Optimal surgical approach during the Sars-CoV-2 (COVID-19) pandemic

29th March 2020
Rev 2

Summary

1. Recently released guidelines with strong language discouraging laparoscopic surgery are not evidence based and have the potential to affect surgical decision making, resource utilisation and patient outcomes
2. There exists no current evidence that laparoscopy presents a greater risk to the surgical team than open surgery in the management of patients with most viral illnesses, including COVID-19
3. Reduction in occupational exposure to the surgical plume during both open and laparoscopic surgery should be the priority of surgical teams who should be resourced appropriately to achieve this
4. Limitation of surgery to urgent/emergent cases will help limit health care worker exposure to potential Sars-CoV-2 infection
5. The choice of surgical approach should be individualised based on team capability and patient's clinical need
6. Surgery should be performed by the most qualified surgeon to minimise operative time
7. Early studies have not been able to demonstrate active coronavirus particles in blood or urine
8. Viral particles have now been observed in faecal cultures, and there is indirect evidence from viral component staining and replication product detection that the GI tract **may** be a site of shedding and therefore transmission

A multitude of guidelines are appearing in many countries to help surgeons manage patients in the setting of the Sars-CoV-2 global pandemic. Some of these guidelines include strong language against the use of laparoscopy, or provide confusing statements that surgeons might choose to avoid laparoscopy out of "an abundance of caution". These statements have no basis in current evidence and only add to the confusion for surgeons on the front line[1,2].

Surgeons should continue to use the most appropriate surgical approach for their patients. They should protect themselves and their teams by careful patient selection, testing in accordance with local guidelines and universal PPE. All non-essential surgery should be deferred.

Introduction

The current coronavirus pandemic has had an effect on the health and wealth of the world that is unprecedented in modern times. It has led to country and community isolation, and as case numbers rise, some health systems around the world have been overwhelmed. With regard to abdominal surgery in patients with confirmed or suspected Sars-CoV-2 infection, much remains unknown. There is little doubt that high density upper aerodigestive tract colonisation and replication by the virus presents significant risks for airway procedures (intubation, bronchoscopy) and endoscopic procedures (any examination of the upper digestive tract) where aerosolization is likely[3]. Anaesthetists, intensivists, respiratory physicians, gastroenterologists (and their teams) are at high risk and have developed processes for protecting their teams as best possible.

What are the issues facing the abdominal surgeon? We can divide the risks to the surgical team into the following categories:

1. Risk during patient intubation/airway protection
2. Risk during the surgical procedure
3. Risk in post-operative care - early and late

The risks during induction and airway management in confirmed Sars-CoV-2 positive patients to the immediate treating team are high and multiple position papers are available to guide management[4,5]. The risks in early post-operative care/recovery are likely similar to those in the induction phase with patient coughing and increased upper airways secretions common. The focus of this discussion will be on the risks during the operative procedure.

Surgical team exposures and safe practice

The risk

During the previous Sars-CoV epidemic, health care workers comprised up to a fifth of infections in some jurisdictions (although no HCW infections were reported in the USA). In Toronto and Taiwan, so-called super-spreading events occurred leading to initially unrecognised spread among HCWs. There is considerable fear that Sars-CoV-2, being a related virus, could similarly affect large numbers of HCWs.

Some current statements (Intercollegiate General Surgery Guidance on COVID-19[6]) strongly suggest that Laparoscopy “generally should not be used” despite the Italian experience with COVID-19[7] that “Laparoscopy may reduce intraoperative exposure to smoke compared with open surgery and devices for smoke evacuation and cleansing are recommended where feasible”. SAGES guidelines initially suggested that laparoscopy may be high risk, however they have subsequently updated the language to reinforce that “there is no current data demonstrating an aerosol presence of the Sars-CoV-2 virus released during abdominal surgery”[1].

The basis of these concerns is the perceived increase in aerosol risk with laparoscopy, although there is little to suggest that the risk is higher than with open surgery. Whilst laparoscopy involves establishing a pneumoperitoneum, most particulates during surgery are generated during electrocautery or ultrasonic equipment use in both open and laparoscopic procedures.

It is unclear where the confusion arises and why such a strong statement can be made against the use of laparoscopy. During a time when we hope to limit inpatient stay and rapidly triage and treat surgical patients, laparoscopy would appear to hold advantages over laparotomy for certain common general surgical conditions.

How can we estimate the risks and protect our teams?

Coronaviruses

Coronaviruses are enveloped RNA viruses that are vulnerable to heat, perturbations of pH and UV-light (among others). The main risks (excluding the airway risks discussed above) during abdominal surgical exposure are related to possible viral particle aerosolization from blood, tissues, peritoneal fluid and the gastrointestinal lumen.

Viral detection and diagnosis can occur in multiple ways. Most commonly used and reported is RT-PCR which aims to directly detect and amplify copies of known viral RNA segments. These viral sequences may be present **without** intact viral particles and don't imply a particular sample is infective. Confusingly, RNA detection alone is often conflated with the presence of infectious viral particles. One can also test for sgRNA (viral subgenomic RNA which is a viral product only produced during intracellular replication), or perform a variety of fluorescence based assays for viral particle components (eg nucleocapsid) in cellular biopsies all of which are indirect markers of active viral infection of a particular sample. To accurately test infectivity however, cell cultures are generally required, which involves incubating the sample in a cell culture and testing for viral replication or particles on microscopy.

Data from the previous SARS-CoV-1 epidemic showed that viral RNA was difficult to find in blood[8]. Viral shedding in blood was more common when people had active clinical symptoms, a finding that has been reproduced in the influenza and ebola literature.

A current analysis of COVID-19 patients from Germany was the first to include cell cultures of sputum, blood, faeces and urine. Infectious virus was cultured from throat and lung samples, but **not** from faeces despite the high RNA load identified by RT-PCR. Blood and urine never yielded active virus. The authors were cautious regarding the possibility of viral replication within the gastrointestinal tract as indirect measures of viral replication were present (sgRNA)[9]. Subsequent work by Wang[10] did detect live virus by electron microscopy in cultured faeces. In a cohort of 205, they reported faecal PCR viral detection in 44 of 153 samples (29%), but as not all patients were tested and some patients were sampled multiple times this may be an overestimate (if testing biased those with GI symptoms) or underestimate. Importantly, 4 patients with high copy number (viral load) were cultured and 2 had detectable live virus on electron microscopy.

A single patient from a cohort of 73 in China (where 53% had positive faecal RNA) was subjected to upper and lower endoscopy with biopsy of the oesophagus,stomach, duodenum and rectum. There was no detectable abnormality on H&E staining, but the gastric, duodenal and rectal biopsies stained for viral nucleocapsid. The absence of detectable inflammation or cellular response (eg apoptosis) and the lack of viral culture make this result difficult to interpret.

Limited data from RT-PCR in 41 patients from Wuhan with COVID-19 showed detection in blood was rare (15%) and RNA blood levels were very low[11]. Another group from China published on 57 patients. 6 patients (11%) had RNA detected in blood and all these patients had severe disease[12]. In the Wang paper, only 1% of samples tested positive for viral RNA.

18 patients from Singapore[13] were analysed with RNA detected in blood by PCR in 1 of 12 patients. RNA was detected in the stool of 4 of 8 tested patients (regardless of GI symptoms). There was no detection in urine and there exists no data on peritoneal fluid.

Note that this is in stark contrast to diseases such as Ebola where the virus is detectable in blood at very high levels and ALL body fluids are considered highly infectious[14,15].

There is as yet no data on viral infection of the liver with Sars-CoV-2 and hepatic impairment is less common with the current pandemic than the previous Sars-CoV-1 epidemic. Up to 60% of Sars-CoV-1 patients had liver impairment. Detailed analyses of the liver in 3 patients demonstrated positive viral RNA by PCR associated with apoptosis, but no viral particles were identified by electron microscopy[16]. This remains an area in urgent need of further research.

Summary

It would appear that in general,viral RNA is detectable by PCR in blood in approximately 1-10% of COVID-19 patients, but concentrations of Sars-CoV-2 are low and infective virus particles unlikely, especially in asymptomatic/paucisymptomatic patients. These patients should pose limited additional risk during most surgical procedures.

Positive Faecal RNA seems to occur in up to 50% of COVID-19 patients and appear higher in the highly symptomatic. Evidence exists for shedding of infectious virus from the GI tract.

Whilst a faecal route of viral transmission has not been confirmed at this time, it would seem prudent to limit the potential for exposure of GI tract content until further data is available. Employing full PPE for high risk procedures (e.g. upper and lower endoscopy, transanal procedures, GI perforations) and where possible, ensuring continuity of the faecal stream to prevent exposure of the health care team to stomata and other less controlled faecal losses.

Aerosol generating procedures (AGPs)

There is much debate regarding exactly what constitutes an “aerosol” vs a “droplet”. Generally speaking, large droplets (>20μm) fall rapidly and don’t penetrate the lower respiratory tract. Aerosol particles (<5μm) may remain suspended in the air column for a

long period and may travel large distances. In between, of course, is confusion. Particles <10μm are more likely to infect the lower respiratory tract. Generally speaking, formation of aerosols depends on (1) high viral concentration in a fluid and (2) the rapid movement of gas over the fluid. This process occurs naturally in sneezing and coughing[17].

Certain procedures are believed to generate aerosols (AGPs) as a source of respiratory pathogens by either initiating cough/sneeze or by forcing gas at pressure into the aerodigestive tract: positive pressure ventilation (BiPAP and CPAP), endotracheal intubation, airway suction, high frequency ventilation, tracheostomy, chest physiotherapy, nebulizer treatment, sputum induction, and bronchoscopy. The 2007 WHO list of AGPs also includes surgery with the use of "high-speed devices" such as drills and cutting saws. There is cadaver data from orthopaedic[18,19], dental and post-mortem procedures using high speed drilling/cutting devices that can spread intact bacteria throughout the operating room. There have not, however, been any reported cases of patient-team disease transmission occurring during actual procedures.

"Aerosolization" of viral and bacterial RNA/DNA may occur during the use of energy devices in general surgery - both open and laparoscopic - although there is in fact limited evidence that viable infective particles are dispersed. The mechanism is different - rather than gas moving over fluid it results from pyrolysis of tissues, an inherently destructive process. The various energy sources lead to varying particle sizes[20] with electrocautery and laser having the smallest, hottest particles and ultrasonic devices larger, cooler particles (Table 1). During both open and laparoscopic surgery, the particle concentration tends to increase over time of use of electrocautery devices[21]. Particle dispersion during open surgery is via suction devices and theatre ventilation systems. During laparoscopic surgery the plume may vent inadvertently via port taps, instrument exchange, port displacement and specimen extraction and be cleared by ventilation, but can also be actively evacuated and filtered by purpose built insufflation systems[22,23].

A recent discussion paper by Zheng and colleagues[24] raised concern about the laparoscopic approach in COVID-19. Despite comments in the paper "after using electrical or ultrasonic equipment for 10 minutes, the particle concentration of the smoke in laparoscopic surgery was significantly higher than that in traditional open surgery" quoting Li et al [21], Li's paper did not in fact demonstrate any significant difference between laparoscopic and open particle density and did not even test ultrasonic equipment.

Table 1. Sizes of particles produced by different surgical instruments (from Fan et al[20])

Instrument	Size(μm)
Electrocautery	0.007–0.42
Laser	0.1–0.8
Ultrasonic scalpel	0.35–6.5

Smoke toxicity

There is appropriate concern regarding occupational (ie long term low dose and peak dosing) smoke exposure due to the toxic chemicals present. Many studies have focused on occupational exposure to toxic smoke compounds and there has been much activity in most jurisdictions to employ all possible techniques (active filtered smoke evacuation, masks) to limit this plume[25–28]. This is a large topic that deserves dedicated analysis.

Conclusion

A plethora of guidelines have now appeared with conflicting information regarding the role of surgery, especially laparoscopy, in the current environment. As surgeons, we should be careful in making recommendations. Is it more sparing of scarce PPE to do an immediate laparoscopic appendicectomy or cholecystectomy with next day discharge, or have a patient in hospital for 3-4 days on intravenous antibiotics (or recovering from an open operation) needing to have PPE worn by nursing staff because they have a fever and therefore are suspect COVID-19? These are difficult decisions in difficult times and the answer will not be the same for each patient around the world.

Occupational surgical plume exposure has been a simmering issue for a long time with perioperative nursing groups such as AORN advocating active smoke evacuation and filtering for more than 20 years. Some jurisdictions already have tight rules on smoke management for the protection of staff from toxic **chemical** exposure. Now, at a time when there is understandable concern about perioperative **viral** exposure we should clarify a baseline safe environment and decide what additional measures may or may not be required for protection or our teams. There seems to be little reason to limit the use of laparoscopy **over and above** the precautions necessary for **any** surgery.

We should clarify, especially to government and hospital administration, that the most appropriate solution is the provision of adequate PPE to allow "universal" precautions and widespread, if not universal testing of patients undergoing surgery. We should advocate for appropriate, effective, ACTIVE smoke evacuation during laparoscopic and open surgery at ALL times, not just during a viral pandemic. We should absolutely minimise smoke and plume dispersion during all surgery by not venting taps and only using filters/suction and appropriate use of electrocautery/ultrasonic tools. These measures will keep our teams safe now and throughout our careers.

Of course, we should also accept that such resources may not currently be universally available, but to not apply the appropriate pressure to provide it so that we may provide optimal patient care may lead to poor clinical decision making with potentially worse long term outcomes for both patients, treating teams and resource utilisation.

This pandemic is a fast moving situation with new data available daily. We must be willing also to continually revise our guidance with a focus on protecting our patients and our teams whilst still providing best possible care under daunting circumstances.

A/Prof David Cavallucci

Supplementary data

Commonly quoted in papers regarding the hazards of surgical plume is the risk of upper aerodigestive tract infection in surgeons treating HPV condylomata with laser ablation (open surgery).

We should be cautious in extrapolating from the HPV data for a number of reasons. Firstly, the Hallmo case report[29] of a single surgeon with recurrent respiratory papillomatosis (RRP) is widely cited as evidence of occupational transmission. In situ DNA hybridizaton demonstrated the tumours to be related to HPV type 6 and 11. At the time, there was still confusion over the cause of RRP. Subsequent research in RRP has shown that HPV 6 and 11 are the commonest associated HPV types and that this disease is well described outside of the occupationally exposed community with well recognised risk factors.Throughout the international literature, only one other case of a potentially occupationally exposed person (a female theatre nurse) has been reported[30] despite the enormous volume of this surgery that occurs each year.

Also widely quoted is the Gloster et al survey of 4200 people in 1995 (and based on data from the preceding decade)[31]. With only a 14% return rate, this paper in fact provides little evidence to suggest significant risks of occupational exposure and considering the progress of personal protective equipment and laser plume evacuation over the subsequent decades its modern relevance is suspect. Weyandt and colleagues[32] performed extensive collection of aerosols during genital wart treatment and confirmed that none of the swabs contained HPV DNA associated with genital warts although it was present in suction devices.

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