



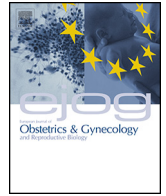
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## Review article

# How can we minimize the potential risk of viral contamination during laparoscopic procedures for suspected or infected COVID-19 patients?

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## ABSTRACT

Several societies have raised the risk of viral transmission of SARS-Cov-2 due to surgical smoke during laparoscopic procedures in infected patients. We propose to discuss this issue and to describe specific measures during laparoscopic procedures and a new homemade closed filtration system for smoke evacuation. Since the outbreak of COVID-19, performing a laparoscopy should meet multi-modal requirements. Surgical smoke evacuation device may be an effective tool in reducing exposure to surgical smoke and aerosols.

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## Introduction

The potential risk of viral transmission of SARS-Cov-2 has been raised by several international colleges and societies of surgery and gynecology during laparoscopic interventions in infected patients [1–5]. No contamination during the extraction of surgical smoke during laparoscopic surgery has been reported. There is only one case-report about a colectomy in a 71-year-old woman hospitalized for covid-19 pneumonia: the swab for SARS-Cov-2 was positive on the peritoneal fluid. There does not seem to have been any analysis of the surgical smoke [6].

However, the presence of the hepatitis B virus was found in these aerosols (in 90 % of the cases in the study by Kwak et al. [7]). The HPV virus was also found in the surgical smoke linked to cervical resections (in 40 % of cases in the study by Sood et al. [8]).

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Four cases of direct HPV contamination in healthcare professionals have been proven to date (two laryngeal papillomatoses in a 44-year-old gynaecologist and in a 28-year old nurse, one tonsillar squamous cell carcinoma in a 53-year-old gynaecologist and one cancer of the base of the tongue in a 62-year-old gynaecologist) [9]. As the size of HBV and HPV is smaller than that of SARS-Cov-2 (respectively, 0.04 μm for HBV, 0.05 μm for HPV and between 0.06 to 0.14 μm for SARS-Cov-2), there is therefore potentially a risk of contamination related to aerosols in a Covid + patient.

Surgical smoke consists of 95 % water vapor and 5% cellular debris: the latter can contain chemical particles (including compounds with a potentially carcinogenic risk such as benzene, formaldehyde, toluene, xylene, etc.), blood, tissue, viral or even bacterial material [9].

The first physical barrier to consider is the systematic use of specific personal protective equipment, especially high filtration masks during any laparoscopy [10,11] (see Table 1).

Because of the risk of contamination by aerosolization, surgical smoke should also be removed using suitable filters. Different

**Table 1**  
Multi-modal requirements for a safe laparoscopy : tips and tricks [1–5,10–12,18,19].

Preparation of the material before the intervention in order to keep the operating room closed during the intervention
Specific Personal Protective Equipment (FFP3/ FFP2 / N95 masks <sup>a</sup> , goggles and appropriate clothing)
Closer collaboration necessary with the anaesthesiologist (rapid sequence intubation, curarization, pneumoperitoneum pressure)
Small skin incisions and use of balloon trocars (better sealing) to avoid untimely removal of the trocars and the occurrence of CO2 leaks during the procedure
Reduction of the pressure of the pneumoperitoneum (10 to 8 mm Hg) and reduction of the Trendelenburg position (10 to 15°) in order to limit the ventilatory and circulatory constraints
Limitation of instrument changes to avoid leaks
Promotion of bipolar energy (with the lower power) rather than ultrasonic energy <sup>b</sup>
Use of smoke filtration systems (see Fig. 1A–C).
Preference for intra-corporeal nodes (gas leak in case of extra-corporeal nodes)
Removing the operator trocars once the pneumoperitoneum is completely evacuated <sup>c</sup>
Port-site closure once the pneumoperitoneum is completely evacuated

<sup>a</sup> FFP3 masks may filter 99% of all particles above 0.3  $\mu\text{m}$ . FFP2 masks (European classification) or N95 masks (American classification) ensure the filtration of at least 95% of the particles in suspension measuring more than 0.3  $\mu\text{m}$ .

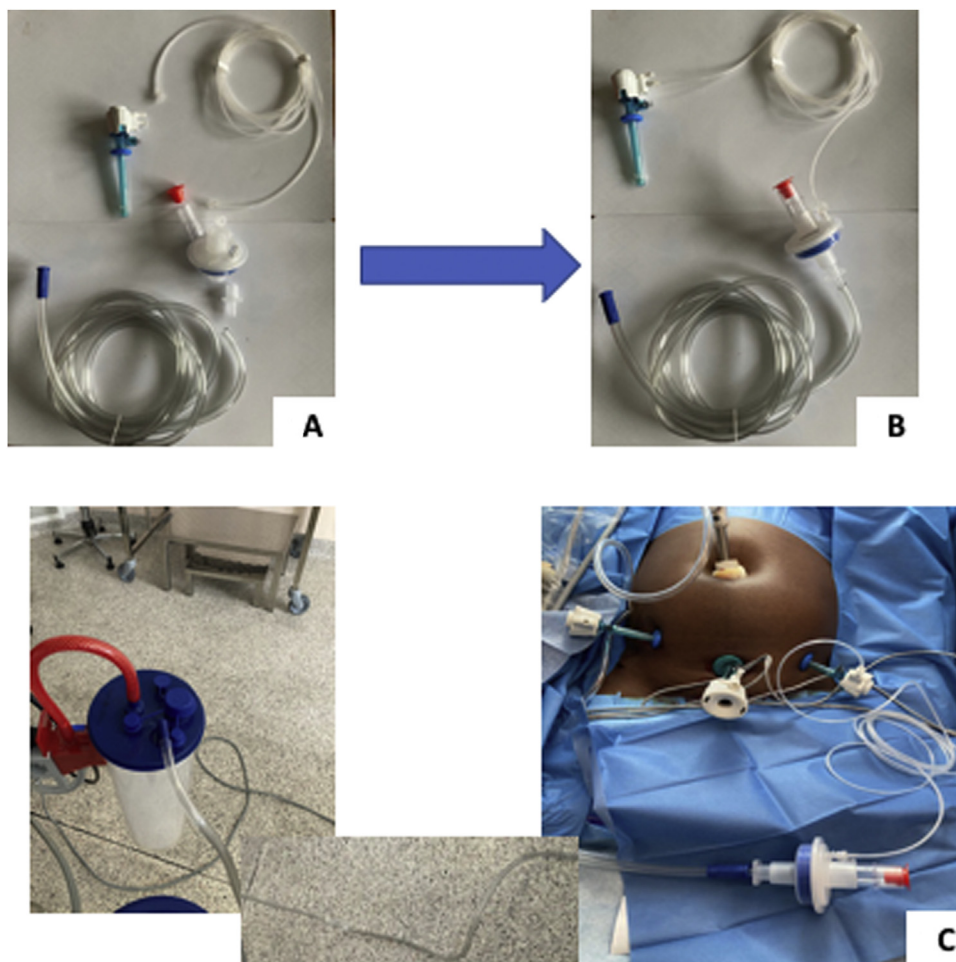
<sup>b</sup> Ultrasonic energy could theoretically be more dangerous than bipolar energy because it leads to a low temperature aerosol which does not allow the cellular components of the virus to be destroyed.

<sup>c</sup> In order to avoid the possible incarceration of an intestinal loop or the omentum, we introduce a blunt-tipped probe (type aspiration probe) to repel the intestinal handles and at the same time remove the trocar. The optical trocar is removed under visual control.

companies have marketed filtration devices suitable for laparoscopy for the evacuation of smoke. None of them have been tested to know if they are effective to prevent the transmission of the COVID-19 Virus. However, these systems of filtration may capture a wide range of particle sizes above 0,05  $\mu\text{m}$  in experimental

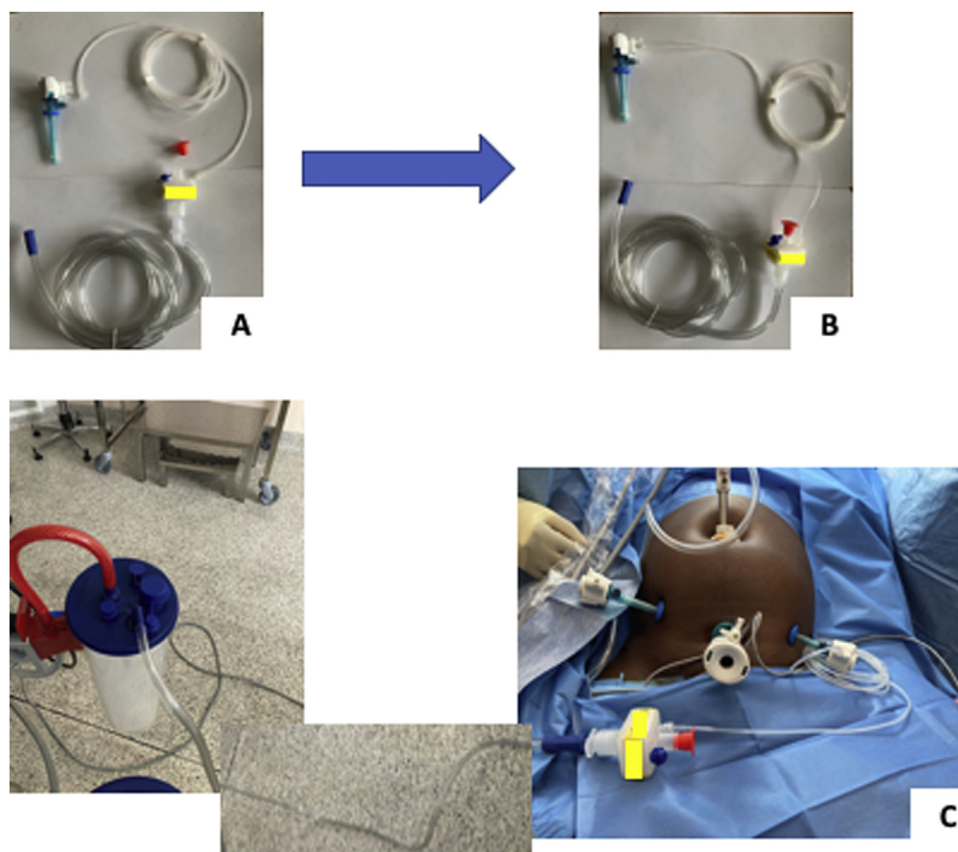
conditions (efficiency ranging between 99.9975% and 99.9999%) [1,2].

Due to the cost of this equipment and the need to be trained (current restriction of training), several surgical teams have developed their own filtration system. Most of them are based on the use of filters of the anaesthesiologist's intubation systems



**Fig. 1.** A: materials of our homemade smoke filtration system. B: connection between the filter, the operating trocar and the suction system. C: Here is our homemade smoke filtration system assembled in clinical use.

We developed two closed systems depending of the type of available filter. The principle of the filtering system is the same: a male-to-male connector is connected between the trocar and the filter. The filter is then connected to the suction container via a vacuum rubber tube. We can easily evacuate the surgical smoke in this closed system by opening the flow stopcock of the trocar.



**Fig. 2.** A: materials of our homemade smoke filtration system. B: connection between the filter, the operating trocar and the suction system. C: Here is our homemade smoke filtration system assembled in clinical use.

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(open system with evacuation of surgical smoke in the operating room [12] or closed system with evacuation of surgical smoke in containers, in washing containers or in thoracic drainage systems Pleur-Evac® or in redon bottles [13]). Even if there are no data about the efficacy of breathing circuit filters for preventing transmission COVID-19, the American Society of Anesthesiologists stated that all breathing circuit filters are rated with a viral filtration efficiency of at least 99.99 % and are currently used for anesthesia management during the COVID-19 pandemic [14]. Moreover since the viability of virus particles once caught in filters is unknown, closed ventilation system should be better.

Other systems are based on the simple evacuation with a tube without filter in a washing solution [2,15–17]. In our opinion, it seems not very appropriate because of the potential risk of leakage due to the connection of several pipes and contamination when disposing of the container containing smoke and washing solution.

Here is the description of our homemade closed filtration system which uses the filtration principle with a variant on the connection and the device for collecting the smoke (see Figs. 1 and 2): the filter is connected in series between an operating trocar fitted with a tap and the suction system. This very simple system allows the clarification of the operating field when the use of monopolar or bipolar energies induces the generation of surgical smoke hindering the visualization of the operating field. The fine gauge of the tube thus allows, in addition to the almost immediate and gentle clarification of visibility, to preserve the pressure of the pneumoperitoneum. The main point lies in the fact that our assembly works in a vacuum. In other words, not using conventional suction (which sucks the gas without being able to

filter the aerosols), our system purifies the pneumoperitoneum evacuated from potentially contaminating surgical smoke. In addition, at the end of the intervention, this gentle aspiration allows practically complete evacuation of the pneumoperitoneum without the risk of aspirating an intestinal loop or the omentum. The gas is collected in the suction container and then eliminated in a container provided for this purpose with the filter and the tubing. We take care to keep the tap on the trocar closed in order to avoid any gas leaks during disposal.

### Conclusion

It would be a mistake to replace the laparoscopic approach (and the numerous proven advantages of minimally invasive surgery) with systematic laparotomies [1–5]. In a recent review of literature, Mintz et al. [18] stated that the risk of COVID-19 transmission by laparoscopic smoke could be lower than for laparotomy (See Table 1).

The use of homemade smoke filtration system, when access to expensive filtration devices does not seem possible, may limit the impact of smoke and aerosol on environmental contamination and thus preserve both the healthcare teams and surfaces. It's certainly necessary to re-invent part of our surgery and to imagine new tips and tricks to continue operating safely [19,20].

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None.

## Declaration of Competing Interest

The authors report no declarations of interest.

## References

- [1] Zakka K, Erridge S, Chidambaram S, Winter Beatty J, Kynoch M, Kinross J, et al. Electrocautery, diathermy, and surgical energy devices. Are Surgical teams at risk during the COVID-19 pandemic? *Ann Surg* 2020;272:e257–62.
- [2] <https://www.sages.org/resources-smoke-gas-evacuation-during-open-laparoscopic-endoscopic-procedures/> march 2020.
- [3] British Society for Gynaecological Endoscopy (BSGE). Joint RCOG BSGE statement on gynaecological laparoscopic procedures and Covid-19. 2020. <https://www.bsge.org.uk/news/joint-rcog-bsge-statement-on-gynaecological-laparoscopic-procedures-and-covid-19/>.
- [4] Royal College of Surgeons (RCS). Updated intercollegiate general surgery guidance on COVID-19. 2020. <https://www.rcseng.ac.uk/coronavirus/joint-guidance-for-surgeons-v2/>.
- [5] European Society for Gynaecological Endoscopy (ESGE). ESGE recommendations on gynaecological laparoscopic surgery during COVID-19 outbreak. 2020. <https://esge.org/wpcontent/uploads/2020/03/Covid19StatementESGE.pdf>.
- [6] Barberis A, Rutigliani M, Belli F, Ciferri E, Mori M, Filaura M. Sars-Cov-2 in peritoneal fluid: an important finding in the Covid-19 pandemic. *Br J Surg* 2020 (July (20)). doi:<http://dx.doi.org/10.1002/bjs.11816>.
- [7] Kwak HD, Kim SH, Seo YS, Song KJ. Detecting hepatitis B virus in surgical smoke emitted during laparoscopic surgery. *Occup Environ Med* 2016;73:857–63.
- [8] Sood AK, Bahrani-Mostafavi Z, Stoerker J, Stone IK. Human papillomavirus DNA in LEEP plume. *Infect Dis Obstet Gynecol* 1994;2:167–70.
- [9] Liu Y, Song Y, Hu X, Yan L, Zhu X. Awareness of surgical smoke hazards and enhancement of surgical smoke prevention among the gynaecologists. *J Cancer* 2019;10:2788–99.
- [10] Zheng M, Boni L, Fingerhut A. Minimally invasive surgery and the novel coronavirus outbreak: lessons learned in China and Italy. *Ann Surg* 2020;272:e5–6.
- [11] Nohuz E, Atallah A, Cerruto E, Curtis M, Bernigaud O, Chassard D, et al. Technics to put on and remove personal protective equipment before surgical or obstetrical procedure in suspected or infected COVID-19 patients (with video). *J Gynecol Obstet Hum Reprod* 2020;8:101859.
- [12] Mintz Y, Arezzo A, Boni L, Chand M, Brodie R, Fingerhut A. Low cost, safe and effective method for smoke evacuation in laparoscopic surgery for suspected coronavirus patients. *Ann Surg* 2020;272:e7–8.
- [13] MIS filtration group. How to manage smoke evacuation and filter pneumoperitoneum during laparoscopy to minimize potential viral spread: different methods from SoMe – a video vignette. *Colorectal Dis* 2020;22:644–5.
- [14] COVID-19: American Society of Anesthesiologists Recommendations for Anesthesia Management [www.asahq.org/about-asa/governance-and-committees/asa-committees/committee-on-occupational-health/coronavirus/clinical-faqs](http://www.asahq.org/about-asa/governance-and-committees/asa-committees/committee-on-occupational-health/coronavirus/clinical-faqs).
- [15] Yeo D, Kaushal S, Ahmed S. Clearing the air: an accessible system for suction and safe evacuation of pneumoperitoneum during laparoscopy in patients with COVID-19. *Br J Surg* 2020;107:e200.
- [16] Hanbali N, Herrod P, Patterson J. A safe method to evacuate pneumoperitoneum during laparoscopic surgery in suspected COVID-19 patients. *Ann R Coll Surg Engl* 2020;102:392–3.
- [17] Hamed H. Underwater-seal evacuation of surgical smoke in laparoscopy during the COVID-19 pandemic: a feasibility report of a simple technique. *Br J Surg* 2020.
- [18] Mintz Y, Arezzo A, Boni L, Baldari L, Cassinotti E, Brodie R, et al. The risk of COVID-19 transmission by laparoscopic smoke may be lower than for laparotomy: a narrative review. *Surg Endosc* 2020;34:3298–305.
- [19] Nohuz E, Dubernard G, Lamblin G, Lebaill-Carval K, Chabert P, Chene G. Gynecological surgery during the COVID-19 pandemic: take home messages. *Gynecol Obstet Fertil Senol* 2020;48(June (6)):526–9 S2468–7189(20)30162–30168.
- [20] Chene G, Cerruto E, Nohuz E. The comeback of vaginal surgery during and after the COVID-19 pandemic: a new paradigm. *Int Urogynecol J* 2020;31:2185–6.