Title: Application of a modified endoscopy face mask for flexible laryngoscopy during the COVID-19 pandemic

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Abstract
Diagnostic flexible laryngoscopy (DFL) is a critical tool in the armamentarium of an otolaryngologist. However, in the midst of the COVID-19 pandemic, DFL represents a high-risk procedure for both patients and otolaryngologists due to the risk of aerosolization. In cases where DFL is required, either in COVID-19-positive patients or in patients with unknown COVID-19 status, we describe the use of a modified endoscopy face mask as an adjunct to personal protection equipment to reduce occupational transmission of COVID-19 while performing DFL. Our modified endoscopy mask provides an additional barrier against the transmission of airborne pathogens. The modified endoscopy face mask may also serve as a useful tool for otolaryngologists as they return to performing more aerosol generating procedures in the outpatient setting.

Introduction
The 2019 novel coronavirus disease (COVID-19), declared as a global pandemic on March 11, 2020 by the World Health Organization, presents extraordinary challenges to healthcare systems around the world, impacting both patients and healthcare workers. Amongst the medical community, otolaryngologists are particularly at high risk of occupational exposure to COVID-19, given the nature of head and neck examinations, where the SARS-CoV-2 is prevalent in high concentrations, and due to commonly performed aerosol-generating procedures. Diagnostic flexible laryngoscopy (DFL) is a critical tool in the armamentarium of an otolaryngologist that aids in the visualization of the nasal cavity, larynx and pharynx. However, in the midst of the COVID-19 pandemic, DFL represents a high-risk procedure for both patients and otolaryngologists, reserved for critical cases where findings may alter management. Furthermore, as the pandemic evolves and medical facilities
resume non-emergent services in the future, there is a need to determine how to perform DFL safely.

In cases where DFL is required, either in COVID-19-positive patients or in patients with unknown COVID-19 status, we describe the use of a modified endoscopy face mask as an adjunct to personal protection equipment (PPE) to reduce occupational transmission of COVID-19 while performing DFL.

Methods

Supplies and Equipment

To simulate outpatient DFL, an airway simulation manikin (Laerdal SimMan Manikin, Laerdal Inc. Wappingers falls, NY) seated upright on a clinic exam chair was used. An adult endoscopy face mask (VBM medical, Sulz am Neckar, Germany), originally designed to allow fiberoptic nasotracheal intubation through a 5mm port with simultaneous ventilation, was modified to enable the passage of a standard flexible laryngoscope by fashioning a 3 mm slit using a scalpel. The endoscopy face mask was then secured on the manikin using a face mask harness (Rusch Medical, Wayne, PA) and attached to a hook ring. A heat and moisture exchanger with bacterial and viral filter (McKesson Corporation, Irving, TX) was attached to the inferior mount of the face mask (Figures 1-3).

A 3.5mm flexible distal-chip laryngoscope (Pentax Medical, Montvale, NJ) was easily passed through its 5mm port. With the 5mm port plugged, the scope was also passed through the modified 3mm slit with minimal resistance, achieving a tighter seal. The scope was able to be maneuvered without difficulty through the mask and reach the subglottis with ease, with only 5 cm of dead space between the face mask and the patient.

Discussion
Otolaryngologists are exceptionally susceptible to iatrogenic transmission of COVID-19, given the high viral load of SARS-CoV-2 in the upper airway of infected patients. Otolaryngologists are exposed to exhaled pathogens during routine examination of the nasal passages, oral cavity, and oropharynx, and particularly more during endoscopy and other AGPs, where gagging, coughing, and sneezing are common events. Aerosolized COVID-19 particles may remain airborne for up to 3 hours, and may survive on surfaces for much longer.\(^5\)

Recommendations have been published in the otolaryngology literature, advocating to perform flexible laryngoscopy only in critical cases and when findings may have an immediate impact on patient management; consideration of pre-procedure COVID-19 testing; use of powered, air-purifying respirator (PAPR) or N95 mask in addition to PPE by the provider and use of surgical masks by the patient.\(^6,7\) Awareness of these practices are key to reduce aerosolization risks to health care workers. In the event flexible laryngoscopy is required, either in the setting of patients with known COVID-19, unknown COVID-19 status, or high-risk patients who test negative on PCR, given the significant false negative rate of current RT-PCR assay for COVID-19,\(^8\) we advocate the use of the modified endoscopy mask described in this communication.

Endoscopy masks are easy-to-use and widely available in centers with endoscopy suites. While it may not provide a complete, 100% air-tight seal, the combination of the modified endoscopy mask and heat and moisture exchanger with viral filter, allows for an additional barrier for transmission of airborne pathogens, and a useful adjunct to PPE. The modified endoscopy face mask also allows for flexible laryngoscopy to be performed in patients who require ventilation, such as in COVID-19 intubated patients, while minimizing aerosolization of airborne pathogens. Additional strategies that mitigate droplet transmission of the virus including the use of anesthetic gels, hand hygiene, and laryngoscope disinfection, previously described in literature should also be employed.\(^6,7\) A recent article by Workman et
al studied the aerosolization of particles from powered-instrumentation during nasal endoscopy in a cadaver model using a surgical mask and a modified surgical ‘VENT mask’, modified with the addition of an internal and external surgical glove through which the endoscope passes. The group showed that aerosols were reduced by both the standard surgical mask and ‘VENT mask’ in a simulated sneezing event.\textsuperscript{9} We believe our modified endoscopy face mask provides an improved barrier to the transmission of aerosols since a tighter seal is achieved, decreasing potential aerosol escape.

**Conclusion**

Flexible laryngoscopy is an essential procedure in otolaryngology which poses a high occupational risk of transmission of COVID-19. Current recommendations include limiting DFL to critical cases. In the event that DFL is required, either in patients with COVID-19, unknown COVID-19 status or high risk patients who test negative on PCR, we advocate the use of our modified endoscopy face mask alongside PPE, to serve as an additional barrier against viral transmission. The modified endoscopy face mask may also serve as a useful tool for otolaryngologists as they return to performing more aerosol generating procedures in the outpatient setting.

**References**


**Figures**

**Figure 1**: Equipment required for the modified endoscopy face mask. From left to right, adult endoscopy face mask with 5mm endoscopy port, hook ring, heat and moisture exchanger with bacterial and viral filter, face mask harness, #10 or #15 scalpel (not pictured).

**Figure 2**: Creation of a 3mm slit in the central silicone membrane of the endoscopy face mask with a #10 scalpel, to allow passage of the flexible fiberoptic laryngoscope.

**Figure 3A**: In-office set up for flexible fiberoptic laryngoscopy, with modified endoscopy face mask, secured with face mask harness B Flexible fiberoptic laryngoscopy at the level of the vocal folds, utilizing a modified endoscopy face mask and a heat and moisture exchanger with bacterial and viral filter.
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