Review Article

Performing Laryngotracheobronchial Procedure in Coronavirus Disease 2019 Pandemic: A highly Aerosol Generating Event in Clinical Practice

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Abstract

The current novel coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 is presenting a significant challenges to the surgical specialties specifically otolaryngologists and head and neck specialties those are dealing with upper airway such as larynx, trachea, and bronchus. The traditional airway procedure like microlaryngeal surgery, tracheostomy, and bronchoscopy are highly aerosol generating surgery often managed by otolaryngologists. The laryngotracheobronchial airway has a high viral density and so it is expected to expel more transmission of the infections in COVID-19 pandemic. This is why the otolaryngologists or laryngologists are more vulnerable medical professional in this dreaded pandemic. Surgeons have high risk for getting the infections during examinations or surgical procedure on the laryngotracheobronchial airway. The surgical interventions should adopt adequate precautions to limit the viral dissemination. Effective management of the suspicious or positive cases of COVID-19 required careful consideration for the safety of the surgeons and associated team members for ensuring the best possible care of the patients. This review article will provide an overview of common methods to limit the viral transmission to the otolaryngologists/surgeons and assisting health care staffs from COVID-19 infections during management of the laryngotracheobronchial airway.

Keywords: Coronavirus disease 2019 pandemic, flexible laryngoscopy, rigid bronchoscopy, tracheostomy

Introduction

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is the etiological agent for the outbreak of the coronavirus diseases 2019 (COVID-19) which was originated in Wuhan, China, since late December 2019.[1] SARS-CoV-2 was earlier known as the 2019 novel corona virus (2019-nCoV), an enveloped single-stranded RNA virus.[1] Otolaryngologists have an important role as a health care provider for seeing the patients with laryngotracheobronchial disorders. There are concerns for more number of the asymptomatic patients infected with COVID-19.[2] Patients often present with diseases related to the airway such as laryngeal pathology, foreign body in trachea or bronchus, tumors in the laryngotracheobronchial area. There is disproportionately high number of clinicians specifically otolaryngologists have been infected with COVID-19 during their patient care specifically during managing the laryngotracheobronchial diseases.[3] This infection spreads mainly through the respiratory airway by droplets, secretions and direct contact.[4] The majority of the laryngotracheobronchial procedures are thought to be aerosol generating. The health-care workers are at high risk for transmission of the infection from the aerosols, "airborne" (rather than droplet), so precautions should be needed. The aerosol is a suspension of fine solid article or liquid droplets in the air. Inside the aerosol, the viral droplet nuclei may travel a long distance and remain in the air for longer period of the time. Examination and procedure in otolaryngology patients involve upper airway which are

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high risk for viral transmission making the otolaryngologist most vulnerable health care professionals. At present, the risk of the viral transmission from the asymptomatic patients with COVID-19 to the health care workers is often difficult on the basis of the clinical evaluation. The asymptomatic pediatric present high chance of the viral shedding during the clinical examination or any surgical procedure on the laryngotracheobronchial region and transmit these infections to the clinicians and assisting team members.[5] The COVID-19 pandemic requires careful assessment of the patients specifically with laryngotracheobronchial disease before any airway intervention.

Methods of the Literature Search

Research articles regarding laryngotracheobronchial procedures in COVID-19 pandemic were searched through a multiple approach. First, we conducted an online search of the PubMed, Scopus, Google Scholar, and Medline database with the word laryngotracheobronchial procedures, flexible laryngoscopy, tracheostomy, bronchoscopy, microlaryngeal surgery, and direct laryngoscopy in the current COVID-19 pandemic. The abstracts of the published article were identified by this search method and other articles were identified manually from the citations. This review article reviews the COVID-19 virus, epidemiology, history, preventions of the viral transmission during managing the laryngotracheobronchial pathology in COVID-19 pandemic. This review article presents a baseline from where further prospective trials can be designed and help as a spur for further research in this clinical aspect where not many studies are done.

Coronavirus Disease 2019 Virus

The etiologic agent for COVID-19 infection was identified as a nCoV which was called as SARS-CoV-2 and this disease is called COVID-19 by the World Health Organization (WHO).[6] This virus was formerly known as 2019-nCoV, positive-sense, single stranded RNA virus with diameter of 60–140 nm.[6] It is a new variety of the coronavirus which belongs to the genus of beta corona virus.[7] So far, 2019-nCoV is the seventh member of the corona virus family which can infect human being. The incubation period of COVID-19 ranges from 1 to 14 days with a median of 5–6 days. Although recent study document that the incubation period may extend to 24 days.[8] A longer incubation has implication in quarantine policies and prevention of the spread of the disease. This virus primarily transmitted through respiratory droplets but also it is found in blood and stool, so raising question regarding mode of transmission.[9]

History

The initial patient of the pneumonia due to nCoV SARS-CoV-2 manifesting COVID-19 was found in Wuhan, Hubei Province, China, in December 2019.[4] Then, the infections transmitted from human to human and lead to pandemic with disastrous manifestations worldwide. The aerosol transmission of the virus was observed during the COVID-19 crisis, specifically after doing endoscopic hypophysectomy at the Wuhan, China, which infected the nCoV to 14 staffs of the surgical team.[10] In that surgery, the drilling system was used for hypophysectomy which generated profuse aerosols during the surgery followed by inhalation to the upper airway of the surgical team. The corona viruses were detected in the upper airway infection already way back in 1998.[11] However, very little knowledge known to medical professionals about the behavior of the new SARSCoV-2 in the anatomical area of the ear, nose and throat.

Epidemiology

The WHO has declared COVID-19 as pandemic disease on March 11, 2020, and COVID-19 spread to around 199 countries by March 26, 2020, with more than 462,680 positive cases and approximately 20,834 deaths.[12] The pandemic of the COVID-19 is showing a grim and tragic situation worldwide in the current days. It is affecting on the global economy along with clinical practice for routine patient care. It is also seriously affecting day-to-day pediatric otorhinolaryngology practice and specifically surgical intervention of the routing and emergency diseases impacting the quality of life. Over a week, the COVID-19 spread to Asian countries to Europe and then America and finally all over the world with a rapid doubling time (6.4 days).[13] It was declared as a public health emergency by the WHO on January 20, 2020.[13] Majorities (81%) of the patients are asymptomatic or present only mild symptoms whereas approximately 15% show severe forms those need hospitalization.[14] Approximately 3%–4% of the cases require respiratory support in an intensive care unit. The mortality or death rate is around 0.39%–4% but it depends on the age of the patients and it is more in elderly patients older than 70 years.[14] The transmissions of this virus mainly occur by symptomatic patients, however, it has been also documented in asymptomatic persons and those are in incubation period which can last more than 14 days.[14] These asymptomatic individuals are source of occult transmission. The clinical data related to the COVID-19 among adult age groups are sobering, pediatric patients appear relatively resistant to this infection. Till today, the total number of the pediatric patients with COVID-19 is not known because of the less number of the testing among asymptomatic children. In one of the largest global studies showing only 2% of the patients were <18 years of age.[15] However, the exact incidence of the pediatric COVID-19 may be more as 4.4%–28% of the children are not symptomatic whereas additional 51% of the pediatric patients show severe symptoms.[16] The pediatric patients are often presented with airway foreign body where urgent interventions are required.[1]

Viral Transmission

The transmission of the COVID-19 commonly occurs through the upper respiratory tract such as nose, nasopharynx, oral cavity, pharynx, and larynx with high levels of viral shedding.[17] It typically spread through droplets but the aerosols generating procedures are more responsible for transmission of the virus

and enhance the spread to the surrounding health-care workers and otolaryngologists in particular.[18] Mild symptomatic or asymptomatic patient of COVID-19 are responsible for spreading the infections in approximately 79% of the documented cases.[19] The transmission of the COVID-19 occurs because of the shedding of the SARS-CoV-2 virus begins before the onset of the symptoms.[20] The airway of the infected persons have high viral load, specifically in the nose, pharynx, larynx, trachea, and bronchus. Otolaryngologists, anesthesiologists, oral surgeon, dentists, and ophthalmologists are at always high risk for infections as they often perform procedure in the upper aerodigestive area. The respiratory aerosols have droplet nuclei of size <5 μm.[21] A droplet of size 10 μm diameter settles in approximately 8.2 min in comparison to 1.5 h for 3 μm diameter particle and approximately 12 h for 1 μm particle.[22] If the procedure rooms are not well ventilated, the droplets can be more concentrated over the time period. For the infection to be transmitted through the aerosol, the micro-organism must be able to survive inside the droplet nuclei till it is found in the mucous membrane of the susceptible persons either by direct contact or through inhalation. During COVID-19 pandemic, the SARS-CoV-2 virus is transmitted through respiratory droplets or contact. It was seen that the viral transmission to clinicians or health-care professionals occurred despite precautions against the droplets and contact, particularly during the time of aerosol generating procedures such as laryngotracheobronchial examinations or surgery.[23]

Screening before the Procedure

A significant number of the COVID-19 patients do not present with symptoms. The negative tested COVID-19 may not accurate. Patients should be screened for respiratory symptoms and fever before performing the laryngeal and trachea-bronchial examinations and surgical procedures. Clinical should obtain the COVID-19 test report (real-time polymerase chain reaction [RT-PCR]) although it has significant false-negative rate.[24] If possible, the flexible laryngoscopy can be delayed in positive patients till appropriate quarantine period has finished with negative test report. Travel history should be asked in all patients those come for airway evaluations although the travel history is no longer considered as important predictor of the disease because of the restriction at the border. Once the laryngotracheobronchial procedure is planned for the patient, preoperative testing for COVID-19 should be done as early as possible and the test result is obtained prior to the surgical procedure. Before any surgical procedure on the pediatric patient, nasopharyngeal swab with RT-PCR should be done within 48 h before surgery, although 30%–40% of the test results are false negative. The rapid antigen test for COVID-19 is helpful in case of emergency laryngotracheobronchial surgical procedure. The sensitivity and specificity of these commonly used COVID-19 diagnostic tests are not definitely determined and so there is no safe gold standard test has yet to be developed. It always better to assess the child for seeing the sign and symptoms of the COVID-19 [Table 1]. The emergency surgical procedures should not be delayed on the ground of the report as in case of stridor or hemorrhage or severe infections. The sensitivity of the computed tomography (CT) scan of the thorax is more than 90%.[25] The thoracic CT scan can be done to get immediate result. If the preoperative report is COVID-19 positive, nonemergency surgery should be delayed for at least 14 days (usual duration of the quarantine period). In case, pediatric patient with suspicious airway foreign body, the diagnosis can be confirmed from low dose, noncontrast CT scan. CT scan of the thorax should be routinely performed in case of laryngotracheobronchial foreign body in children.[25] CT thorax is highly sensitive and specific to confirm the foreign body in the airway and minimize the negative bronchoscopy rates.[26] If the foreign body in the bronchus is absent and the low clinical suspicion, the surgical procedure can be cancelled and the child can be followed closely. With CT scan of the thorax of the child, the health care personnel are at very low risk and also less personal protective equipment (PPE) consumption in comparison to the performing rigid bronchoscopy. However, the clinically unstable or with stridor, the child should shift to the operating room by full precautions with adequate PPE.

Table 1: Clinical screening before laryngotracheobronchial procedure

Serial number	High risk clinical presentations
1	Travel history to outside state/country
2	Contact with COVID-19 positive patients
3	Fever
4	Influenza like symptoms
5	Shortness of breath
6	Cough
7	Sore throat
8	Altered taste sensation
9	Altered smell sensation

COVID-19: Coronavirus disease 2019

Flexible Laryngoscopy

Flexible laryngoscopy is the gold standard evaluation of the larynx and pharynx. It is one of the commonly performed examination procedure in the outpatient department of the otorhinolaryngology. In COVID-19 pandemic, the flexible laryngoscopy shows a risk of the infections to the otolaryngologists, assisting staffs and also patients during this procedure. Otolaryngologists must maintain a distance from the patient who underwent the flexible laryngoscopy. Clinician should maintain hand hygiene before and after patient interaction in each case. The flexible laryngoscopy has restricted indications during COVID-19 pandemic as it has a high risk for viral transmission to the health-care workers and other surrounding personnel.[27] It should be only performed in critical condition of the patient such as airway obstruction to find out the site of obstructive pathology and doing some intervention in compromised airway.[28] In majority of the cases of flexible laryngoscopy, the patient may cough because of the instrumentations. The aerosols expelled through cough may

touch the assisting health care personnel. The frequency of the cough is more in patient with COVID-19 as it is the clinical symptom of the infection.[29] The WHO considers cough as an aerosol generating which is supported by several studies.[30] When performing such procedure, the otolaryngologists must wear the PPE such as filtering face piece 2 (FFP2) mask, gown, head cap, face shield, and protective goggles. In case flexible laryngoscopy, a small opening can be made on the mask [Figure 1] for entry of the flexible laryngoscope and so the examiners can be protected from aerosols.

After finishing of the procedures, PPE should be thrown into the specially made infected waste basin except the protection goggles which can be decontaminated and reused. The flexible laryngoscope should be kept separately on the table. If the camera is used, must be surrounded with a protective cover. The flexible laryngoscope should be properly sterilized. The surface areas of the examination room should be thoroughly sanitized. The next procedure should be delayed at least 30 min.

Tracheostomy

Emergency or elective tracheostomy provides a significant risk for virus aerosolization and it should be done with extreme caution. Tracheostomy is a high risk surgical procedure in COVID-19 pandemic. Tracheostomy generates aerosols which easily transmits the virus. The elective tracheostomy can be delayed until active COVID-19 infections have passed with consideration of the current guidelines.[31] The trachesotomy must be performed with wearing adequate PPE [Figure 2]. Nonfenestrated cuffed tracheostomy should be used for tracheostomy to minimize the aerosol spread. There should be initial advancement of the endotracheal tube before performing the tracheostomy. Ventilation should be stopped before opening made on the trachea as it helps to produces aerosols.[31] Before inserting the tracheostomy, the cuff should be checked for any leak. After tracheostomy, the tube changes should be delayed till infectivity of the patient ceases. The crust formation in the tracheostomy can be minimized by doing humidification through the tracheostomy tube. Clinician should carefully judge the selection of the proper method of the humidification and a heat moisture exchanger which represents an alternate to the wet circuit and may reduce the aerosols generation. Nebulizers can be avoided and the spacers with a metered dose inhaler which often give an alternative technique for medication delivery to the respiratory airway. Unlike to the adult patients, pediatric tracheostomy tube has no inner cannula for removal, so without doing humidification are likely to cause occlusion of the tracheostomy tube.[32] The occluded tracheostomy tube may disrupt the circuit at the time of the emergency and enhances chances of aerosol spread.

Microlaryngeal Surgery and Rigid Bronchoscopy

Microlaryngeal surgery, rigid bronchoscopy, and laryngotracheal reconstruction are very high risk procedure during the COVID-19 pandemic and make a high chance of the transmission of the infections to the health-care workers because of the aerosol generation and prolonged gas flow.[31] Every effort should be made to shorten the procedure for minimal exposure of the virus to the health care staffs. Hence, only urgent airway cases should be undertaken. All these airway cases should be treated as infective. There should be very minimal number of the expert persons present in the operation room for performing the procedure, so that it will prevent transmission of infection to other health-care personnel inside the theater. Adequate PPE must be used for all otorhinolaryngological procedures with suspected, unknown or positive COVID-19 status. Routine direct laryngoscopy, bronchoscopy or tracheoscopy should be avoided in this COVID-19 pandemic specifically in stable patients without any airway symptoms. If patient with airway symptoms present, may proceed for surgery on the semi-urgent or urgent basis following the COVID-19 testing with the use of appropriate PPE. Surgical tent is done for the suspension microlaryngoscopy and rigid bronchoscopy by attaching the microscope drape with the microscope lens and inverting the drape on the patient. The surgeon works with his or her hands by introducing through two slits [Figure 3].

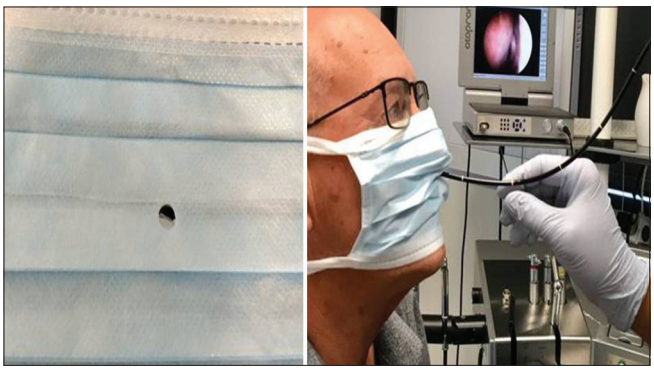

Figure 1: Technique for introducing the flexible laryngoscope through the mask which avoids the exposure of the aerosols to the examiner

Figure 2: Surgeon with personal protective equipment before performing the tracheostomy

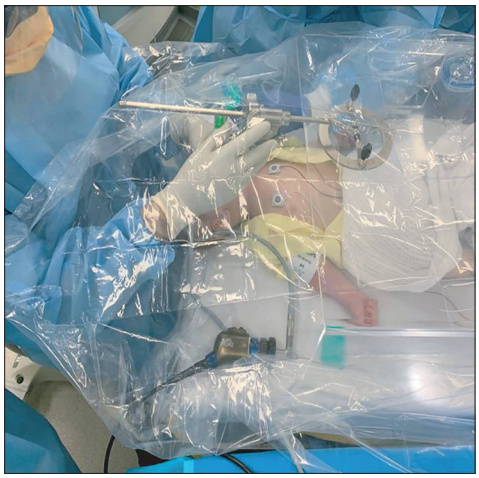

Figure 3: Surgical tent for suspension microlaryngoscopy and bronchoscopy which prevent the exposure of the aerosols to the surgeon

Precautions

Laryngotracheobronchial procedures are important diagnostic and therapeutic procedures done in patients with airway disorders. Before the procedure, history of the travel and contact history should be traced from the patient. Surgeon should obtain the COVID-19 test report (RT-PCR) and also aware about its significant false negative rate. The number of the staff in the procedure rooms or operation room should be reduced for minimizing the staff exposure. No students, observers or trainees should be present in the procedure room or operation room. Only essential health care personnel should be in the operation room to reduce the unwanted exposure to the infections and PPE use. The operation table for patient should be prepared before starting the surgical procedure or entry of the patient. The surgeon should avoid forced air warming blankets as it may aerosolize the contaminants of viral particles.[33] If required keep a blanket on the operation table and cover it with a liquid impermeable drape. Operation room staff should prepare the smoke evacuator for clearing the aerosolized particles. A sterilized metallic bar should be over the patient to suspend the drapes above the patient. The patient must wear a surgical mask at the preprocedure room, bronchoscopy suite, and recovery room. The otolaryngologists and other team members must wear disposable gowns, surgical gloves, head cap, and FFP2 mask inside the procedure room. Otolaryngologists and the assistants should wear disposable goggles, face shield. In case flexible bronchoscopy or laryngoscopy, the slotted mouth of the mask can be used for entry of the flexible laryngoscope or flexible bronchoscopy and the nose and mouth of the examiners should be protected. The jet ventilation during rigid bronchoscopy should be replaced with closed ventilation systems such example laryngeal mask if medically justifiable. In case of unavoidable rigid bronchoscopy, the conventional ventilation and reduction of the aerosol leakage can be preferred.

Personal Protective Equipment in Laryngotracheobronchial Procedure

During COVID-19 pandemic, the use of the PPE by health-care personnel is critical for decreasing the transmission of the infection specifically at the time of aerosol generating medical procedure. The PPE includes FFP3 masks or powered air purifying respirator, long sleeved gown, surgical gloves, disposable eye protectors and face shields. The use of PPE is to protect the health-care staffs and patients. Only with appropriate PPE, the laryngeal examinations and laryngotracheobronchial procedures should be undertaken. The risk of the viral transmissions will be minimized by use of the proper N95 mask and adequate PPE.[34] The health-care workers directly dealing with COVID-19 patient should wear medical mask, gown, gloves and protective eye goggles.[34] Otolaryngologists or health-care workers dealing with aerosol generating procedures on the COVID-19 patients should wear respirator N95 or FFP2, gown, gloves, eye protections with goggles.[34] The use of the face shield is difficult during performing laryngeal surgery under microscope. The use of microdebrider, coblation, or laser has a great chance for aerosolization particles in the operating room. Hence, the health-care professionals in the operating room have high risk of the virus transmission. Approaching the larynx, trachea and bronchus and performing surgeries are high risk aerosol producing surgical procedure. It has significant potential for exposing to the surgeon and staffs of the operating room. The strategies for preventing the transmission of the virus include adequate PPE use with head, face, and neck covering of the drapes which limits the spread of the infections particles generated by laryngotracheobronchial airway. FFP3 masks with protective goggles or face shield or FFP2 in case of limited resource can be used by the surgical team during the laryngotracheobronchial surgery.

Conclusion

The present COVID-19 pandemic due to SARS-CoV-2 presents a challenge to the surgical community worldwide specifically otolalaryngologists and airway surgeons in particular. The laryngotracheobronchial airway is an anatomical site for maximum generation of the aerosolization where the health-care professionals are at high risk during performing the procedures. The laryngotracheobronchial airway has been shown a high viral load and so high chance for transmitting the viral infections to the clinicians specifically otolaryngologists and assisting staffs. There are different precautions used for reducing widespread contamination of the dispersed droplets and aerosols. These precautions are a collaborative effort made on the knowledge gained from the clinical experience from the COVID-19 pandemic.

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Conflicts of interest

There are no conflicts of interest.

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