


# The Difficult Airway and Aerosol-Generating Procedures in COVID-19: Timeless Principles for Uncertain Times

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## Abstract

The impact of the COVID-19 pandemic on otolaryngology practice is nowhere more evident than in acute airway management. Considerations of preventing SARS-CoV-2 transmission, conserving personal protective equipment, and prioritizing care delivery based on acuity have dictated clinical decision making in the acute phase of the pandemic. With transition to a more chronic state of pandemic, heightened vigilance is necessary to recognize how deferral of care in patients with tenuous airways and COVID-19 infection may lead to acute airway compromise. Furthermore, it is critical to respect the continuing importance of flexible laryngoscopy in diagnosis. Safely managing airways during the pandemic requires thoughtful multidisciplinary planning. Teams should consider trade-offs among aerosol-generating procedures involving direct laryngoscopy, supraglottic airway use, fiberoptic intubation, and tracheostomy. We share clinical cases that illustrate enduring principles of acute airway management. As algorithms evolve, time-honored approaches for diagnosis and management of acute airway pathology remain essential in ensuring patient safety.

## Keywords

COVID-19, coronavirus, difficult airway, aerosol-generating procedures, SARS-CoV-2, novel coronavirus, tracheal stenosis, subglottic stenosis, laryngotracheal stenosis, flexible fiberoptic laryngoscopy, ultrasound, intubation, pandemic

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The COVID-19 pandemic has profoundly altered care delivery in otolaryngology–head and neck surgery,<sup>1</sup> raising dilemmas in airway diagnosis and management.<sup>2</sup> Concerns of viral transmission<sup>3</sup> have prompted modifications to intubation,<sup>4,5</sup> tracheostomy,<sup>6</sup> and endoscopic airway surgery.<sup>7</sup> We examine how pandemic-inspired modifications to otolaryngology practice may conflict with trusted diagnostic approaches. Even in a pandemic, the duty to deliver high-quality, patient-centered care persists. We also

highlight the importance of heightened vigilance in ensuring timely diagnosis and intervention for airway compromise amid COVID-19 infection.

## Case I: Foreign Body Airway Management

A 38-year-old woman presented after a fall during which she sustained blunt mandibular trauma, displacing her dental appliance. She reported throat and neck pain, gagging, and dysphagia. Neck films demonstrated an aspirated partial denture overlying the larynx (**Figure 1**). Staff suggested proceeding directly to surgery to avoid risk from aerosol-generating procedures including endoscopy; however, flexible laryngoscopy was performed with personal protective equipment, including fit-tested N95 respirators, eye protection, gowns, and gloves, which revealed the appliance situated over the arytenoid cartilages, partially obstructing the glottis, with clasps anchored in soft tissues of the oropharynx and supraglottic larynx. SARS-CoV-2 test results from polymerase chain reaction returned negative, and she was taken to the operating room, where the airway was secured with awake fiberoptic intubation. The appliance was removed endoscopically (**Figure 1**), and the patient was safely discharged to home.

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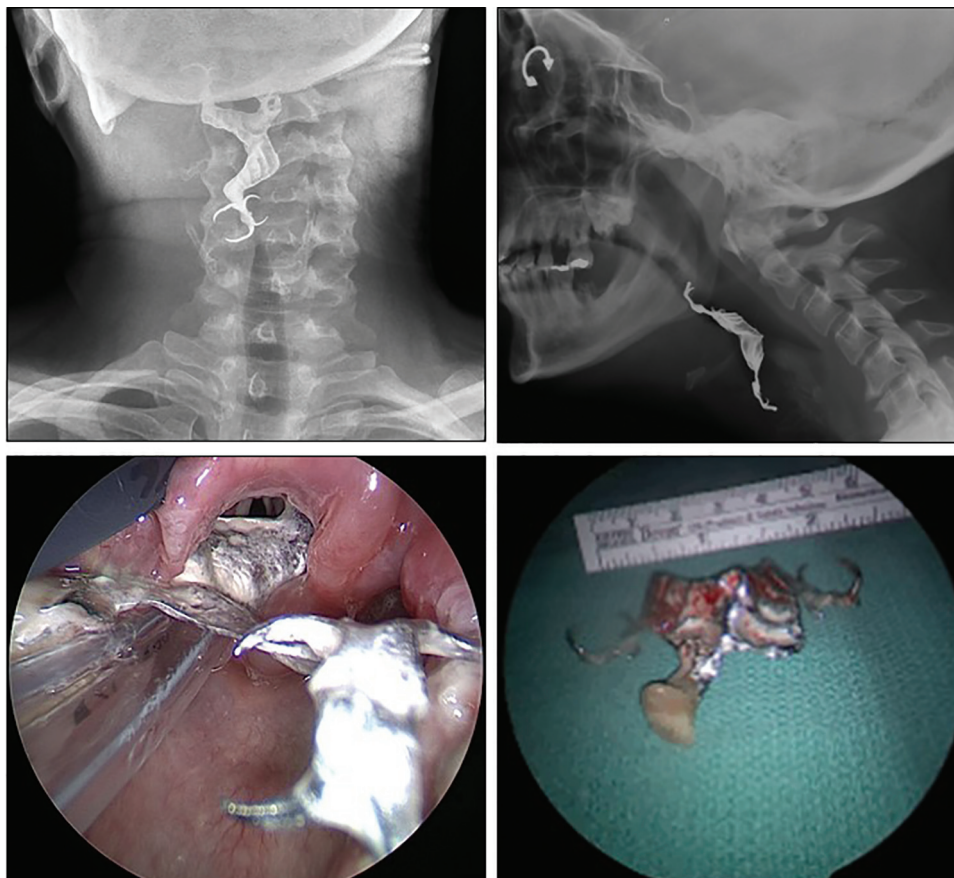
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**Figure 1.** Anterior-posterior (top left) and lateral (top right) neck films show radiopaque dental appliance partially obstructing the patient's supraglottic airway. Direct laryngoscopy view (bottom left) demonstrates the appliance overlying the arytenoids. The appliance is extracted (bottom right).

### Case 2: Infant With Bilateral Vocal Fold Immobility

An infant presented with persistent biphasic stridor after extubation following a tracheoesophageal fistula repair. As an alternative to flexible laryngoscopy (an aerosol-generating procedure), translaryngeal ultrasound was employed to evaluate vocal fold motion during an unsuccessful extubation attempt.<sup>8</sup> The ultrasound, which was performed by an expert operator mindful of respiration phase, suggested intact true vocal motion, and the patient was reintubated. After a second extubation attempt the following week, the patient developed progressive stridor and persistent need for respiratory support; subsequent flexible laryngoscopy confirmed bilateral true vocal fold immobility that was not identified on initial translaryngeal ultrasound. The patient underwent endoscopic airway intervention with improvement in symptoms.

### Case 3: Airway Compromise From COVID-19 Exacerbation of Tracheal Stenosis

A 67-year-old woman with long-standing tracheal stenosis after tracheostomy for angioedema (now decannulated) presented with severe dyspnea, cough, diarrhea, and fatigue.

The patient tested positive for SARS-CoV-2. Prior endoscopic dilations afforded only transient relief, and tracheal resection was planned but deferred due to the pandemic. She was admitted to the intensive care unit (ICU) with evolving acute respiratory distress syndrome, and the otolaryngology division was consulted for assistance with intubation. No recent imaging or airway examination findings were available, and reimaging was deferred due to COVID-19 status. After contacting her outside otolaryngologist, the otolaryngology, anesthesiology, pulmonary, and ICU teams coordinated her airway management plan. She was taken to the operating room emergently with preparations for intubation, bronchoscopy, tracheal dilation, and emergent tracheostomy. Ultimately, she was successfully intubated with a 6-0 endotracheal tube via video laryngoscopy after rapid sequence induction without bag mask ventilation. She had a prolonged hospital course requiring a tracheostomy, and she is scheduled for a tracheal resection.

### Case 4: Emergency Tracheostomy for Respiratory Distress in a Patient Positive for COVID-19

A 60-year-old woman with tracheal stenosis had suffered multiple exacerbations requiring intubation. She had



**Figure 2.** Cross-sectional computed tomography image demonstrates a roughly 2-cm short segment tracheal stenosis measuring 4 mm in maximum diameter.

undergone 2 bronchoscopies with tracheal dilation; however, these procedures did not achieve sustained improvement in airway patency. She was referred for tracheal resection and reanastomosis. The patient was admitted to the ICU with shortness of breath and increased work of breathing. She tested positive for SARS-CoV-2. Subsequent chest computed tomography demonstrated a 2-cm short segment tracheal stenosis, 4 mm in diameter (**Figure 2** and Supplemental Video). The patient's respiratory demands quickly escalated, requiring bag mask ventilation by the ICU team. The decision was made to proceed with an emergent tracheotomy, as the patient's short segment tracheal stenosis precluded safe intubation. Anesthesia and otolaryngology teams donned personal protective equipment, including powered air-purifying respirators,

gowns, and gloves. The patient's oxygenation was maintained, and emergent tracheotomy was performed via vertical incision through the length of the tracheal stenosis to determine inferiormost extent. A 6-0 Shiley tracheostomy tube was placed, and the patient was returned to the medical ICU team, with a plan for resection and reanastomosis of the stenotic segment.

## Discussion

These cases illustrate not only how COVID-19 infection may exacerbate preexisting airway pathology but also how changes to provision of care in the pandemic may conflict with countervailing principles of timely, patient-centered care. In the case with a complex airway foreign body, diagnostic flexible laryngoscopy was critical for planning how to secure the airway before extricating a dental appliance ensnared in soft tissues of the larynx and oropharynx. In the second case, diagnosis of bilateral vocal fold immobility was delayed, but flexible laryngoscopy allowed for definitive diagnosis and surgical intervention. Cases 3 and 4 reveal how COVID-19-induced exacerbation of airway narrowing resulted in high-risk, acute airway interventions.

These cases illustrate the challenges inherent in acute airway management in the COVID-19 era, while demonstrating the rationale for adhering to time-honored principles. Heightened vigilance is necessary in avoiding infectious transmission and ensuring the safety of patients. Patients with tenuous airways are at risk for delayed diagnosis, and departures from standard of care may occur amid operational barriers, uncertainty, and fear.<sup>9</sup> Safe airway management requires multidisciplinary collaboration between surgeons and anesthesiologists. Based on these experiences, we offer principles for safe airway management (**Table 1**). Rapid modification of practice may be necessary, but timely and equitable access to care is a foremost consideration in otolaryngology.<sup>10</sup>

**Table 1.** Timeless Principles for Definitive Airway Management.

Prioritize safety	<p>Prioritize safety of patient and multidisciplinary team in all airway planning, including procedural location, equipment, personnel, and personal protective equipment in pandemic.</p> <p>Identify patient- and system-specific considerations that may modify planning, including patient comorbidities; urgency for intervention; surgical history; and availability of negative pressure rooms, team members, and equipment.</p>
Select optimal diagnostics	<p>Consider sensitivity, specificity, and positive and negative predictive values of diagnostic processes; pretest probability is important.</p> <p>Proceed to definitive diagnostic modality when indicated (eg, when clinical suspicion and test results do not align) to ensure safe and accurate diagnosis.</p>
Promote timely care	<p>Advocate for timely care of patients with pathologic alterations to the airway, as a metastable airway may deteriorate precipitously.</p> <p>When a delay of definitive therapy is unavoidable, educate the patient and have a contingency plan in place in the event of acute airway deterioration.</p>
Plan for the unexpected	<p>Make contingency plans and conduct a timeout with all providers to ensure an understanding of the airway management and procedural plans and backups.</p> <p>Plan ahead and engage multidisciplinary teams in airway assessment, planning, and equipment availability, with case-specific procedural and safety details.</p>

## Author Contributions

**Joshua D. Smith**, conception, design, and drafting of the work, acquisition, analysis, and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Michelle M. Chen**, drafting and analysis and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Karthik Balakrishnan**, drafting and analysis and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Douglas R. Sidell**, drafting and analysis and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Arianna di Stadio**, analysis and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Samuel A. Schechtman**, drafting and analysis and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Robert M. Brody**, drafting and analysis and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Robbi A. Kupfer**, analysis and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Christopher H. Rassekh**, analysis and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work; **Michael J. Brenner**, conception, design, and drafting of the work, acquisition, analysis, and interpretation of data for the work; critically revising the work for important intellectual content; approval of the final submission; agreement to be accountable for all aspects of the work.

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## Supplemental Material

Additional supporting information is available in the online version of the article.

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