Laparoscopy during the COVID-19 Pandemic: Absence of Evidence is not Evidence of Absence

Prabudh Goel, Ashoke K. Basu

ABSTRACT
From a local outbreak to a global pandemic, the severe acute respiratory syndrome-coronavirus-2 infection has spread across 210 borders to infect 2.5 million humans. There is an organized disruption in the routine hospital functioning to divert the available resources for effective crisis management; most of the departments have been split to carve out a “COVID task force.” The recommended indications for treatment of various medical conditions, medical procedures, and protocols have regressed on the evolutionary timeline. Newer recommendations are being released and updated regularly based on emerging evidence and experts’ opinions. In view of exponential spread of the virus through routes already identified or those still elusive, the shedding of the virus during the incubation period, and lack of scientific evidence, the questions of “laparoscopy” or “no laparoscopy” assume importance. Herein, the evidence in literature pertaining to patient safety, efficient and effective utilization of hospital resources, and safety of health-care workers (HCWs) during the pandemic have been reviewed from the perspective of laparoscopy. The pathobiology of the virus including its survival properties and the different modes of transmission has been highlighted, and the relative risk to the HCWs between open and laparoscopic surgery dwelt upon. The recommendations from various international bodies have been discussed. Notwithstanding the absence of concrete evidence to exclude the possibility of bioaerosol-based transmission of the disease to the operating room staff, there is a multitude of other concerns which are addressed by avoiding the use of the laparoscope in the current scenario. Moreover, the absence of evidence is not evidence of absence; considering the high contagion and a long latent period associated with this virus, the onus is upon each individual surgeon to decide if one needs evidence of bioaerosol-based transmission or evidence in favor of safety before taking up 'laparoscopy' against 'open surgery'.

KEYWORDS: Aerosol-generating procedure, coronavirus disease 2019, health-care workers, laparoscopy, novel coronavirus, open surgery, patient safety, severe acute respiratory syndrome-coronavirus-2

BACKGROUND
The corona crisis has assumed gigantic proportions in a short time span. There is an organized disruption in the routine hospital functioning to divert the available resources for crisis management; the hospital staff world-over has been split to carve out a “COVID task force.” Health-care workers (HCWs) fighting in the frontline are exposed to the virus in bolus proportions, occupational burnout, psychological distress, family pressures, and irrational societal response fueled by apathy and paranoia of stigma, social isolation, and physical violence.

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The recommended and upheld indications for treatment of various medical conditions, medical procedures, and protocols have regressed on the evolutionary timeline. While the elective surgeries have been cancelled and semi-elective procedures stalled, emergencies and malignancies are being managed on “high alert.” Newer recommendations are being released, and the existing ones are being updated regularly based on emerging evidence and the opinion of experts.[1–4] One such aspect of medical care is the use of 'laparoscopy' vis-à-vis 'open surgery'.

**The Debate of Laparoscopy versus Open Surgery**

Shot off with a tumultuous debut, the progression of laparoscopy from an adjunct to an indispensable tool in the surgeons’ armamentarium has been unprecedented. However, with the crisis situation at hand, the rights, roles, and responsibilities of health workers are being re-scanned through the coronavirus disease 2019 (COVID-19) filter in close synchronization with patient care and treatment. The debate upon laparoscopy is fueled by the exponential, previously undocumented spread of the virus through routes already identified or still elusive, the shedding of the virus before clinical manifestation, and lack of scientific evidence in favor of laparoscopy.

i. **Safety of the patient has always been the first concern in medical profession.** Laparoscopy causes less physiological disturbances and is less traumatic to the tissues. The postoperative profile of cytokines (pro-inflammatory and anti-inflammatory) dictates lesser perioperative inflammation.[5] The plasma levels of adrenaline, noradrenaline, or cortisol uphold the smaller incision in minimally invasive approach.[6] Such benefits are translated to the patient in terms of faster recovery and reduced hospital stay and the attendants by reducing their “hospital time”

However, it is important that the “… current greater risks of adverse outcomes from possible COVID-19 infection after surgery should be factored into planning….”[2] The patient may be incubating the infection with the severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) virus, and the lungs may be affected overtly if not manifesting clinically. The surgical time and difficulty of operation affect the outcomes of surgery adversely in such patients. There is an exacerbation of the respiratory infection, and the mortality is higher than the case-fatality rate for COVID-19.[7] In view of “pharmacological vacuity,” the final outcomes largely depend on the patient’s immune system.

The carbon dioxide used in laparoscopy can move across the body tissues and may affect the physiology of the anesthetized patients in its own unique way. The anesthetists are required to increase their vigilance of the patient’s vital signs during laparoscopy. This concern assumes importance in view of reduced workforce during the current crisis.

The 'cost of procedure' in laparoscopy may be a concern for many in view of economic lockdown or rising unemployment. Similarly, the availability of an expert to minimize the operating time and ensure that lack of technical expertise is not a cause of surgical complications or prolonged hospital stay may be another cause for apprehension during the COVID-19 commotion. Stoma formation has been considered appropriate over and above anastomosis in these guidelines.[5]

ii. **Effective and efficient utilization of hospital resources,** since they are finite and run a risk of being inundated. The resource scarcity forced the medical system of Italy to adopt the “clinical reasonableness” approach. Minimal staff in the operating room (OR) has been strongly recommended in the current crisis situation.[2]

The global supply of personal protective equipment (PPE) has been disrupted due to heightened demand, panic buying and hoarding and is still not “regular.” The limited supply threatens the hospital machinery by staff shortage, psychological setback with disenchantment of the frontline soldiers, and the nosocomial spread of infection by the incubating HCWs.

The staff and equipment requirement for laparoscopy is higher as against open surgery, both overall and when adjusted for the degree of difficulty. An increase in procedure time necessitates recruitment of a higher number of nurses, especially if the procedure spreads across two work shifts. Often, industry people have to be called inside the OR for troubleshooting. A larger team in the OR means, a larger workforce at work, more people being exposed to the virus, crowding of the ORs, larger PPE demand, and escalated generation of hospital waste.

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The mean procedure time is higher for laparoscopy, although this point has been debated. They may be related to a longer learning curve, use of delicate instruments with multiple hinges making them tedious,[8] remote manipulation as an integral part of the procedure, the frequent instrument changes through the limited number of trocars,[9] and need for a close coordination between the lead-surgeon and the “camera-man.”[10]

Contrarily, the hospitals are trying to manage work with restricted hospital staff. Teams from other
departments are working “across-specialties” to support the directly related departments. The high transmissibility of the virus, long quarantine, and longer morbidity necessitates the maintenance of a backup workforce. The length of duty shift is a concern after donning the PPE in the absence of central air conditioning in view of standard recommendations.

The Intercollegiate General Surgery Guidance has recommended laparoscopy only “when the clinical benefit to the patient substantially exceeds the risk of potential viral transmission to surgery and theater teams in that situation” with, “…considerable caution….” The rationing has to be based on clinical judgment, administrative feasibility, surgeons’ preferences, and the disease under scanner. Gallbladder calculi are better operated laparoscopically while a congenital inguinal hernia can be operated with minimum instruments, workforce, and operating time by the “open approach”.

iii. Safety of the surgeon and other HCWs who form the frontline of defense is important. The China’s National Health Commission reported infection in 3300 HCWs in early March, while 22 deaths were reported by the local media. One-in-five HCWs have been infected in Italy.

Patient care would be affected if staff become sick and leave work. Besides adding to the disease statistics, an exposed HCW ceases to work and a bigger team of hospital staff is quarantined. The Hospital work suffers in exaggerated proportions. One doctor’s death is a blow to 1445 patients in India and 10,000 in Africa. Transmission of SARS virus from infected patients to HCWs during aerosol-generating procedures (AGPs) is known; however, the origin of the SARS-CoV-2 virus is recent and such data is not yet available. Medical personnel may get infected from an unsuspected COVID-19 patient or due to a breach in the integrity of PPE. The SARS-CoV-2 virus is extremely stable over a wide range of pH at room temperature. Survival of the virus on the outer surface of the surgical mask has been documented for up to 7 days though it is susceptible to standard methods of disinfection.

The potential risks of laparoscopy have been taken into cognition, and multiple precautions have been suggested.

Positive pressure pneumoperitoneum

There is unavoidable air leak through the port sites during insertion, removal or change of trocars, “non air-tight” instrument exchange, sudden release of trocar valves, enlargement of port-site incisions for specimen retrieval, and final closure. There is a certain amount of air leak around the port sites as well, more so when they are inserted by the open technique. The air leak is seldom visible to the naked eye. Indirectly, however, the cloud of smoke is generated with the use of cautery and cleared spontaneously. Frequently, one port is opened to expedite smoke evacuation. The need for regular gas flow to maintain the intra-abdominal air pressure is also suggestive of occult air leak.

The closed abdominal compartment has a low gas mobility. Concentrated aerosols are formed by the use of energy devices; a sudden and intermittent release from the sites of air leak contaminates the environment and creates a potential health hazard to the OR staff. The “occupational hazard” has been recognized and it has been recommended to keep the laparoscopic instruments clean of blood and body fluids at all times, monitor the sites of air leak, use of suction devices to remove the aerosols generated during surgery and avoid the use of two-way pneumoperitoneum insufflators which run a risk of colonization.

Surgical plumes from use of energy devices

Surgical plumes are produced inside the OR while using diathermy or laser. The role of AGPs such as tracheal intubation, noninvasive ventilation, and tracheostomy in SARS transmission to the HCWs is known.

The presence of viruses (both intact virions and DNA) (HIV and human papillomavirus [HPV]) in the surgical plumes is known. Hepatitis B virus in bioaerosols is present in 90% of cases undergoing laparoscopic or robotic surgery.

Since no aerosol-based transmission of HIV or hepatitis B virus has been demonstrated to the OR personnel, the use of laparoscopy, with the use of PPE, has been recommended. Contrarily, the transmission of HPV to doctors through the surgical plumes has been recorded. The case of the SARS-CoV-2, however, is different from the HIV and the hepatitis B virus. The SARS-CoV-2 is a respiratory virus transmitted by close contact and through aerosols. The viral loads are highest in the upper respiratory tract (nose and throat) throat after infection. The virus is highly contagious and is shed liberally even during incubation. It can survive for several days on the various OR surfaces such as plastics and stainless steel. Moreover, the target angiotensin-converting enzyme-2 (ACE-2) receptors are abundant in the respiratory tract.

There is no evidence to support that laparoscopy-generated bioaerosols are benign and may not transmit infection to the OR staff. In the absence of conclusive evidence on the safety of bioaerosols...
generated during laparoscopy, the SAGES and EAES have advocated the use of devices to filter the released carbon dioxide.[1] Smoke evacuation devices connected to trocars and self-sealing trocars with built-in mechanism to connect negative-pressure suction have been described. The pressure barrier insufflator systems which maintain a forced gas pressure barrier at the proximal end of the trocar may also be relevant.[27] However, the use of such attachments is tedious, required added infrastructure, and adds to the cost of the procedure. Lack of training and reflexes in the use of such devices and the consequential hazards of inadvertent errors are limiting. The health-care systems are working under tremendous pressure, and each staff member is vital.

SAGES[1] has recommended (a) small port-site incisions, (b) use of electrosurgical units at low setting and monopolar diathermy pencils with smoke evacuators, and (c) filtered evacuation of pneumoperitoneum before specimen extraction, trocar removal, conversion to open surgery, or final closure to minimize the aerosol-attributable risk.

Bioaerosols are generated during open surgery also, but the concentration of surgical smoke particles is higher in laparoscopy. The process is further exaggerated by the positive pressure during laparoscopy, and the contents are released intermittently as concentrated jets.

**Airborne transmission of the virus**

The knowledge about the mode of transmission of the SARS-CoV-2 virus is evolving. Transmission through respiratory droplet particles (5–10 μm) and to individuals in close contact is known. Kim et al.[28] demonstrated airborne transmission in ferrets. Subsequent detection of more expansive transmission events to nonhousehold contacts has confirmed the presence of community transmission with the SARS-CoV-2 virus.[29] Airborne transmission during AGPs inside the operation theater has been considered,[1] and a judicious staffing pattern inside the OR recommended, “only those considered essential staff should be participating in the surgical case.”[1]

**Feco-oral transmission of the virus**

Fecal shedding of the virus is seen in animal models.[28,30,31] The virus replicates in the intestines of rhesus macaque monkeys. The golden Syrian hamsters respond by enlargement of Peyer’s patches with N-protein expression.[31] Viral antigen has also been detected in the ferrets’ intestines by immunohistochemistry.[28] Indirect evidence of feco-oral transmission was available in the hamster model. Diarrhea with abdominal pain and vomiting (2%–10% of cases) in humans sometimes manifesting before fever or respiratory symptoms and pancreatitis-like presentation is known.[32] The fecal isolation of the virus has also been reported. Successful isolation of live virus from the stool specimens of infected patients has been reported.[33] Another study has reported the fecal presence of the virus in one-third of these patients.[34] Bioinformatics analysis has confirmed expression of ACE-2 receptors, the host targets for this virus in the esophagus upper and stratified epithelial cells, and absorptive enterocytes from the ileum and colon.[35] ACE-2 expression has also been documented in ~60% of cholangiocytes.[36] Simultaneous elevation of liver aminotransferases, hypoproteinemia, and prolongation of prothrombin time has been documented in COVID-19 patients. Embryologically too, the origin of the esophagus and the organs of the respiratory tract can be traced back to the intermediate foregut.[37]

Laparoscopic surgery on the bowel in the presence of gross contamination is considered a high-risk AGP.[38] SAGES has also recognized the presence of the virus in the gastrointestinal tract and all fluids including saliva, enteric contents, stool, and blood.[39,40]

**Presence of severe acute respiratory syndrome-coronavirus-2 in blood and peritoneal fluid**

Viral RNA in blood of COVID-19 patients has been reported in 15% of the patients,[41-43] which correlates with the disease severity.[44] All patients in this cohort in whom the serum viral RNA became detectable were either already in severe disease stage or progressed shortly. A recent report from Italy, probably the first in literature, has identified the presence of virus in peritoneal fluid during an emergency surgical procedure in a COVID-19 sick patient. The viral load was higher in the peritoneal fluid as compared to the respiratory tract. The report has highlighted the risk of aerosolization of the virus and infection of the OR personnel.[45]

The presence of virus in multiple body secretions and more than one route of viral transmission is hazardous for the HCWs. Herein, the benefits of laparoscopy need to be weighed against the potential cost of infecting our workforce. Even though there is no conclusive evidence for or against laparoscopy vis-a-vis open surgery, the need to recruit more staff in the OR along with the need for a higher instrument count and a prolonged operating time (for some if not all operative procedures) is a point for contemplation.

**OT environment pressures: Negative or positive**

A standard OR is designed to have a positive air pressure in relation to adjoining areas. However, in case of respiratory infections, the infected aerosols can be...
transmitted to the OR staff in the neighboring areas or hallways.\cite{46,47} A negative OR pressure in such cases will prevent the nosocomial transmission of the infection to the OR staff working in adjacent areas\cite{48} and has been recommended by SAGES.\cite{1}

However, if a negative environmental pressure inside the OR is not feasible, sufficient time depending on the number of air exchanges per hour must be allowed in between two cases for complete room air exchange.\cite{49}

**Eliminating the use of energy devices during surgery: Significantly if not completely**

The surgical plumes are generated with the use of energy devices and may be laden with live virus. Different devices have different propensity to generate such plumes. The particle size of the plumes is least with the use of electrocautery (>0.1 μm) and largest with the use of harmonic scalpel (0.35–6.5 μm).\cite{23} Such particles may travel up to 100 cm from their point of production.\cite{50} The logical conclusion that eliminating or minimizing the use of such devices during surgery will reduce the aerosol generation may help in reducing the risk of transmission of the infection to the hospital staff.

Explorative laparotomy without the use of cautery or any other energy device has been practiced over the years, while such devices were not available commercially. The same is still a practice in all the trauma centers in context of major trauma cases with an imminent risk to life.\cite{51} The same may not be contemplated while performing a procedure laparoscopically.

**Conclusions**

An exhaustive literature review has highlighted certain vital concerns in context of laparoscopy. First, there is little concrete evidence to eliminate the possibility of bioaerosol-based transmission of disease to the OR staff. However, the absence of evidence is not evidence of absence. Second, there is a multitude of concerns addressing the patient, the HCWs, and the infrastructure dynamics which are addressed adequately by avoiding the use of the laparoscope during the crisis period. Finally, upon the background of an infectious disease with such high contagion and a long latent period, the onus is on each individual surgeon to decide if one needs evidence of bioaerosol-based-transmission to avoid using a laparoscope or evidence in favor of safety before taking up laparoscopy against open surgery.

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**Conflicts of interest**

There are no conflicts of interest.

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