1 Title: Airway Management for Endoscopic Laryngotracheal Stenosis Surgery During COVID-19

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Abstract

The novel coronavirus disease 2019 (COVID-19) pandemic presents unique challenges for surgical management of laryngotracheal stenosis. High viral concentrations in the upper aerodigestive tract, the ability of the virus to be transmitted by asymptomatic carriers and through aerosols, and the need for open airway access during laryngotracheal surgery create a high-risk situation for airway surgeons, anesthesiologists, and operating room personnel. While some surgical cases of laryngotracheal stenosis may be deferred, patients with significant airway obstruction or progressing symptoms often require urgent surgical intervention. We present best practices from our institutional experience for surgical management of laryngotracheal stenosis during this pandemic including preoperative triage, intraoperative airway management, and personal protective measures.
Introduction

The novel coronavirus disease 2019 (COVID-19) outbreak was designated a pandemic by the World Health Organization on March 11, 2020.\(^1\) Global spread has occurred at an alarming rate. High viral concentration in the upper aerodigestive tract, the possibility of transmission by asymptomatic carriers, and aerosolization during airway procedures contribute to a high risk of occupational exposure among otolaryngologists.\(^2\)

Efforts to reduce non-essential procedures to minimize patient and provider risk have heightened the need for procedure prioritization and management protocols for patients with time-sensitive conditions. While surgical treatment of severe laryngotracheal stenosis (LTS) is essential to prevent devastating consequences including respiratory failure and death, published guidance for management during the COVID-19 crisis does not exist.

Treatment of LTS commonly includes endoscopic surgery to dilate the airway. Intraoperative management requires open access to the airway, often utilizing techniques implicated in viral transmission including jet ventilation, spontaneous ventilation, trans-nasal humidified rapid-insufflation ventilatory exchange (THRIVE), and/or laser excision.\(^3,4\) Operations employing standard airway management techniques for LTS are thus highly aerosolizing and should be avoided at this time. We present alternative airway management techniques to minimize aerosolization and discuss patient triage and safety measures.

Preoperative Evaluation and Triage

During COVID-19, LTS surgery should be performed when delay poses significant risk to the patient. Evaluation during COVID-19 may involve initial phone or video triage to ascertain
severity of LTS symptoms including dyspnea or stridor. Patients who have had prior procedures can often provide insights into the acuity of their symptoms. When circumstances require visualization of the larynx, office visits with laryngoscopy should be conducted with appropriate airborne precautions. Given current public health mandated mobility restrictions, scheduling surgery without in-person examination can be considered for patients with known history of recurrent stenosis.

Shared decision making between the patient and surgeon about whether to proceed with surgery is paramount. Triage discussions must also involve departmental and operating room leadership in the setting of pandemic-related resource limitations. Appropriate timing should be considered, as a controlled LTS surgery may save emergency resources and possibly pose less viral transmission risk to health care providers and patients than an emergent procedure.

Preoperative Testing and Personal Protective Equipment (PPE)

Preoperative testing for asymptomatic patients has the potential to provide reassurance to proceed with surgery if negative; however, testing resources are limited and may not be available. Furthermore, a single negative test may be misleading. Current guidelines at our institution are therefore to wear full airborne precautions PPE and mitigate occupational exposures (Table 1) during high risk aerosol generating procedures without requirement for preoperative COVID-19 testing.

Laryngotracheal Stenosis Endoscopic Surgical Protocol During COVID-19
Development of an airway management plan for LTS surgery always mandates close coordination of care amongst surgeon and anesthesiologist, and this need is amplified during the COVID-19 pandemic due to recommended modifications in standard techniques. Individual patient factors must also be considered, including comorbidities, degree and nature of stenosis, and surgical access via direct laryngoscopy. The protocol outlined in Table 2 for patients requiring subglottic stenosis surgical intervention at our institution during the COVID-19 crisis was developed collaboratively by otolaryngology along with head and neck anesthesiology colleagues.

The key principle guiding pandemic-related modifications in airway management is mitigation of viral aerosolization, which is achieved by using closed systems when possible, rapid sequence induction (RSI), neuromuscular blockade, and avoiding bag-mask ventilation. Prolonged awake preoxygenation for five minutes can extend apnea time and reduce need for bag masking. Direct laryngoscopy, telescopic bronchoscopy, dilation, and intubation are performed by the surgeon immediately following RSI. Patients selected through triage are likely to have severe stenosis, requiring immediate dilation to allow for safe intubation. Our protocol utilizes intubation with 5.0 cuffed microlaryngeal tracheal tube (Medtronic, Minneapolis, MN) with an outer diameter of 6.9 mm; therefore, dilation is performed prior to intubation if the stenosis is narrower than this diameter.

Once intubation is accomplished, surgery proceeds with intermittent apnea using closed-loop communication between the surgeon and anesthesiologist to ensure ventilation is held any time the cuff is deflated, circuit is disconnected, or tube is removed. Neuromuscular blockade is maintained throughout the case to minimize upper respiratory response. Laser is avoided due to risk of virus aerosolization.
Extubation can also lead to aerosolization due to coughing, gagging, and endotracheal tube removal. Similar to the rest of the procedure, we recommend minimizing the number of personnel present and continuing to utilize full airborne precautions PPE. Use of glycopyrrolate may help to minimize secretions, while intravenous lidocaine, opioids, sedatives, and topical lidocaine applied to the larynx and trachea at the conclusion of the surgical procedure may attenuate laryngeal and cough reflex at extubation.\textsuperscript{8} Aerosolization barriers may also be considered, although we are not currently using these devices at our institution.\textsuperscript{9}

### Laryngeal Mask Airway (LMA) Considerations

For patients with inadequate direct laryngoscopy access or known difficult laryngoscopy, airway dilation can be accomplished over a guidewire using flexible bronchoscopy through a supraglottic airway (i.e. LMA). While this technique is an invaluable tool in select cases, risk of aerosolization is thought to be higher with LMA than with endotracheal intubation\textsuperscript{10} and therefore we recommend using this technique with caution during the COVID-19 pandemic.

### Conclusion

Surgical management of LTS presents unique challenges during the COVID-19 pandemic requiring careful consideration of patient triage and protocols that minimize patient and provider risk. Close collaboration between otolaryngology and anesthesiology teams is essential to safely navigate these difficult airways while mitigating risk of viral aerosolization.
Acknowledgments: None

References


Table 1. Mitigation of Occupational Exposures During Airway Surgery

<table>
<thead>
<tr>
<th>Principle</th>
<th>Implementation</th>
</tr>
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<tbody>
<tr>
<td>Airborne precautions PPE</td>
<td>• All personnel in OR should wear gown, gloves, and PAPR or fit-tested N95 mask and full face shield (eye protection)</td>
</tr>
<tr>
<td></td>
<td>• Providers should be trained in appropriate donning and doffing procedures</td>
</tr>
<tr>
<td>Optimize personnel</td>
<td>• Procedures should be performed expeditiously by experienced providers with the fewest assistants and trainees possible</td>
</tr>
<tr>
<td>Room air clearance</td>
<td>• Room air clearance times should be followed to ensure aerosolized virus has cleared prior to room entry by OR turnover personnel</td>
</tr>
<tr>
<td>Minimize virus aerosolization</td>
<td>• Airway management should include closed circuits when possible utilizing intermittent apnea and avoiding bag-mask ventilation</td>
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<tr>
<td></td>
<td>• Use of laser should be avoided</td>
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<tr>
<td></td>
<td>• Cough should be mitigated upon emergence from anesthesia</td>
</tr>
</tbody>
</table>

Abbreviation: PPE, personal protective equipment; PAPR, powered air-purifying respirator
Table 2. Laryngotracheal Stenosis Surgical Protocol in COVID-19

<table>
<thead>
<tr>
<th>Protocol Step</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid Sequence Induction</td>
<td>• Awake preoxygenation with 100% FiO₂ for 5 minutes followed by rapid sequence induction</td>
</tr>
<tr>
<td></td>
<td>• Avoid bag-mask and laryngeal mask ventilation</td>
</tr>
<tr>
<td>Direct Laryngoscopy&lt;sup&gt;a&lt;/sup&gt;</td>
<td>• Assess degree of laryngotracheal stenosis with rigid telescope</td>
</tr>
<tr>
<td>Initial Dilation</td>
<td>• Dilate stenosis with balloon or rigid dilators prior to intubation if airway diameter less than outer diameter of ETT&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>• Surgeon should be familiar with relative diameters of: lumen of chosen laryngoscope, available dilators, and outer diameter of ETT&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Initial Closed System with ETT Intubation</td>
<td>• Tracheal intubation with small cuffed ETT</td>
</tr>
<tr>
<td></td>
<td>• ETT loaded over rigid telescope may mitigate risk of false passage</td>
</tr>
<tr>
<td></td>
<td>• Once intubated ventilate with 100% FiO₂ to preoxygenate before apneic interventions</td>
</tr>
<tr>
<td>Laryngoscope Suspension</td>
<td>• Hold ventilation before disconnecting ETT and removing laryngoscope if closed laryngoscope used for intubation</td>
</tr>
<tr>
<td></td>
<td>• Reconnect circuit before reinserting and suspending laryngoscope</td>
</tr>
<tr>
<td>Intermittent Apnea</td>
<td>• Proceed with procedures that can be done while intubated, e.g. steroid injection/mitomycin application</td>
</tr>
<tr>
<td></td>
<td>• Intermittently extubate for balloon dilation/biopsy/excision</td>
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<tr>
<td></td>
<td>• Stop ventilation during end expiration prior to extubation</td>
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<tr>
<td></td>
<td>• Maintain neuromuscular blockade throughout the surgery</td>
</tr>
<tr>
<td></td>
<td>• ETT can be replaced directly through the operative laryngoscope between apneic interventions</td>
</tr>
<tr>
<td>Extubation</td>
<td>• Administer glycopyrrolate during procedure to minimize secretions</td>
</tr>
</tbody>
</table>
• Apply topical lidocaine to larynx and trachea upon completion of surgical procedure
• Intravenous lidocaine, opioids, sedatives at time of extubation to attenuate laryngeal and cough reflexes

\[ \text{Abbreviation: } \text{FiO}_2, \text{ fraction of inspired oxygen; ETT, endotracheal tube; THRIVE, trans-nasal humidified rapid-insufflation ventilatory exchanges} \]

\[ a \text{ May use closed operating laryngoscope or anesthesia laryngoscope blade} \]
\[ b \text{ Outer diameter of } 5.0 \text{ cuffed microlaryngeal tracheal tube is } 6.9 \text{ mm} \]
\[ c \text{ A } 28\text{-French Jackson laryngeal dilator (Pilling/Teleflex, Morrisville, NC) has an outer diameter } 9.3 \text{ mm and can be passed through a standard (male) Ossoff-Pilling laryngoscope (Pilling/Teleflex, Morrisville, NC)} \]