Surgical Outcomes in Benign Gynecologic Surgery Patients during the COVID-19 Pandemic (SOCOVID study)

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Precis: Only 0.3% of patients developed COVID-19 in the 14-days after benign gynecologic surgery. There were no differences in peri-operative complications in those with and without prior COVID-19 infections.

Abstract:

Study Objective: To determine the incidence of perioperative COVID-19 in women undergoing benign gynecologic surgery, and to evaluate perioperative complication rates in patients with active, prior or no prior SARS-CoV-2 infection.

Design: Multicenter prospective cohort study

Setting: Ten institutions in the United States

Patients: Patients over the age of 18 years who underwent benign gynecologic surgery from July 1, 2020 to December 31, 2020 were included. All patients were followed from the time of surgery until 10 weeks post-operatively. Those with intra-uterine pregnancy or known gynecologic malignancy were excluded.

Interventions: Benign gynecologic surgery

Measurements: The primary outcome was the incidence of perioperative COVID-19 infections which was stratified as 1) prior COVID-19 infection, 2) pre-operative COVID-19 infection and 3) post-operative COVID-19 infection. Secondary outcomes included adverse events and mortality following surgery, as well as predictors for post-operative COVID-19 infection. If surgery was delayed due to the COVID-19 pandemic, the reason for postponement and any subsequent adverse event was recorded.

Main Results: Of 3423 patients included for final analysis, 189 (5.5%) postponed their gynecologic surgery during the pandemic. Forty-three patients (1.3% of total cases) were due to a history of COVID-19. The majority (182 [96.3%]) had no sequelae attributed to surgical postponement. Following hospital discharge to 10 weeks post-operatively, 39 (1.1%) patients became infected with SARS-CoV-2. The mean duration of time between hospital discharge and

the follow-up positive COVID-19 test was 22.1 ± 12.3 days (range 4-50 days). Eleven (31.4% of post-operative COVID-19 infections, 0.3% of total cases) of the newly diagnosed COVID-19 infections occurred within 14 days of hospital discharge. On multivariable logistic regression, living in the Southwest (adjOR 6.8) and single-unit increase in age-adjusted Charlson co-morbidity index (adjOR 1.2) increased the odds of post-operative COVID-19 infection. Peri-operative complications were not significantly higher in patients with a history of prior positive COVID-19 compared to those without a history of COVID-19, though the mean duration of time between prior COVID-19 diagnosis and surgery was 97 days (14 weeks).

Conclusion: In this large multi-center prospective cohort study of benign gynecologic surgeries, only 1.1% of patients developed a post-operative COVID-19 infection, with 0.3% of infection in the immediate 14-days after surgery. The incidence of post-operative complications was not different in those with and without prior COVID-19 infections.

Keywords: COVID-19, SARS-CoV-2, gynecologic surgery, surgical outcomes, adverse events, nosocomial infections

Introduction

In January of 2020, the Centers for Disease Control and Prevention (CDC) confirmed the first United States (U.S.) case of COVID-19 caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Washington state.[1] By March of 2020, the rapid spread of COVID-19 led to the halt of non-emergent healthcare services across the Unites States in order to preserve healthcare resources for patients with COVID-19.

Elective and non-urgent surgeries resumed in mid-2020 once personal protective equipment and COVID-19 testing became more readily available. To continue caring for patients with non-urgent conditions, we witnessed a rapid scale-up of telemedicine.[2] When surgical cases resumed, it was estimated that 41% of U.S. adults delayed or deferred care during the pandemic.[3] This delay may reflect adherence to stay-at-home orders, pandemic circumstances making access to medical care difficult or fear of contracting or spreading COVID-19 despite implementation of universal COVID testing pre-operatively across major institutions.[4] For patients who did subsequently proceed with surgery during the pandemic, there are limited data on surgical outcomes during the COVID-19 pandemic including outcomes in patients actively or previously infected with SARS-CoV-2.

This study was designed to understand peri-operative COVID-19 infection rates and how COVID-19 impacts surgical outcomes in women undergoing benign gynecologic surgery. The primary objective of our study is to determine the incidence of peri-operative COVID-19 in women undergoing benign gynecologic surgeries. Our secondary aims were to determine the incidence of surgical morbidity and mortality in gynecologic patients undergoing surgery with an active SARS-CoV-2 infection, prior infection, or no infection, in addition to identifying predictors for post-operative COVID-19 infection.

Methods:

This multicenter prospective cohort study was conducted at ten institutions across the United States to evaluate the surgical outcomes of patients undergoing benign gynecologic

surgeries during the COVID-19 pandemic (SOCOVID study). Ten institutions were selected to attempt to capture a wide geographic cohort and variety of benign gynecologic procedures. Institutional review board (IRB) approval was obtained at each site.

All patients over the age of 18 years old who underwent benign gynecologic surgery from July 1, 2020 to December 31, 2020 were included. All patients were prospectively followed from the time of surgery until 10 weeks post-operatively to capture wide practice variations across ten sites. Those with intra-uterine pregnancy or known gynecologic malignancy were excluded. Peri-operative variables of interest were extracted from the medical record, including retrospective data for demographics and variables related to COVID infection (Appendix, Table 1). The Charlson co-morbidity index, a tool that has been studied to predict mortality based on scoring of medical comorbidities, was calculated for all patients with age and non-age adjustments.[5]

As previously published, all patients received pre-operative COVID-19 testing up to 5 days before scheduled surgery per institutional protocols.[4] Our primary outcome was the incidence of peri-operative COVID-19 infections defined as a documented positive SARS-CoV-2 PCR test from nasopharyngeal swabs or lower respiratory tract samples. We stratified COVID-19 infections by the timing of the infection relative to surgery as 1) **Prior COVID-19 infection**, defined as history of COVID-infection at any point independent of surgery; 2) **Pre-operative COVID-19 infection**, defined as COVID-infection detected pre-operatively within 5 days of scheduled surgery; 3) **Post-operative COVID-19 infection**, defined as COVID-infection detected after surgery until 10 weeks post-operative period. We defined COVID-19-related adverse events to include pneumonia; abnormal chest radiography; acute respiratory distress syndrome, intensive care unit admission, use of mechanical ventilation or extracorporeal membrane oxygenation, multisystem inflammatory syndrome, and involvement of other organ systems including gastrointestinal, neurologic, hematologic, dermatologic, and cardiac complications and death.

The reason for the postponement of surgery and any adverse events resulting from delayed surgery were recorded. Our secondary outcomes included adverse events and mortality following benign gynecologic surgery. Adverse events included blood transfusion intraoperatively or within 72 hours of surgery, venous thromboembolic disease, pneumonia, reintubation, renal insufficiency or failure, sepsis or septic shock, wound dehiscence, myocardial infarction or cardiac arrest, cerebral vascular accident, urinary tract infection, and deep or organ space infection. Additional events such as readmission, reoperation, Emergency Department (E.D.) utilization and death following hospital discharge were recorded.

All study data were collected and managed using REDCap (Research Electronic Data Capture)[6] electronic data capture tools hosted at Indiana University School of Medicine. Study population means, medians, and proportions were calculated for all parametric and non-parametric continuous and categorical variables. Continuous variables were compared for patients with prior and pre-op COVID infection and post-op COVID infection to all others using Student's t-test and Mann Whitney U test. Categorical variables were compared for patients who had prior and pre-operative COVID infection and post-op COVID infection to all others using Chi square test for association. Data reduction techniques were used to minimize the number of response categories for categorical data when small cell frequencies were observed for two-by-two crosstabulations. Unadjusted odds ratios with 95% confidence intervals were calculated for all two-by-two categorical comparisons. One parsimonious hierarchical multivariable logistic regression model was constructed to identify independent surgical predictors of post-operative COVID-19 infection after controlling for sociodemographic and clinical variables. Variables associated with post-operative COVID-19 infection at a significance level of 0.05 during bivariate analysis, were included in the regression model. Adjusted odds ratios with 95% confidence intervals were calculated to identify independent surgical predictors of post-operative COVID-19 infection after controlling for categorical sociodemographic, clinical,

and surgical predictors of post-operative COVID-19 infection. P values < 0.05 were considered significant. IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA) was used for all computational analyses.

Results

A total of 3541 patients were included in the prospective cohort from ten surgical sites from July 1st 2020 until December 31st 2020. After removing entries for missing or inconsistent data, a total of 3423 entries (96.7%) were included for final analysis. Our study period occurred during the second and third peak of COVID-19 infections in the United States. Figure 1 shows the number of surgeries performed monthly in our cohort in relation to COVID-19 infections in the United States. The sociodemographic and clinical variables of the patient cohort are shown in Table 1. Surgical variables including the most commonly performed surgeries are shown in Table 2. The most commonly performed surgery was hysteroscopy (17.5%), followed by laparoscopic adnexal surgery (13.6%) then total laparoscopic hysterectomy (12.5%). Most surgeries were elective (96.5%).

Postponement of original surgery

One hundred and eighty-nine (5.5%) patients had their gynecologic surgery postponed from their original surgical date. Of these postponed cases, 43 (1.3% of all cases, 22.9% of all postponements) were due to a COVID-19 diagnosis, 11 (5.8%) were due to symptoms of COVID-19 or a COVID-19 exposure without a COVID-19 test result (either not yet tested, or test pending at the time of postponement), 125 (66.5%) were delayed because of a moratorium on elective cases and 9 (4.8%) were for other causes such as surgeon quarantining, patient's fear of infection and unknown causes. The mean duration of postponement time between the original date and their actual gynecologic surgery was 104.3 ± 60 days. Among the 189 postponed patients, 182 (96.3%) had no sequelae because of surgical postponement, 2 (1.1%)

required a blood transfusion for bleeding, 3 (1.6%) required an emergency room visit, 1 (0.55%) had an office procedure, and 1 (0.55%) had a delayed diagnosis of endometrial intraepithelial neoplasia.

Prior COVID-19 infection independent of surgery

One hundred and fourteen (3.3%) patients had a positive COVID-19 test more than 5 days before their gynecologic surgery. The mean duration of time between their previous COVID-19 diagnosis and their gynecologic surgery was 97.3 ± 64 days. The sociodemographic, and clinical differences in the 128 study subjects who had a uniquely positive COVID-19 test at any time prior to their gynecologic surgery (114 prior COVID-19 infection, 14 pre-operative COVID-19 infection) were compared to all others are shown in Table 3. On bivariate analysis, there were significant differences in age and body-mass index, race/ethnicity, region of country, and occupation in healthcare between groups.

Pre-operative COVID-19 infection

Twenty-seven (0.8%) patients had a positive requisite pre-operative COVID-19 test. Among these 27 patients, 5 (18.5%) had a prior COVID infection, and retesting was not warranted per institutional protocol, 8 (29.6%) patients had a prior COVID infection and tested positive pre-operatively and 14 (51.9%) had a positive pre-operative COVID testing obtained within 5 days of surgery. Of the 118 emergent surgeries, 10 (8.5%) emergent surgeries were performed despite a positive COVID-19 test. The indications for emergent surgeries included dilation and curettage, diagnostic and operative laparoscopy for adnexal pathology and marsupialization of Bartholin's cyst abscess. There were no adverse sequelae for these ten cases post-operatively. The mean duration of time between the requisite pre-operative COVID-19 test and their actual gynecologic surgery was 2.9 ± 4.8 days.

Post-operative COVID-19 infection

After hospital discharge to 10 weeks post-operatively, 39 (1.1%) patients developed a COVID-19 infection. The mean duration of time between hospital discharge after gynecologic surgery and the post-operative positive COVID-19 test was 22.1 ± 12.3 days (range 4-50 days). Eleven (31.4% of post-operative COVID-19 infections, 0.3% of total cases) of the newly diagnosed COVID-19 infections occurred within 14 days of hospitalization for gynecologic surgery, with most of the diagnoses of COVID-19 infections occurring 15-20 days post-operatively (Figure 2). The median length of hospital stay in hours was longer for patients who developed a post-operative COVID-19 infection compared to those who did not (median 17.7, IQR 24 vs. median 8.7, IQR 18.1, p = 0.002). The length of hospital stay after gynecologic surgery was beyond 24 hours for 18 (46.2%) of the 39 patients with post-operative COVID-19 infections. The remaining sociodemographic, clinical, and surgical differences in the 39 study subjects who had a newly diagnosed COVID-19 infection on follow-up compared to all others are shown in Table 4.

There were no adverse clinical outcomes as a result of post-operative COVID-19 infection in 27 (69.2%) cases while 12 patients had adverse clinical outcomes including: 5 cases (12.8%) of pneumonia, 3 cases (7.7%) of abnormal chest radiography, 3 cases (7.7%) of hospital readmission, 1 case (2.6%) of gastrointestinal symptoms, 1 case (2.6%) of neurological symptoms, and 1 case (2.6%) of sinusitis symptoms. None of the patients with a post-operative COVID-19 infection required an ICU admit, mechanical ventilation, ECMO and did not develop coagulopathy, cardiomyopathy, multi-system inflammatory syndrome or death.

On the multivariable parsimonious hierarchical logistic regression model of post-operative COVID-19 infections, living in the Southwest region (adjusted OR 6.8, 95% CI = 2.0-23.1) of the United States increased the odds of a post-operative COVID-19 infection after discharge compared to the Northeast region. A single unit increase in age-adjusted Charlson co-morbidity increased the odds of a post-operative COVID-19 infection by 20% (adjusted OR

1.2, 95% CI= 1.002- 1.35). There was a statistical trend showing that for each one hour increase in hospital stay, the odds of post-operative COVID-19 infections increased by 0.3% (adjusted OR 1.003, 95%CI = 1.001 - 1.005).

Intraoperative complications

There were 104 (3%) intraoperative complications associated with gynecologic surgery. There were 22 cases (0.6% of total surgeries) of urinary tract injuries, 19 cases (0.6%) of required additional/unplanned surgery, 18 cases (0.5%) were hemorrhage complications, 8 cases (0.2%) were gastrointestinal tract injuries, 6 cases (0.1%) were injuries to organs distant from the primary surgical site, 5 cases (0.1%) of pulmonary complications, 3 cases (0.08%) of anesthetic complications, and 2 cases (0.06%) were major vessel injuries. Twenty patients (0.5%) had other complications ranging from unanticipated surgical complexity (n=11), uterine perforation (n=5), transient cardiac arrhythmias (n=2), transient ureteral obstruction (n=1), and use of cell saver (n=1).

Post-operative complications during hospitalization

In the cohort, 277 (8.1%) patients developed immediate post-operative complications. The most common were pain, nausea/vomiting and blood product transfusion. Details are available in the Appendix, Table 2. There were no cases of newly diagnosed COVID-19 infection in the immediate post-operative hospitalization period. There was one death post-operatively during hospitalization, that was neither due to a COVID-19 diagnosis nor a surgical complication.

Post-operative complications after hospital discharge

Post-operatively, 2479 (72.4%) patients presented for in-person follow-up while 447 (13.1%) patients followed up virtually by telephone or video virtual visit. There were 1066

(31.1%) post-operative complications following hospital discharge with the most common being pain (n=299, 8.7% of all patients), return to emergency room unrelated to COVID-19 infection (n=216, 6.3% of all patients), urinary tract infection (n=119 cases, 3.5% of total surgeries), hospital readmission unrelated to COVID-19 infection (n=81, 2.4% of all patients), nausea and vomiting n=70, 2% of all patients) and surgical site infection (n=62, 1.8% of all patients). There were two deaths post-operatively after hospital discharge due to cancer-related complications, that were neither due to a COVID-19 diagnosis nor a surgical complication.

Any intraoperative, immediate post-operative, or post-discharge follow-up complications were not significantly higher in patients who had a positive COVID-19 test at any time prior to gynecologic surgery compared to all others (Table 5).

Discussion

To date, the SOCOVID study is the largest known national prospective cohort study in the United States that evaluates benign gynecologic surgery outcomes during the SARS-CoV-2 pandemic. We found a low incidence (1.1%) of post-operative COVID-19 infections in the 10 weeks after surgery. Those living in the Southwest had higher odds of developing post-operative COVID-19 infection. There were no differences in intraoperative or post-operative complications between those with prior COVID-19 infections compared to those without.

Our study showed that only 0.3% of the study population tested newly positive for COVID-19 within 14 days of hospitalization for gynecologic surgery. Given that the Center for Disease Control reports a 14-day incubation period for COVID-19[7], with another study reporting that most onset of symptoms are within 11.5 days of infection[8], we conclude that the risk of nosocomial COVID-19 infection during hospitalization for gynecologic surgery was very low. Furthermore, this 0.3% may overestimate nosocomial transmissions since some patients may have acquired COVID-19 in the community post-operatively. The low conversion rate may be valuable for counseling patients concerned about COVID-19 exposure in the hospital setting;

however, because universal post-operative COVID testing was not conducted as part of our study, the reported incidence may be an underestimation of post-operative infections.

In this study of mostly minimally invasive gynecologic surgery, only 1.3% of benign surgical cases from July 1 to December 31, 2020 were postponed due to a pre-operative COVID-positive test. Fortunately, most of these patients did not suffer any sequelae as a result of surgical postponement though this likely is because most patients in our cohort were undergoing elective surgeries. Most cases for benign gynecologic conditions such as uterine fibroids, abnormal uterine bleeding or pelvic organ prolapse were categorized as Tier 1a (defined as low acuity and non-life-threatening illness) with the previously published "Elective Surgery Acuity Scale".[9] This may affirm that the tiered ranking systems developed to re-introduce elective cases appropriately triaged cases. Furthermore, in the event that elective procedures are to be postponed or delayed in the future, our data shows that postponement of these types of elective surgery did not lead to significant morbidity or mortality.

When looking at the 1.1% of patients who developed post-operative COVID-19 infection in the 10-week post-operative period, patients living in the Southwest had higher odds of developing a post-operative COVID-19 infection. This is likely because the timing of our study coincided with an increase of cases in the Southwest region, suggesting that higher incidence of community spread may play a role in post-operative COVID-19 infections beyond nosocomial spread. Our study demonstrated a statistical trend that each one hour increase in hospital stay was associated with increased odds of post-operative COVID-19 infections by 0.3%;in other words, shorter hospital stays reduced the odds of developing COVID-19 post-operatively. Prior to the pandemic, same-day discharge was shown to be feasible[10] with no differences seen in readmission after hysterectomy[11] or pelvic organ prolapse surgery.[12] In light of the current pandemic, our study suggests the additional benefit of limiting the duration of post-operative hospital stay to also include reduced odds of acquiring nosocomial COVID infection.

In patients with active COVID-19 infections undergoing surgery, there is a reported increase in surgical mortality and complications,[13] specifically increased pulmonary complications[14] and venous thromboembolism.[15,16] However, current data remains mixed with some showing no change in the rate of post-operative morbidity and mortality[17,18] In one large international multicenter cohort of 1128 patients undergoing surgery at 235 hospitals in 24 countries from January 1 to March 21, 2020, the COVID-19 infection rate was 26.1% pre-operatively, with 51.2% suffering post-operative pulmonary complications and over-all 30-day mortality at 23.8%.[14] In another multicenter international prospective cohort study of 140,231 surgical patients from 116 countries, 2.2% had a pre-operative COVID-19 positive test and the adjusted odds ratio for 30-day mortality was significantly higher in patients having surgery within 7 weeks of a COVID-19 infection.[19] In the SOCOVID study, we did not find a difference in complications between patients with and without a history of COVID-19 infection. Furthermore, the rate of complications from the SOCOVID cohort does not differ from known 30-day post-operative complications reported from large registries such as the American College of Surgeons National Surgical Quality Improvement Project (NSQIP). In one NSQIP study of 27,167 hysterectomies, the overall 30-day complication rate was 8.1%.[20] The most likely difference for the relative low rate of complications in patients with prior history of COVID-19 is related to the average delay from time of COVID-19 diagnosis to surgery in our study was approximately 14 weeks. While our study was not designed to determine the ideal time frame to delay surgery after a positive COVID-19 test, it certainly challenges current institutional pre-operative COVID-testing protocols[4] with a mean wait time of 10 days (range 10-30 days) after a COVID-19 infection. Perhaps, the ideal wait time should be reconsidered particularly with recent data showing that patients who have surgery less than 7 weeks after COVID infection suffer from greater post-operative mortality[19], though more large scale studies are needed to support this recommendation.

There are several strengths to this study. This prospective study design allowed us to follow all patients during the study period to capture all peri-operative COVID-19 infections and the associated complications. The multi-center design of this study allowed the inclusion of a diverse population of women undergoing a variety of mostly elective, minimally invasive and outpatient gynecologic surgeries. All centers underwent training to ensure standardized data entry.

There are several limitations to this study. To coordinate IRB approval across 10 study-sites, data collection did not begin until July 1, 2020 which was after the initial peak of cases in the Northeast. Furthermore, we do not have a complete geographic representation of the United States. We planned to have sites from the West coast, but again due to IRB-related issues our West coast sites were unable to enroll subjects. Because the incidence of new COVID-19 cases in the United States varied from month to month during different regions of our country and thus, this may have skewed the overall number of new cases in certain regions of the United States. Finally, our reported incidence of post-operative COVID-19 infection may be underestimated because patients did not undergo universal COVID-19 testing post-operatively.

In summary, in this large multi-center prospective cohort study of benign gynecologic surgeries, only 1.1% of patients developed a post-operative COVID-19 infection with 0.3% of patients with an infection in the immediate 14-days after surgery. For those with a previous COVID-19 infection remote from surgery, the incidence of surgical complications was low and not statistically different from those without prior COVID-19 infection.

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Figure Legends

Figure 1. Frequency distribution of US COVID-19 infections by month (top of figure) and frequency distribution of surgical cases by month during study period (bottom of figure)

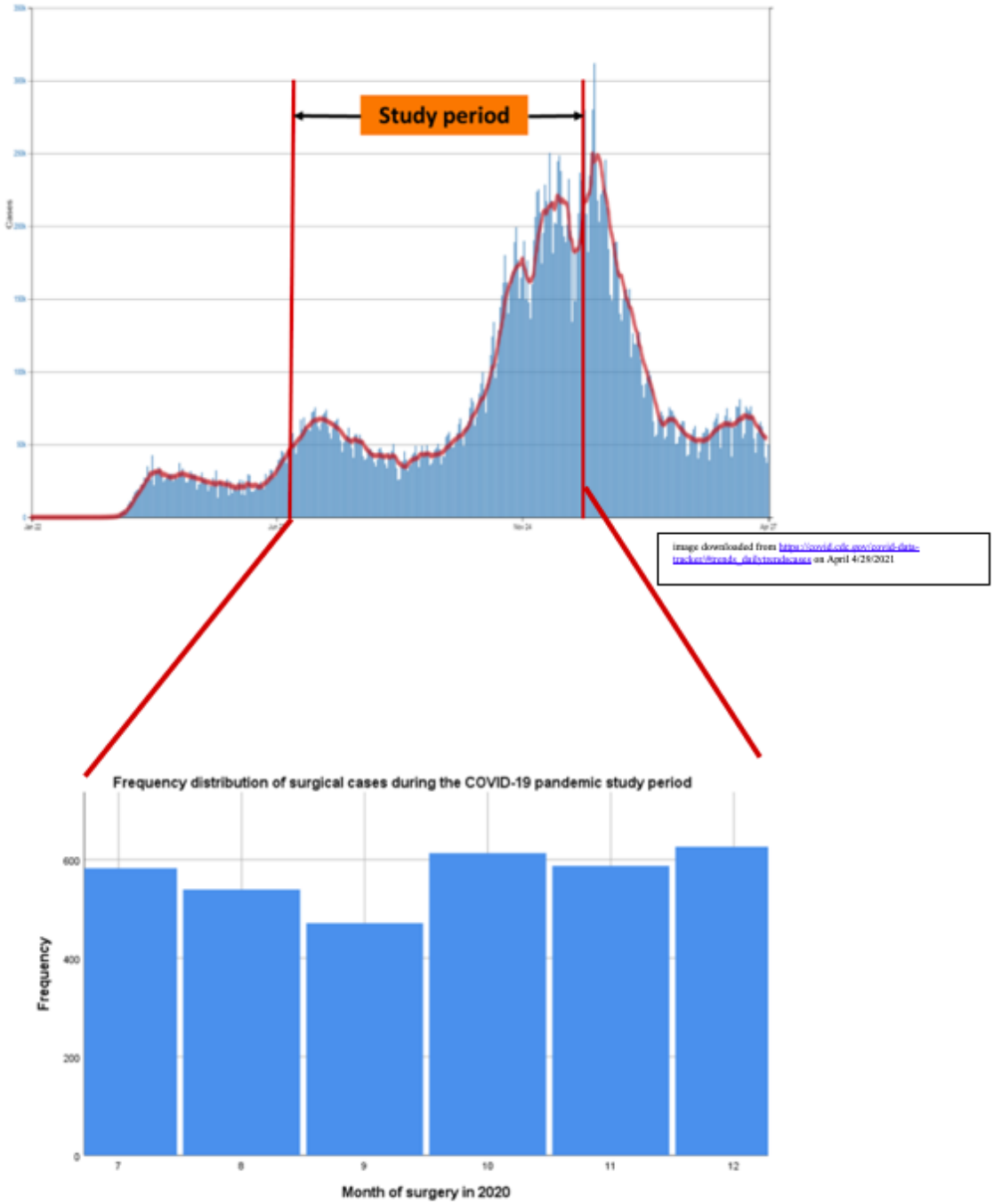

Figure 2. The frequency distribution of time between hospital discharge and newly diagnosed post-operative COVID-19 infection

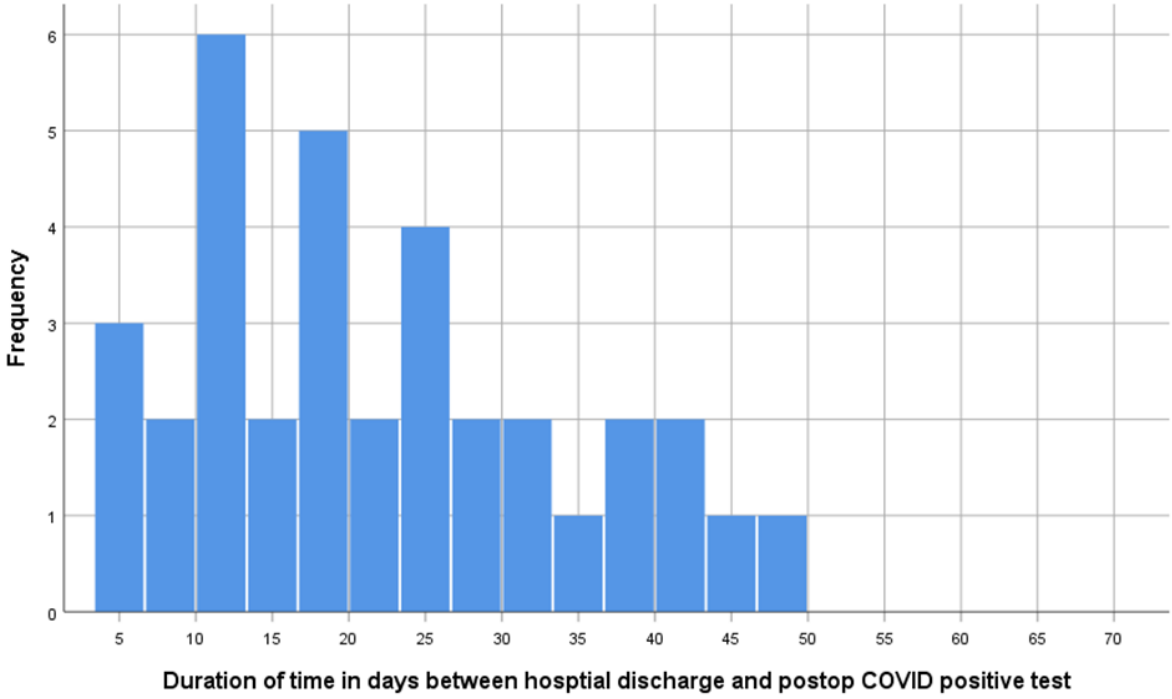

Table 1. Sociodemographic and clinical variables for study cohort

Variables	N = 3423
Sociodemographic variables	
Age (years)	46.6 ± 14.4
Race/Ethnicity	
• Non-Hispanic White	1624 (47.7%)
• Non-Hispanic Black	837 (24.6%)
• Hispanic or Latino	654 (19.7%)
• Asian	128 (3.7%)
• American Indian and Alaska Native	11 (0.3%)
• Native Hawaiian and Other Pacific Islander	6 (0.2%)
Region of Country	
• Northwest	785 (22.9%)
• Midwest	1323 (38.7%)
• South	447 (13.1%)
• Southwest	866 (25.3%)
Health care worker	
• Yes	386 (11.3%)
• No	2293 (67.6%)
• Unknown	713 (21%)
Clinical variables	
Body-mass Index (kg/m^2)	30.3 ± 7.9
Charlson co-morbidity index (non-age adjusted)	0.45 ± 1.0
Charlson co-morbidity index (age adjusted)	1.7 ± 1.8
Prior surgery	
• None	1412 (41.3%)
• Prior Non-Gyn Abdominopelvic Surgery	1011 (29.5%)
• Prior Gyn Abdominopelvic Surgery	1493 (43.6%)
Smoking History	
• None	2633 (77%)
• Prior Smoker, not currently	495 (14.5%)
• Currently smoking	259 (7.6%)
• Unknown	32 (0.9%)

All data presented as N(%), mean ± standard deviation unless otherwise specified

Table 2. Surgical variables for study cohort

Variable	N = 3423
Surgical variables	
Ten most common surgeries	
Hysteroscopy/Endometrial ablation	597 (17.5%)
Laparoscopic adnexal surgery	463 (13.6%)
Total laparoscopic hysterectomy with or without BSO	428 (12.5%)
Midurethral sling	157 (4.6%)
Laparoscopic colpopexy	130 (3.8%)
Laparoscopic myomectomy	127 (3.7%)
Vaginal hysterectomy with or without BSO	99 (2.9%)
Anterior and posterior colporrhaphy	98 (2.9%)
Laparoscopic supracervical hysterectomy with or without BSO	98 (2.9%)
Laparoscopic assisted vaginal hysterectomy with or without BSO	90 (2.6%)
Other	1297 (38%)
Region of Country	
• Northeast	785 (22.9%)
• Midwest	1323 (38.7%)
• South	447 (13.1%)
• Southwest	866 (25.3%)
Need for surgery	
• Emergent	118 (3.5%)
• Elective	3301 (96.5%)
Surgical route	
• Laparotomy	237 (6.9%)
• Robotic/Laparoscopic	1525 (44.6%)
• Vaginal	1544 (45.1%)
• Other	115 (3.4%)
Surgical subspecialty	
• General Ob/Gyn	1249 (36.5%)
• MIGS	925 (27%)
• Urogyn	1075 (31.4%)
• REI	106 (3.1%)
• Other	68 (2.0%)
ASA class	
• ASA I	512 (15.1%)
• ASA II	1973 (59%)
• ASA III	893 (26.3%)
• ASA IV	19 (0.6%)
• ASA V	2 (0.1%)
Length of surgery (minutes)	110.6 ± 90.4 (range= 1- 620),
Length of hospital stay (hours)	18.8 ± 49.7 (range = 0.17 -1620),

MIGS = minimally-invasive gynecologic surgery. REI = Reproductive Endocrinology and Infertility, ASA = American Society of Anesthesiologists; BSO = bilateral salpingo-oophorectomy; All data presented as N(%), mean ± standard deviation unless otherwise specified

Table 3. Bivariate analysis of preoperative COVID-19 status at any time prior to gynecologic surgery on sociodemographic, and clinical variables.

	Positive preop COVID-19 Test *	Negative pre-op COVID-19 test**	P value
Age (n = 3403)	42.2 ± 12.1	46.7 ± 14.5	<0.001
BMI	32.4 ± 8.1	30.3 ± 7.9	0.003
	Positive COVID-19 Test	Negative, Pending, Uncertain	P value
Race/Ethnicity • Non-Hispanic White • Non-Hispanic Black • Hispanic or Latino • Asian • American Indian and Alaskan Native • Native Hawaiian and Other Pacific Islanders	 35/123 (28.5%) 30/123 (24.4%) 55/123 (44.7%) 3/123 (2.4%) 0/123 (0%) 0/123 (0%)	 1572/3106 (50.6%) 803/3106 (25.9%) 591/3106 (19.0%) 125/3106 (4.0%) 10/3106 (0.3%) 5/3106 (0.2%)	<0.001
Region of Country • Northeast • Midwest • South • Southwest	 34/128 (26.6%) 36/128 (28.1%) 6/128 (4.7%) 52/128 (40.6%)	 728/3254 (22.4%) 1279/3254 (39.3%) 434/3254 (13.3%) 813/3254 (25%)	<0.001
Healthcare worker • Yes • No • Unknown	 21/125 (16.8%) 67/125 (53.6%) 37/128 (29.6%)	 365/3229 (11.3%) 2196/3229 (68%) 668/3229 (20.7%)	0.003

*Positive pre-operative COVID-19 tests included those who tested positive remote from surgery, or those who tested positive pre-operatively per institutional testing protocols.
**Negative pre-operative COVID-19 tests include patients who tested negative, had pending or inconclusive tests.
BMI = body-mass index; Only statistically significant bivariate associations are shown. All data presented as N(%), mean ± standard deviation unless otherwise specified

Table 4 Bivariate analysis of patients with post-operative COVID-19 infections compared to those without COVID-19 infections

	Post-operative COVID-19 infections (N=39)	No post-operative COVID-19 infection (N=3384)	P value
Charlson co-morbidity index (not age adjusted)	0.9 ± 1.2	0.4 ± 1.0	0.001
Charlson co-morbidity index (age adjusted)	2.2± 1.7	1.7 ± 1.8	0.02
	Post-operative COVID-19 infections	No post-operative COVID-19 infection	P value
Region of Country • Northeast • Midwest • South • Southwest	 3/39 (7.7%) 14/39 (35.9%) 1/39 (2.6%) 21/39 (53.8%)	 782/3382 (23.1%) 1309/3382(38.7%) 446/3382 (13.2%) 845/3382 (25%)	<0.001
Surgical Specialty • General Ob/Gyn • MIGS • Urogynecology • REI • Other	 15/39 (38.5%) 13/39 (33.3%) 8/39 (20.5%) 0/39 (0%) 3/39 (7.7%)	 1234/3384 (36.5%) 912/3384 (27%) 1067/3384 (31.5%) 106/3384 (3.1%) 65/3384 (1.9%)	0.04
ASA class • Class I • Class II • Class III • Class IV • Class V	 6/39 (15.4%) 19/39 (48.7%) 12/39 (30.8%) 2/39 (5.1%) 0/39 (0%)	 506/3360 (15.1%) 1954/3360 (58.2%) 881/3360 (26.2%) 17/3360 (0.5%) 2/3360 (0.1%)	0.004
	Post-operative COVID-19 infections	No post-operative COVID-19 infection	P value
Length of hospital stay (hours)	Median 17.7, IQR 24	Median 8.7 IQR 18.1	0.002

MIGS = minimally-invasive gynecologic surgery. REI = Reproductive Endocrinology and Infertility, ASA = American Society of Anesthesiologist. Only statistically significant bivariate associations are shown. All data presented as N(%), mean ± standard deviation unless otherwise specified

Table 5. Perioperative complications in patients with and without prior COVID tests

	Positive preop COVID-19 test*	Negative preop COVID-19 test**	P value
Intraoperative complications	5/128 (3.9%)	99/3275 (3.0%)	0.57
Postoperative complications (prior to discharge)	5/128 (3.9%)	201/3275 (6.1%)	0.30
Postoperative complications (after discharge)	30/128 (23.4%)	1031/3275 (31.5%)	0.05

*Positive pre-operative COVID-19 tests included those who tested positive remote from surgery, or those who tested positive pre-operatively per institutional testing protocols.
**Negative pre-operative COVID-19 tests include patients who tested negative, had pending or inconclusive tests.

Appendix

Appendix - Table 1.

Table 1 Variables Collected From Medical Record

Pre-operative data	Peri-operative data	Post-operative data
Date of birth, Height, Weight, Race, Ethnicity, Occupational status as health care worker, Past medical history (Charlson co-morbidity index), History of prior gynecologic and/or non-gynecologic abdominal-pelvic surgery, Smoking history	Date of surgery, Pre-op COVID-19 test date, type (NP, nasal, oral secretions, sputum, other) & result (positive, negative, pending at time of surgery), Date & time of hospital admission & discharge, Need for surgery (elective vs emergent), Lead surgical CPT code, ASA classification, Surgical approach (robotic/laparoscopic, open, vaginal, other), Class of surgery (inpatient vs outpatient), Location of surgery (ambulatory/outpatient center vs hospital), Specialty of surgeon, Level of trainee involvement (Resident and/or Fellow), Anesthesia type, Use of antibiotic and VTE prophylaxis, Duration of surgery & anesthesia, EBL, Need for blood product transfusion, Intraoperative complications	Post-operative complications prior to discharge or until time of clinic follow up including: New COVID-19 infection, Emergency department visits or hospital readmissions unrelated to COVID-19, Surgical site infection, VTE events, UTI, Myocardial infarction, Acute kidney injury, Renal failure, Congestive heart failure, Cerebrovascular events, Small bowel obstruction, Sepsis, Shock, *Clostridium difficile* colitis, Neuropathy, Arrhythmia, Pulmonary edema, Pneumonia, Cardiac arrest, Post-op blood transfusion, Ileus, Nausea and vomiting, Undiagnosed injury to urinary or gastrointestinal tracts, Unplanned return to operating room, ICU admission, Death

NP= nasopharyngeal, CPT = Current Procedural Terminology, ASA = American Society of Anesthesiology, VTE = venous thromboembolism, EBL = estimated blood loss, UTI = urinary tract infection, ICU = Intensive care unit

Appendix - Table 2. Postoperative complications (prior to discharge)

Postoperative complications	All surgeries (N=3423)
Pain	84 (2.5)
Nausea/Vomiting	48 (1.4)
Blood product transfusion	44 (1.3)
Other complications	24 (0.7)

All numbers reported as N (%)