Endoscopic shield: barrier enclosure during the endoscopy to prevent aerosol droplets during the COVID-19 pandemic

Ryota Sagami, MD,[1] Hidefumi Nishikiori, MD,[1] Takao Sato, MD,[1] Kazunari Murakami, MD, PhD[2]

Coronavirus disease 19 (COVID-19) refers to human infection with severe acute respiratory syndrome coronavirus 2. The World Health Organization declared COVID-19 a pandemic on March 11, 2020. By April 21, 2020, the number of confirmed COVID-19 cases had increased to more than 2,397,000 globally, with an overall mortality rate of 6.8%.[1]

COVID-19 is mainly spread through direct contact or aerosol droplets.[2,3] Whether endoscopy represents an aerosol-generating procedure remains unclear, but insufflation during endoscopic procedures could cause splash and the production of aerosol droplets owing to processes such as reflex vomiting, sneezing, and coughing. Contamination by such aerosol droplets may increase the risk of severe acute respiratory syndrome coronavirus 2 transmission. In areas with many infected patients, approximately 10% of healthcare personnel (HCP) have contracted COVID-19, and protection of HCP is recommended.[4] HCP involved in endoscopy face substantial risks because of the short physical distance between patients and

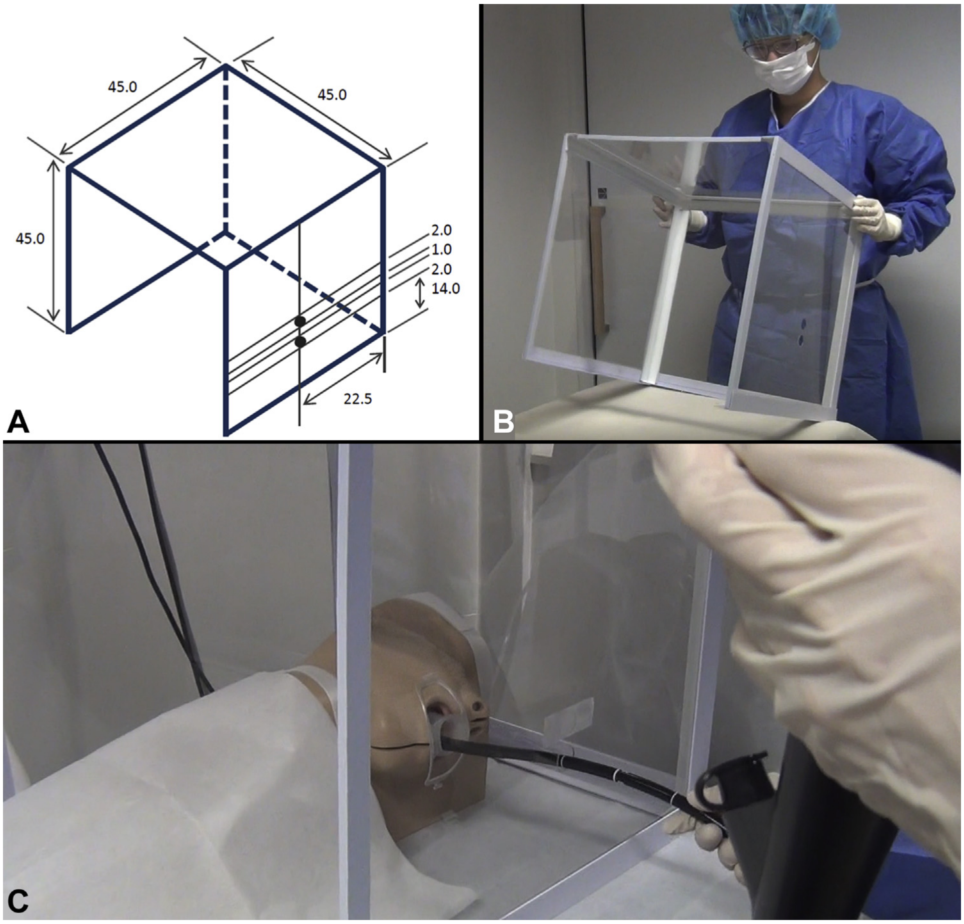

Figure 1. Details of the endoscopic shield. **A,** This device is a plastic cube with sides measuring 45 cm. With the patient in a left lateral position, the bottom and left side of the cube are open, and the head of the patient is covered. **B and C,** The facial side of the cube contains 2 small holes, and the endoscope is inserted through 1 of the holes, selected according to the size of the patient's face and the height of the patient's mouth. The other hole is closed with medical tape.

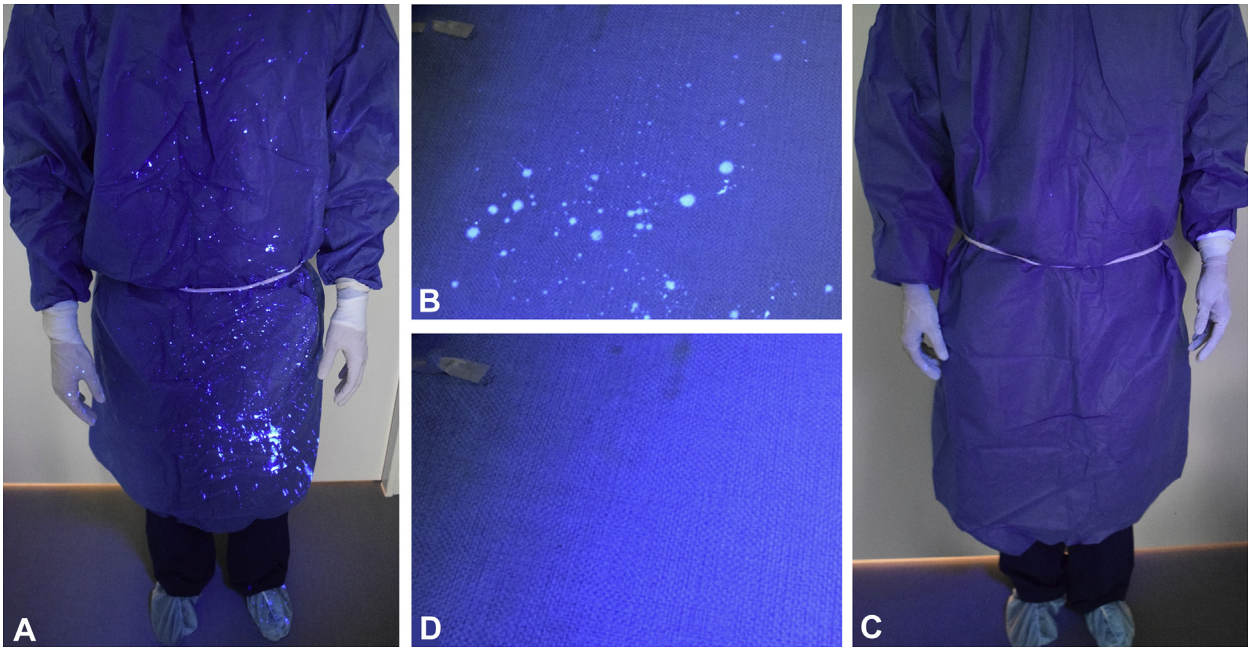

Figure 2. Comparison of the spread of fluorescent dye droplets from a simulated patient cough during endoscopy. **A and B,** Dye was identified on the right glove, arm, and chest near the neck of the endoscopist. In addition, much contamination of the floor occurred after the simulated endoscopy without the endoscopic shield. **C and D,** A little dye was found only on the right glove, arm, and chest of the endoscopist, and contamination of the floor was minimal after simulated endoscopy with the endoscopic shield.

personnel. Many endoscopic centers have thus reduced normal endoscopic activities.[5]

Triage and assessment of risk from patients with suspected or confirmed COVID-19 before endoscopy, regular monitoring of the supply and use of personal protective equipment (PPE), and performance of endoscopies in a negative pressure room, when available, and with strict isolation precautions for suspected or confirmed cases of COVID-19 are recommended.[2] In addition, urgent endoscopies, such as for upper GI bleeding or severe cholangitis, should be performed by strategically assigned HCP to minimize risks of concomitant exposure.[2]

DESCRIPTION OF TECHNOLOGY

Protection against COVID-19 infection during endoscopic procedures should be considered from not only the side of the HCP but also the side of the patient. Newly developed barrier enclosures for use during endotracheal intubation may provide additional protection as an adjunct to standard PPE by preventing the spread of aerosol droplets.[6] Thus, the endoscopic shield was developed. This plastic cube barrier was designed to cover the head of the patient during upper GI endoscopy.

VIDEO DESCRIPTION

The device is a plastic cube with sides measuring 45 cm. Four square, 1.5-mm thick plastic plates were glued together, with 2 holes in the plate on the facial side. With the patient in a left lateral position, the bottom and left side of the cube are open, and the head of the patient is covered, especially on the facial side (Fig. 1A). In our situation, a 170-cm tall endoscopist in standard PPE performed upper GI endoscopy on a mannequin with the mouthpiece placed as usual.

The facial side of the cube contains 2 small holes, each 2 cm in diameter, and the endoscope is inserted through 1 of the holes, selected according to the size of the patient's face and the height of the patient's mouth (Figs. 1B and C). The other hole is closed with medical tape (Fig. 1C). The size of the hole was determined based on the diameter of the TJF-260V side-view endoscope (Olympus Medical Systems, Tokyo, Japan); it has a diameter of 13.5 mm and working space because the TJF-260V has the largest diameter of any endoscope in Japan and is used for urgent ERCP.

A single episode of reflex vomiting or cough was simulated by bursting a small nitrile rubber balloon containing 10 mL of fluorescent dye. The balloon was attached to a tube and placed in the hypopharynx of the mannequin, and oxygen was pumped through the tube inside the mannequin until the balloon burst. Simulated endoscopy was then performed without and with placement of the endoscopic shield. The scene for each simulation was illuminated with ultraviolet light to visualize the area of scattered dye droplets.

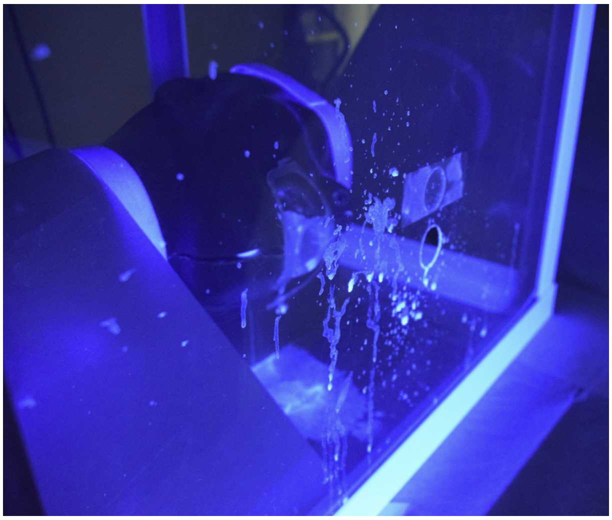

Figure 3. Most dye was identified on the inner front surface of the endoscopic shield.

In the situation without the endoscopic shield, dye was clearly identified on the right glove, arm, upper chest, abdomen, and socks of the endoscopist (Fig. 2A). Little dye was identified on the face mask or eye shield. Contamination of the floor occurred in an area approximately 1.5 m from the head of the bed (Fig. 2B). With the endoscopic shield, most of the dye was identified on the inner front surface of the cube, on the inner upside surface to a lesser extent, and not on other surfaces (Fig. 3). Little dye was found only on the right glove, arm, and chest of the endoscopist, with none on the abdomen, socks (Fig. 2C), face mask, or eye shield. Contamination of the floor was also minimal (Fig. 2D). The endoscopic shield thus appeared to protect against widespread dispersal of aerosol droplets. The endoscopic shield therefore could contain the majority of splash and aerosol droplets from a patient, markedly reducing the exposure of HCP including endoscopists and the surrounding environment such as floors. (Video 1, available online at www.VideoGIE.org).

USE IN AN ACTUAL PATIENT PROCEDURE

Next, use of the endoscopic shield for a live patient was evaluated. One of the authors underwent upper GI endoscopy with the endoscopic shield without conscious sedation, after providing informed consent. The patient was placed in a left lateral position, and the endoscopic shield was placed to cover the head. There was no discomfort, and vital signs did not change. When the endoscopic procedure is performed with conscious sedation, the cube can be placed after the start of sedation.

The endoscope was inserted through 1 of the holes on the facial side of the cube. A disposable rubber check valve was attached to 1 hole to reduce the risk of infection resulting from contact with the endoscope. During the procedure, head repositioning was performed without difficulty because the cube allowed sufficient working space, and a nasal cannula was smoothly inserted through the bottom of the cube during the procedure. The standard GI screening was completed in approximately 10 minutes without problems, and there was no interference between the endoscope and the endoscopic shield. After the procedure, many droplets resulting from reflex vomiting and coughing were noted on the inner front surface of the cube. The attached check bulb was discarded, and the cube was carefully washed and wiped with sodium hypochlorite. Because the endoscopic shield is an external device, the device can be reused after such disinfection.

The device may be useful for all patients who undergo upper GI endoscopy, including urgent endoscopic procedures. However, the device may have little to no clinical applicability for patients undergoing general endotracheal intubation; aerosolization would not be a concern in such cases. The new device was easy to use, and no particular training was required. Of course, our simulation only partially reproduced the true situation of endoscopy and could not determine whether the shield prevented widespread dispersal of smaller aerosol particles that could still prove infectious. In addition, access to the patient may be restricted by the device, depending on the situation. However, the shield may provide an additional level of protection against COVID-19 infection during necessary endoscopic procedures. The prototype of the endoscopic shield was easy and inexpensive to produce, at a price of $40 U.S. dollars; therefore, commercialization of this device is now planned. However, the shape and durability should be considered in detail for it to be commercialized.

CONCLUSION

The endoscopic shield could prevent widespread dispersion of aerosol droplets. HCP, including endoscopists, and surrounding environments, such as floors, were exposed only slightly with endoscopic shield use. Therefore, the endoscopic shield may reduce the spread of COVID-19 infection during endoscopy.

DISCLOSURE

All authors disclose no financial relationships

Abbreviations: COVID-19, coronavirus disease 19; HCP, healthcare personnel; PPE, personal protective equipment.

REFERENCES

1. World Health Organization. Situation report - 92. Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200421-sitrep-92-covid-19.pdf?sfvrsn=38e6b06d_4 Accessed April 25, 2020.
2. Chiu PWY, Ng SC, Inoue H, et al. Practice of endoscopy during COVID-19 pandemic: position statements of the Asian Pacific Society for Digestive Endoscopy (APSDE-COVID statements). Gut 2020;69:991-6.
3. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N Engl J Med 2020;382:1564-7.
4. COVID-19: protecting health-care workers. Lancet 2020;395:922.
5. Repici A, Aragona G, Cengia G, et al. Low risk of covid-19 transmission in GI endoscopy. Gut. Epub 2020 Apr 22.
6. Canelli R, Connor CW, Gonzalez M, et al. Barrier enclosure during endotracheal intubation. N Engl J Med. Epub 2020 Apr 3.

Department of Gastroenterology, Oita San-ai Medical Center, Oita, Japan (1), Department of Gastroenterology, Faculty of Medicine, Oita University, Oita, Japan (2).

https://doi.org/10.1016/j.vgie.2020.05.002