determine morbidity and mortality rates associated with operating on SARS-Co-V-2–positive patients for operations done from March 16 to June 30, 2020.

METHODS

The two most significant changes in the operating rooms during this time period were related to workflows and to preoperative SARS-CoV-2 testing.

Process Changes in the Operating Rooms. The LAC + USC Medical Center is a 676-bed facility with 25 operating rooms that in the "pre-COVID" era did approximately 14,000 operations per year, 35% of which were urgent or emergent. The hospital cares for almost 40% of all major trauma cases in the County of Los Angeles. Three of the 25 operating rooms are routinely dedicated to emergency procedures.

On March 16, scheduled elective block times in the operating room were suspended. Three rooms were dedicated to patients who had symptoms of or tested positive for SARS-CoV-2 infection, or to those who had been tested for SARS-CoV-2 but the results were pending at the time of the operation. The latter patients were designated as "persons under investigation (PUIs)."

The Los Angeles County Department of Health Services stratified patients according to a 5-tier system, designating patients requiring emergent or urgent procedures as Tiers 0 and 1, respectively. From March 16 until April 24, patients having surgical procedures were in these 2 tiers. In addition, patients were allowed to be scheduled for operations if they had invasive cancers, fractures requiring open reduction and internal fixation, or critical limb ischemia or if they required dialysis access or procedures that would result in clearing of in-patient beds. When deciding which operations to place on a schedule for procedures fitting these descriptions, operating room leadership considered using the Medically Necessary, Time-Sensitive (MeNTS) triage method which took into account procedure, disease, and patient factors [4]. However, our initial experience with this method created a cumbersome process that was difficult to manage because of the complexities imposed by the significant percentage of trauma cases, the acuity of the heterogeneous cases across multiple services, and the requirement for service chiefs to complete MeNTS scoring for each potential patient. Instead, a general guide was adopted which stipulated that if a service chief determined that an operation could wait from mid-March until mid-June, it should be considered elective, canceled, and rescheduled at a later date. If not, it was to be done as a scheduled operation. Between April 24 and June 30, patients in Tier 2 (requiring a procedure within 1 month) were also permitted to have scheduled operations. All procedures were reviewed by the operating room medical directors before being scheduled and again on the day prior to operation. The directors were vigilant in each case to assess, with the service chief, the relative risks of delaying an operation versus SARS-CoV-2–related complications incurred by operating, especially for SARS-CoV-2–positive and PUI patients. Outpatients who were designated American Society of Anesthesiology (ASA) Class I/II had their preoperative anesthesia clinic appointment deferred, and they were assessed by the Anesthesiology team on the day of operation.

COVID-19 Testing. All patients were tested upon admission for SARS-CoV-2 using the in-house Xpert Xpress (Cepheid) real-time polymerase chain reaction (RT-PCR) assay, which had a 2-hour turnaround time from swabbing until results were posted in the electronic medical record. If possible, operations were limited on SARS-CoV-2–positive patients until they were asymptomatic or 10 days after a positive test result.

For scheduled outpatients, patients received a call from their service coordinators 24–48 hours prior to operation to ensure that the patients did not have primary contact with a known SARS-CoV-2–positive person and that they were asymptomatic. Upon arrival in the preoperative holding area on the day of operation, patients were again screened before entering the operating room suites. For either encounter, if patients were symptomatic or had direct contact with a SARS-CoV-2–positive person, the procedure was canceled. Universal preoperative SARS-CoV-2 testing for outpatients having surgical procedures commenced on May 26, 2020. Patients were tested from 4 to 7 days prior to operation using the naso- or oropharyngeal Quest Diagnostics RT-PCR assay. Patients testing SARS-CoV-2–positive had their operations canceled and rescheduled.

Data Analysis. This study was a retrospective analysis of all operations and SARS-CoV-2 tests done from March 16 to June 30, 2020, at LAC + USC Medical Center. Data were abstracted from the analytics section of the electronic medical record. The operating room logs were merged on an Excel spreadsheet with a list of patients who were tested for SARS-CoV-2. The charts of all SARS-CoV-2–positive patients who had a surgical procedure during the study time period were retrospectively reviewed to assess the outcomes. This study was approved as expedited with waiver of informed consent by the University of Southern California Health Sciences Institutional Review Board (HS-20-00834).

RESULTS

To put the extent of the SARS-CoV-2 infection into context, the total number of cases diagnosed per week in Los Angeles County between March 8 and June 28, 2020, is shown in Fig 1 [5]. The number of positive test results for SARS-CoV-2 per week at LAC + USC Medical Center from March 15 to June 28, 2020, is shown in Fig 2.

The total number of operations done per service and the results of SARS-CoV-2 tests for LAC + USC Medical Center from March 16 to June 30, 2020, are shown in Table 1. For 2,208 operations during that time, 29 (1.3%) patients were SARS-CoV-2–positive and were asymptomatic at the time of their operations. Twenty-four (82.7%) of the 29 required urgent or emergent procedures. The median time between availability of test results and operations for these patients was 0.63 $\pm$ 1.94 days. Five (17.2%) of the 29 SARS-CoV-2–positive patients had their operations deferred a median of 20.41 $\pm$ 11.69 days after the SARS-CoV-2–positive test results were available.

The median follow-up from the date of operation was 89 days. Only 1 (3.4%) of the 29 SARS-CoV-2–positive patients died, this after a palliative internal fixation of a hip in conjunction with metastatic colon cancer to the liver, with kidney and liver failure. However, none of the 29 patients developed clinically evident thromboembolic complications

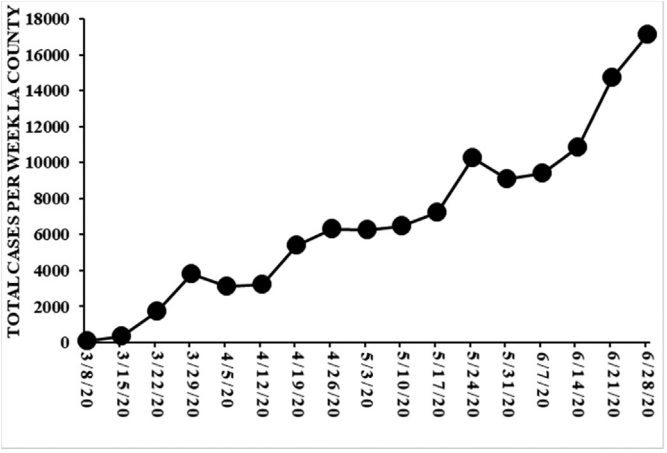

Fig 1. Total number of COVID-positive cases in Los Angeles County during the study period.

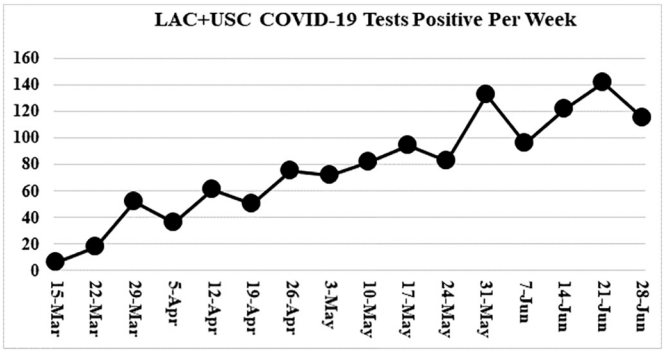

Fig 2. Total number of positive COVID test results per week at LAC + USC Medical Center during the study period.

Table 1
Summary of cases done, by service

		Total cases done				Testing	
Service	*Mar 16–31*	*April*	*May*	*June*	*Total*	*PUI*	*COVID +*
Burns	7	9	11	22	49	4	3
Cardiac	4	15	15	16	50	0	0
Colorectal	8	14	23	25	70	2	0
ENT and head/neck	14	30	25	38	107	1	2
Gynecology	21	51	44	49	165	6	1
Hepatobiliary	0	0	0	0	0	0	0
General surgery	77	122	120	133	452	69	6
Neurosurgery	22	24	37	49	132	16	4
Ophthalmology	24	47	110	143	324	0	0
Orthopedics	85	138	168	190	581	20	9
Pediatrics	0	1	4	2	7	0	0
Reconstructive	4	12	18	15	49	0	0
Surgical oncology	8	19	13	10	50	0	0
Thoracic	3	7	0	1	11	0	0
Urology	7	13	28	44	92	2	3
Vascular	4	14	21	30	69	1	1
Total	288	516	637	767	2,208	121	29

or required reintubation secondary to postoperative SARS-CoV-2–related pneumonia.

During the time period of this study, a total of 1,275 patients were diagnosed with SARS-CoV-2 infection at LAC + USC Medical Center, 76 (5.9%) of whom died from causes related to SARS-CoV-2 infection.

DISCUSSION

This observational study demonstrated that after carefully prescreening patients for symptoms of infection prior to emergent or urgent operations and operating only on those who were asymptomatic, none developed clinically evident thromboembolic complications or required reintubation secondary to postoperative SARS-CoV-2–related pneumonia.

In early April 2020, reports began to appear from surgeons around the world, which described significant morbidity and mortality risks associated with operating on SARS-CoV-2–positive patients (Table 2).

One of the first to appear was an article by Lei et al, which described the clinical characteristics and outcomes for 34 patients from Wuhan, Hubei, China, who were unintentionally scheduled for a variety of elective surgical procedures during the incubation period of their SARS-CoV-2 infections [3]. These patients were treated between January 1 and February 5, 2020, before preoperative testing protocols were in place for SARS-CoV-2, and they developed clinical signs of infection in the early postoperative time period. The authors reported that 15 (44.1%) of the 34 patients required ICU care and 7 (20.5%) died. All 34 patients were admitted to the hospital at a median of 2.5 days before their operations, and they developed symptoms of SARS-CoV-2 at a median of 2.5 days after operation. The median time from the onset of symptoms to death was 9 days (range 4–13 days). Risk factors for poor prognosis in this small patient sample were length and acuity of the operations.

Similar experiences were subsequently described in several other studies from Iran, the United Kingdom, and Italy [6–9]. In 2 of these studies, the management of hip fractures during the pandemic posed significant challenges in the elderly population living in residential care facilities. Surgeons had to balance risk associated with hip fractures versus risk of mortality from SARS-CoV-2 infection by virtue of age and comorbidities. Although nonoperative management for hip fractures was not strongly recommended because of the increased mortality risk from the fractures, the authors recommended that patients with SARS-CoV-2 be informed of the increased perioperative risks and that their operations be deferred when possible [7,8].

On May 20, 2020, the COVIDSurg Collaborative published an international multicenter observational cohort study at 235 hospitals in 24 countries, providing cross-specialty patient-level outcomes for 1,128 patients who had a surgical procedure between January 1 and March 31, 2020, and who developed perioperative SARS-CoV-2 infection between 7 days before and 30 days after operation [10]. The outcomes were obtained in the early days of the pandemic, so the quantitative RT-PCR assay was not available at all sites. There were 835 (74.0%) emergency and 280 (24.8%) elective operations. SARS-CoV-2 infection occurred before operation in 294 (26.1%) patients. The diagnosis was made by RT-PCR assay in 969 (85.9%) patients, radiological findings (chest CT) in 80 (7.1%), and clinical symptoms alone in 68 (6.0%). However, it was not clear how many patients were symptomatic at the time of their operations. Postoperative 30-day mortality occurred in 261 (25.2%) of 1,037 patients with complete outcomes data. There was no significant difference in the 30-day mortality rate for patients diagnosed with SARS-CoV-2 infection before (21.9%) versus after (26.4%) operation (OR 0.94, CI 0.65–1.36, $P = .753$). Pulmonary complications occurred in half of patients with perioperative SARS-CoV-2 infection and were associated with high mortality rates. The authors stated that the increased risks associated with SARS-CoV-2 infection should be balanced against the risks of delaying operations in individual patients. They further concluded that consideration be given for postponing nonurgent procedures and promoting nonoperative treatment to delay or avoid the need for operative interventions.

The high mortality rates described above from the early international experiences during the pandemic are contrasted to those obtained in this study, in which there was no mortality associated with

Table 2
Selected published results of perioperative mortality rates in COVID-positive patients

Lei [3]	Neurosurgery Orthopedics Gynecology Ophthalmology Transplant General surgery Otolaryngology	34	7 (20.5%)	Postop	Symptomatic
Aminian [6]	General surgery Gynecology	3	2 (66.7%)	Postop clinical infection	none
Narang [7]	Orthopedics	86	30 (34.9%)	Preop	Symptomatic
Kayani [8]	Orthopedics	82	25 (30.5%)	Preop	All admissions
Doglietto [9]	Vascular General surgery Neurosurgery Orthopedics Thoracic	41	8 (19.5%)	Preop to ≤5 d postop	Preop: both Postop: symptomatic
COVIDSurg Collaborative [10]	All	1,037	261 (25.2%)	≤7 d preop to ≤30 d postop	Testing based on individual hospital protocols

operating on asymptomatic SARS-Co-V-2–positive patients. There are 3 potential explanations for the difference between the outcomes our patients experienced and previously published reports: (1) the association between perioperative SARS-CoV-2 infection and increased postoperative mortality in prior reports was a result of chance; (2) the virus mutated enough to have a lower mortality rate in Los Angeles than other parts of the world; or (3) the interventions here were effective in reducing the postoperative complication rates from SARS-CoV-2 infection.

First, the large number of case reports from multiple sources around the world makes it unlikely that the association between perioperative SARS-CoV-2 infection and postoperative mortality was related to chance. Second, 76 (5.9%) of 1,275 patients died from SARS-CoV-2 infection diagnosed in LAC + USC Medical Center during this time period, indicating that there was a measurably different disease-related in-hospital mortality rate in other areas of the same hospital. In addition, the case fatality rate in Los Angeles County for SARS-CoV-2 infection during the time period of the study peaked at a maximum of 4%, both data points suggesting that the virus had not mutated to a less virulent strain [5]. Third, patients were screened upon admission to the hospital using an RT-PCR assay for SARS-CoV-2, and all candidates for a surgical procedure were carefully prescreened for symptoms of infection. The 29 patients testing positive for SARS-CoV-2 infection were asymptomatic at the time of their operations. This careful prescreening process likely accounted for the fact that there were not any patients who died from SARS-CoV-2–related complications.

Limitations. One of the limitations of this study was that the design did not use a case control or matched cohort group for comparison. It might have been appropriate to consider comparing results of operating on asymptomatic versus symptomatic SARS-CoV-2–positive patients to determine whether the degree of physiologic alteration from SARS-CoV-2 infection was associated with outcomes. However, the emerging data from international sources demonstrated unacceptably high rates of morbidity and mortality by operating on SARS-CoV-2–positive patients. Therefore, we chose to limit operations to those who were asymptomatic, and a group of symptomatic SARS-CoV-2–positive patients for comparison did not exist. Another limitation was that data were collected only until June 30, 2020, and a longer study time period could conceivably have resulted in an increase in the postoperative mortality rate related to SARS-CoV-2 infection.

In conclusion, these results demonstrated that it was possible to limit the risk of postoperative complications due to SARS-CoV-2 infection by operating on carefully screened, asymptomatic SARS-CoV-2–positive patients. These findings appeared to reinforce the practice of allowing urgent or emergent operations to proceed when a delay would result in increased risk of morbidity or mortality from the surgical disease or when there are no viable nonoperative management strategies.

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Conflict of Interest Statement

This research did not receive funding from agencies in the public, commercial, or not-for-profit sectors.

References

[1] WHO Director-General's opening remarks media briefing on COVID-19: 11 March 2020. https://www.who.int/dg/speeches/detail/who-director-general's-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020. Accessed March 15, 2020.

[2] American College of Surgeons. COVID-19: recommendations for management of elective surgical procedures. https://www.facs.org/covid-19/clinical-guidance/electivesurgery; March 13, 2020. First accessed March 15, 2020. Last accessed September 11, 2020.

[3] Lei S, Kiang F, Su W, Chen C, Chen J, Mei W, et al. Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. EClinicalMedicine. 2020;21:100331. https://doi.org/10.1016/j.eclinm.2020.100331.

[4] Prachand VN, Milner R, Angelos P, Posner MC, Fung JJ, Agrawal N, et al. Medically-necessary, time sensitive procedures: a scoring system to ethically and efficiently manage resource scarcity and provider risk during the COVID-19 pandemic. J Am Coll Surg. 2020. https://doi.org/10.1016/j.jamcollsurg.2020.04.011.

[5] publichealth.lacounty.gov/media/coronavirus/data/index.htm. Accessed April 1, 2020. Last accessed September 13, 2020.

[6] Aminian A, Safari S, Razeghian-Jahromi A, Ghorbani M, Delaney CP. COVID-19 outbreak and surgical practice: unexpected fatality in perioperative period. Ann Surg. 2020 Jul;272(1):e27–9. https://doi.org/10.1097/SLA.0000000000003925.

[7] Narang A, Chan G, Aframian A, Ali Z, Carr A, Goodier H, et al. Thirty-day mortality following surgical management of hip fractures during the COVID-19 pandemic: findings from a prospective multi-centre UK study. Int Orthop. 2020 Aug;29:1–9. https://doi.org/10.1007/s00264-020-04739-y.

[8] Kayani B, Onochie E, Patil V, Begum F, Cuthbert R, Ferguson D, et al. The effects of COVID-19 on perioperative morbidity and mortality in patients with hip fractures. A multicenter study. Bone Joint J. 2020;102-B(9):1136–45. https://doi.org/10.1302/0301-620X.102B9.

[9] Doglietto F, Vezzoli M, Gheza F, Lussardi GL, Domenicucci M, Vecchiarelli L, et al. Factors associated with surgical mortality of complications among patients with and without coronavirus disease 2019 (COVID-19) in Italy. JAMA Surg. 2020;155:1–14. https://doi.org/10.1001/jamasurg.2020.2713 Published online ahead of print.

[10] COVIDSurg Collaborative. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. Lancet. 2020;396(10243):27–38. https://doi.org/10.1016/S0140-6736(20)31182-X.