

## Research Article

# The Impact of COVID-19 on Surgical Outcomes

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## Abstract

Millions of surgeries are performed each year across the globe. However, the COVID-19 pandemic greatly impacted the number of surgeries performed and the patient outcomes. Prior to the pandemic, the patients undergoing surgeries faced a slightly high mortality risk due to common complications, especially if they had critical co-morbidities. However, it is worth while to evaluate if being infected with COVID-19 exacerbates or has no effect on the post-operative condition of these patients. Researchers used to describe COVID-19 as simply a respiratory disease, but it is now known to be an illness that leads to systemic effects. New findings are evaluating the long-term impact of this illness, so it is beneficial to observe its prognosis after undergoing a surgical procedure. This review summarizes the recent progress in this area of research. Such a study might help healthcare professionals to develop a complete understanding of COVID-19 and to know how to provide effective postoperative care.

**Keywords:** SARS-CoV-2; Spike protein; Surgery

## Introduction

There are over 300 million major surgeries performed worldwide every year with 40 to 50 million performed in the USA and around 20 million done across Europe. In 2020, it was estimated that up to 4% of patients undergoing surgical procedures will die and that 15% will develop postoperative morbidity [1]. The ten most common surgical procedures in the United States in 2017 were the cesarean section, knee arthroplasty, hip replacement (total and partial), spinal fusion, laminectomy and excision of intervertebral disc, cholecystectomy and common duct exploration, colorectal resection, treatment of fracture or dislocation of hip and femur, ligation of fallopian tubes, and appendectomy [2]. Due to the large number of surgeries performed worldwide, it is important to consider how pandemics can affect postoperative prognosis.

COVID-19 is a systemic disease caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). What was an initial outbreak that began in December 2019 morphed into a pandemic that has killed millions so far [3]. In addition, researchers have come to realize that "Long COVID" or "post-COVID syndrome" causes long term impacts on patients beyond the acute infectious period. These patients experience one or

more continuous or relapsing symptoms of acute COVID even after the predicted clinical recovery time [4,5]. Thus, it would be beneficial to analyze the impact of COVID-19 on the surgical outcomes since the onset of the pandemic.

COVID-19 impacts patients undergoing surgery in multiple ways. According to a study by Doglietto et al, patients positive for the virus and undergoing emergent surgery had a greater amount of complications with several characteristics. Patients at the Spedali Cviili hospital in Italy who had positive results pre-operatively or developed it within 1 week after surgery were included, and the study excluded those undergoing minor procedures such as suturing and gynecological procedures. The study revealed that mortality was significantly higher by 19.51% in the COVID-19 group vs the control group [6]. Other studies also showed that pulmonary complications were the most common with a high prevalence of Acute Respiratory Distress Syndrome (ARDS) and respiratory failure [7,8,9]. Preoperative testing revealed that C-Reactive Protein (CRP) and fibrinogen were significantly associated with infection as well [10]. This is due to the fact that the inflammatory cytokine storm consisting of IL-6, CRP, and Procalcitonin (PCT) has been associated with

severe COVID-19 infections [11]. CRP is an acute phase protein that is a biomarker of infection. It is induced by IL-6 in the liver and increases rapidly during acute inflammation caused by bacterial and viral infections [12-14]. In addition, IL-6 is a notable trigger for cytokine storms as it regulates cell proliferation, metastasis and inflammation [15]. PCT is an acute phase reactant peptide that is a useful biomarker to differentiate between bacterial and viral infections as its concentration increases markedly in the presence of bacterial infections but remains low in viral infections [16,17]. These inflammatory factors combined with elevated plasma fibrinogen levels, manifest in coagulation abnormalities with elevated D-dimers and mild prolongation of prothrombin time by 15.6 seconds [18]. In addition to inflammation, the hypoxia and Diffuse Intravascular Coagulation (DIC) seen in COVID-19 collaborate to cause an increased incidence of thrombotic complications with pulmonary embolisms being the most common one [19-21]. All of these findings are consistent with the fact that this disease is predominantly a respiratory illness.

One of the main factors determining the outcomes of patients undergoing surgery is the timing of infection. According to Codner et al, the odds of major complications in the COVID-19 group who tested positive 31 to 50 days before surgery was 0.98 times the odds for COVID negative surgery variables. However, for patients who tested positive in less than 15 days before the day of surgery, the odds approximately doubled to 1.88 times the odds of complications in COVID negative surgery patients [22]. These findings suggest that there could be an optimal timing for surgery for those who have been infected. Before the pandemic, patients with respiratory infections were recommended to delay surgery by 4 weeks [23]. A prospective cohort study by the COVID surg collaborative found that undergoing surgery for more than 4 weeks after a positive COVID-19 swab test resulted in lower risk of postoperative mortality. [24]. Another study by the COVID surg collaborative and Global Surg Collaborative discovered that risk for a 30 day postoperative mortality and postoperative pulmonary complications for patients operated 7 weeks or later after diagnosis decreased to baseline compared with patients who were operated on within 6 weeks or under [25]. As of now, the widely accepted recommendation is to delay elective surgeries for 4 to 12 weeks after infection with later surgery days being more preferable [26,27].

It is also interesting to observe secondary effects, such as abdominal and cardiac complications, caused by COVID-19 in surgery patients. In a study by Seeliger et al, they found that patients with acute abdomen needing emergency surgery had worsened outcomes when they were diagnosed with severe COVID-19 in their hospital stay. These patients experienced septic shocks, renal failures, and 33% died [28]. There is a link between gastrointestinal complications in critically ill COVID patients due to the coagulopathy caused by the disease. In fact, there is a high incidence of hypomotility and there is a subset that develops mesenteric ischemia which requires emergent surgical intervention [29]. Several studies further reveal that these ischemia were specifically caused by venous thrombosis [30,31]. The current hypothesis is that the ARDS induced by COVID results in small vessel thrombosis [32,33]. Another study by Rassalan et al which examined patients undergoing emergency hernia surgeries in Brazil revealed the development of cecum necrosis, perforation, and peritonitis that resulted in intestinal resection. However, these patients were also critically ill and had prior existing morbidities, so it is unclear if the severity of the coronavirus disease alone is what caused the complications

[34]. Other researchers have noted that COVID-19 positive patients undergoing cardiac surgery also have poor short-term outcomes due to myocardial damage [35]. This is due to the finding that the COVID-19 virus utilizes the Angiotensin-Converting Enzyme 2 (ACE-2) receptor to enter host cells, and this mechanism can lead to endothelial cell dysfunction to create severe myocardial injury [36-38]. Greater ACE-2 receptor expression leads to a higher risk of COVID infection and can lead to the cytokine storm caused by a systemic inflammatory response which can further injury to cardiac myocytes [39,40]. Therefore, this respiratory illness leads to effects across the body due to its inflammatory mechanism.

The research on COVID-19 and its long term effects need to be further studied in order to understand the true severity of this disease. In addition, knowing the complications in surgical patients allows healthcare workers to improve screening for patients who are eligible to undergo surgery and to provide safer postoperative care. Continued studies should also evaluate the effects of COVID-19 in combination with co-morbidities to investigate the most lethal combinations which can allow for greater insight on disease prevention. Increased interest in this field will hopefully yield greater survival rates for patients undergoing surgery in the future.

### Author Statements

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### Disclosure of Interest

The authors report no conflict of interest.

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