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Easy-to-use electrocautery smoke evacuation device for open surgery under the risk of the COVID-19 pandemic

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Abstract

Objective: This study was performed to introduce an easy method of surgical smoke evacuation for patients with confirmed or suspected COVID-19 undergoing emergency surgery.

Methods: An easy, inexpensive, protective, and practical surgical smoke evacuation device/ system was developed and is herein described.

Results: The use of this surgical smoke evacuation device/system in open surgery is convenient and effective. It allows for easy, economic, useful, and protective surgical smoke evacuation.

Conclusions: COVID-19 infection causes direct mortality and morbidity, and its incidence has recently increased. Protection from electrosurgery-related smoke is recommended particularly during the current pandemic. This surgical smoke evacuation device/system is easy to use and provides a convenient and effective method of smoke evacuation during both open surgery and all cauterization interventions.

Keywords

Open surgery, COVID-19, smoke evacuation, electrocautery, virus, transmission

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Introduction

Occupational health and safety issues are important among industrial workers. However, they are also very important for healthcare professionals. In the field of healthcare, biological factors and gases must be added to the already-existing

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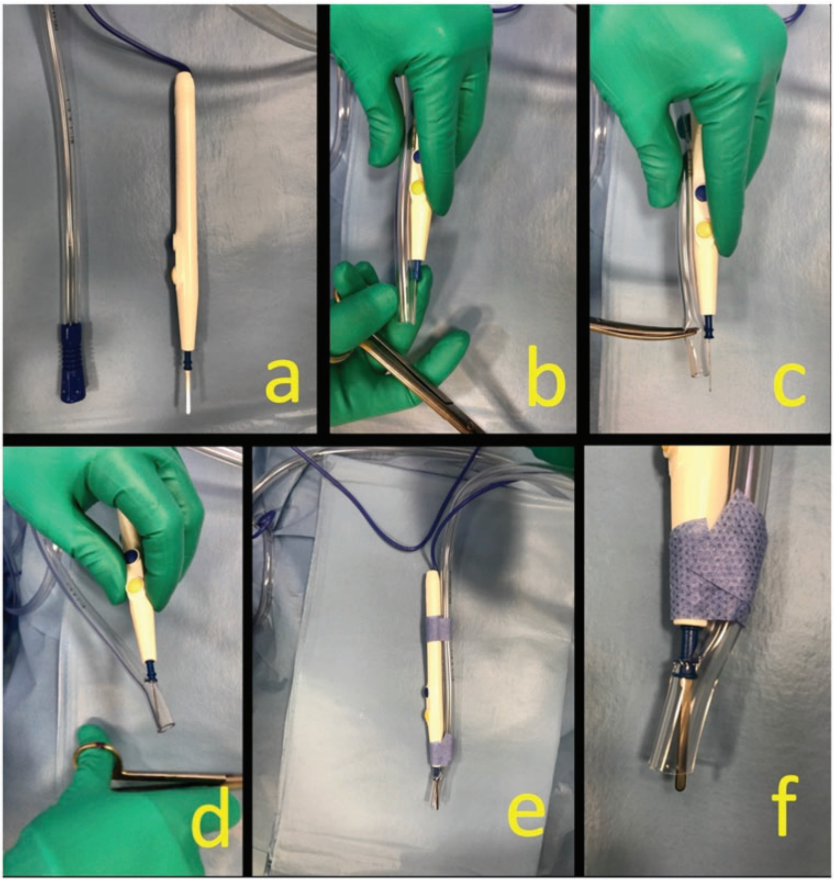

Figure 1. Steps of preparation of electrocautery smoke evacuation device. (a) Suction tube and electrocautery device prior to set-up. (b) Determination of the location of the incision on the tube. (c) Creation of small incision on the tube using scissors. (d) Insertion of the electrocautery tip into the tube. (e) Fixation of electrocautery tip and tube with sterile strips. (f) Final view of the electrocautery smoke evacuation device.

occupational health and safety issues. These factors are not visible, and they may be readily encountered in both living spaces and working environments. Therefore, personal protective equipment must be used to reduce exposure to hazardous effects. Personal protective equipment includes gloves, goggles, face shields, gowns, and respiratory protective equipment. Exposure is minimized by following various rules and precautions, sharing protocols that healthcare personnel use in hospitals, and preparing specialized operating rooms for patients with confirmed or suspected COVID-19 undergoing emergency surgery.[1–8] This study was performed to describe an easy-to-use, inexpensive, protective, and practical surgical smoke evacuation device/system for patients with confirmed or suspected COVID-19 undergoing emergency surgery.

Methods

The novel smoke evacuation system is composed of an aspiration connecter tube and cautery device. The preparation and use of this system are shown in Figure 1 and Video 1 (Supplemental video, available online). The tube is detached from the aspiration evacuation system. A small incision is made using scissors. The distance from the incision to the head of the suction tube is important because a small part of the electrocautery tip will be located outside the head of the tube (Figure 1(a)–(c)). From this incision, the cautery tip is inserted into the aspiration tube (Figure 1 (d)). The aspiration tube and cautery tip are fixed together with sterile strips (Figure 1(e), (f)). The location of the electrocautery tip is also important. If it extrudes too far from the head of the suction tube, sufficient aspiration or suction is prevented (unwanted leakage of surgical smoke occurs). Conversely, if it is placed too far behind the suction head, it will prevent proper functioning of the electrocautery device (proper contact of the cautery tip with the surgical site is prevented). In such cases, either sufficient aspiration or suction is prevented or the aspiration tube makes it difficult to use the cautery device. When the system is working properly, smoke is effectively evacuated, thereby preventing its inhalation.

Ethical approval and consent

Ethical approval was not required for this study because no humans or animals were involved in the study process. A consent statement is not applicable because this study is a technical report without the involvement of human subjects.

Discussion

Humankind is facing a novel virus that causes COVID-19, a detrimental and potentially life-threatening disease. This viral disease is spread by droplets and close contact, and it has now turned into a pandemic. COVID-19 is being fought worldwide, and healthcare workers are on the front lines. The World Health Organization and worldwide government agencies, associations, professional organizations, and scientists are publishing precautions and information that is updated almost every day.[1–4,7]

The main transmission routes of COVID-19 are reportedly respiratory droplets and direct contact. However, the virus has also been detected in bodily fluids such as blood, feces, saliva, vomit, and urine, broadening the previously described routes of transmission.[9,10] The Chinese Center for Disease Control and Prevention has also reported the possibility of aerosol transmission, which can occur during aerosol-generating surgical procedures. Concordantly, the Canadian Association of General Surgeons Minimally Invasive Surgery Committee has developed a directive to prevent the risk of aerosolization of viruses during laparoscopy.[11]

These facts have raised a primary concern regarding another potential route of virus transmission: surgical smoke. Dissection or cauterization of tissue using heat-generating devices such as electrosurgery devices, lasers, and ultrasonic scalpels produces a gaseous by-product known as surgical smoke. Surgical smoke contains potentially hazardous substances such as cellular material, blood fragments, microorganisms, toxic gases, and vapors.[3,4,10] Other than the virus that causes COVID-19, previous studies have shown that pathogens such as activated *Corynebacterium*, human papillomavirus (HPV), hepatitis B virus (HBV), and human immunodeficiency virus (HIV) can also be present in surgical smoke.[12–15] In addition, the bioaerosol produced at low temperatures as when using harmonic scissors may contain viable multidrug-resistant *Mycobacterium tuberculosis* and the viral DNA of HBV, HCV, HIV, and HPV. Surgical masks and local exhaust ventilation may not be capable of filtering the produced bioaerosol.[16–18]

Bacteria and viruses can be transmitted through this smoke.[18,19]

In one study, approximately 40% of smoke plumes following loop excision biopsy of the cervix tested positive for HPV DNA.[20] Similarly, a recent study of surgeons treating 134 patients who underwent cervical loop electrosurgical excision procedures for HPV revealed that HPV DNA was present in the surgical smoke plume of 40 patients (30%).[21] Another study showed that HBV was found in the surgical smoke of more than 90% of HBV-positive patients undergoing robotic or laparoscopic abdominal surgeries.[22] Therefore, the risk of transmission through surgical smoke exists even if the actual number of reported cases of infection is scarce. Four reported cases in the literature to date have described occupational exposure to HPV.[3] The common factor among all of the infected healthcare professionals was that they had no significant medical history or risk factors other than their long-term occupational exposure.[10] Schultz[23] showed that only blended-current electrosurgery contained viable bacteria and that placing the suction device near the electrosurgical site reduced the number of viable bacteria. In other studies, viral DNA has been identified in surgical smoke and could potentially transmit disease.[4,24] Bree et al.[19] recommended the regular use of smoke evacuation in operating rooms to protect against potential long-term harmful effects.

Zheng et al.[25] suggested that the electrocautery power settings should be as low as possible and that long dissecting times on the same spot using electrocautery and ultrasonic scalpels should be avoided to reduce surgical smoke. Likewise, in their review, Mallick et al.[26] recommended employing electrosurgical and ultrasonic devices in a manner that minimizes surgical smoke production with low-power settings and avoidance of prolonged activation. Suction devices and smoke evacuation filters should be used to prevent aerosol transmission and remove smoke, aerosol, and carbon dioxide pneumoperitoneum during surgery. The Society of American Gastrointestinal and Endoscopic Surgeons and the European Association of Endoscopic Surgery recommend minimal use of tissue-cutting energy devices such as monopolar electrocautery and ultrasonic energy devices or the use of these devices with smoke evacuators to reduce particle aerosolization.[27]

Another important point is the distance of the smoke evacuation device from the site of surgery. A recent study evaluating the risk of HPV transmission from HPV-positive patients undergoing cervical loop electrosurgical excision procedures indicated that the presence of HPV in smoke was inversely associated with the distance of the suction device from the surgical site.[4] The Association of periOperative Registered Nurses recommends that the evacuation apparatus should be no more than 2 inches from the source of generated smoke during open surgical procedures.[28] In accordance with these data, our simple smoke evacuation system described in the present study is precisely designed so that the cautery tip is directly inserted into the suction tube, enabling very close contact with the operation area without leakage of surgical smoke.

Although the COVID-19 pandemic has raised concerns about the risk of virus transmission to staff in the operating room, there is no evidence that COVID-19 is transmissible through surgical smoke.[29] However, considering that the SARS-CoV-2 virus has been identified in blood and stools, the theoretical risk of virus diffusion through surgical smoke cannot be excluded.[30] van Doremalen et al.[31] reported that aerosol and fomite transmission of SARS-CoV-2 is possible because the virus can remain viable and infectious in aerosols for several hours and on surfaces for several days. Wang and Du[32] suggested that

COVID-19 may be directly transmitted through aerosol, but they concluded that this needs to be further verified by experiments. SARS-CoV-2 was recently reported to be present in peritoneal fluid in a SARS-CoV-2–positive patient undergoing an emergency surgical procedure.[33] In contrast, the COVID-19 virus was not detected in the peritoneal fluid and peritoneal washings of a COVID-19–positive patient with acute appendicitis following laparoscopic appendicectomy.[34]

Products similar to our novel device are currently sold on the market. However, considering that COVID-19 is now a pandemic, that the routes of transmission of the virus to healthcare professionals are not entirely known, and that these products can be expensive and difficult to find, our easy-to-use, practical, and inexpensive device/system is preferred to overcome the risk of transmission. The development and addition of a filter or chemical-containing component in addition to the discharge part of the suction tube is also recommended to enable safe evacuation of surgical smoke.

Conclusion

Even if hazardous viral transmission from surgical smoke to healthcare professionals does not appear to be common, it is not necessarily impossible. Protection from and reduction of occupational exposure to surgical smoke and aerosol particles during surgical procedures should be the top priority of all healthcare workers at all times, not only during pandemics.

In conclusion, this easy-to-use surgical smoke evacuation device/system is a convenient and effective method for both open surgery and all cauterization interventions. It allows for easy, economic, useful, and protective surgical smoke evacuation.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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Supplemental material

Supplemental material is available online for this article.

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