

# Impact of the COVID-19 Pandemic on Presentation, Management and Outcomes of Patients with Airway Stenosis

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## Background

Laryngotracheal stenosis (LTS) describes narrowing of the airway at one or more subsites, including the supraglottis, glottis, subglottis or trachea. Patients present with symptoms ranging from dysphonia/mild stridor to progressive dyspnea or asphyxiation.<sup>1</sup> Etiologies for LTS include congenital, idiopathic, iatrogenic (prolonged intubation, tracheotomy), traumatic, rheumatologic or neoplastic.<sup>2</sup> LTS is often treated surgically, with endoscopic or open procedures to improve or maintain airway patency.<sup>3,4</sup>

The impact of the SARS-CoV-2 (COVID-19) pandemic on the healthcare system has been significant, and may never be completely understood.<sup>5</sup> While the vast majority of positive COVID-19 cases were mild or asymptomatic, early estimates of pre-vaccine cases illustrated up to 14-17% of severe disease with acute respiratory distress syndrome (ARDS).<sup>6</sup> Many of these patients required endotracheal intubation, prolonged mechanical ventilation, and tracheotomy. Globally, there was a significantly increased number of patients requiring intensive care unit (ICU) level care with mechanical ventilation, at times overwhelming unit and hospital capacities. Limited understanding of the virus, especially early in the pandemic, may have changed or delayed standard protocols for avoiding prolonged intubation times and tracheotomy procedures. Elective procedures, especially highly aerosolizing procedures (such as those using jet-ventilators etc.) were cancelled or delayed. In addition to hospitals being overfilled, lockdowns, social distancing, and transportation limitations significantly affected the ability for non-COVID-19 patients to access routine healthcare for their chronic conditions.<sup>7</sup> This study seeks to identify differences in etiologies of airway stenosis, patterns of patient presentation, and outcomes before and after the onset of the pandemic. We hypothesized that there would be an increase in traumatic LTS after the onset of the pandemic, and that patients would present with more severe disease requiring an increased number of surgical interventions.

Variable	Total (n=204)	Pre-Pandemic (n=131)	Post-Pandemic (n=73)	p-value
Age (years)	56 [17-89]	55 [17-89]	56 [22-84]	0.9743
Number of female patients (%)	145 (71%)	94 (72%)	51 (70%)	0.7750
Race				0.9479
White	143 (70%)	93 (71%)	50 (68%)	
Black	49 (24%)	31 (24%)	18 (25%)	
Asian	3 (1%)	2 (2%)	1 (1%)	
Other	9 (4%)	5 (4%)	4 (5%)	
Ethnicity				0.2057
Hispanic/Latino	9 (4%)	4 (3%)	5 (6%)	
Non-hispanic/latino	195 (96%)	127 (97%)	68 (94%)	
BMI	29.5 [18.7-56.1]	29.4 [18.7-54.9]	29.6 [20.0-56.1]	0.6570
Smoking History				0.7325
Never	136 (67%)	85 (65%)	51 (70%)	
Current	4 (2%)	3 (2%)	1 (1%)	
Former	64 (31%)	43 (33%)	21 (29%)	
Comorbidities				
Hypertension	111 (54%)	64 (49%)	47 (64%)	0.0328*
Type 2 Diabetes	55 (27%)	31 (24%)	24 (33%)	0.1552
Heart Disease	45 (22%)	30 (23%)	15 (21%)	0.6976
Asthma	36 (18%)	20 (15%)	16 (22%)	0.2323
COPD	28 (14%)	18 (14%)	10 (14%)	0.9934
Cancer (all types)	27 (13%)	16 (12%)	11 (15%)	0.5641
OSA	41 (20%)	24 (18%)	17 (23%)	0.3961
Rheumatologic	17 (8%)	11 (8%)	6 (8%)	0.9649
GERD	100 (49%)	64 (49%)	36 (49%)	0.9498
Psychiatric	76 (37%)	40 (31%)	36 (49%)	0.0078*
Stenosis Etiology				
Congenital	3 (1%)	1 (1%)	2 (3%)	0.2610
Idiopathic	83 (40%)	55 (42%)	28 (38%)	0.6130
Acquired (intubation)	51 (25%)	33 (25%)	18 (25%)	0.9328
Acquired (tracheotomy)	85 (42%)	47 (36%)	38 (52%)	0.0247*
Acquired (total)	136 (67%)	80 (61%)	56 (77%)	0.1081
Rheumatologic	5 (2%)	4 (3%)	1 (1%)	0.4560
Stenosis Location				
Supraglottic	6 (3%)	5 (4%)	1 (1%)	0.3214
Glottic	59 (29%)	35 (27%)	24 (33%)	0.3523
Subglottic	126 (62%)	77 (59%)	49 (67%)	0.2397
Tracheal	91 (45%)	64 (49%)	27 (37%)	0.1021
Stenosis Duration				
<1 year	111 (54%)	65 (50%)	46 (63%)	0.0656
1-2 years	27 (13%)	17 (13%)	10 (14%)	0.8841
>2 years	66 (32%)	49 (37%)	17 (23%)	0.0388*
Trach history	64 (31%)	38 (29%)	26 (36%)	0.3295
History of COVID-19	30 (15%)	0 (0%)	30 (41%)	

Table 1. Summary of demographic and clinical data. COPD chronic obstructive pulmonary disease; OSA obstructive sleep apnea; GERD gastroesophageal reflux disease; COVID-19 coronavirus disease 2019

## Methods

This study was approved by the appropriate institutional review board. Patients who presented between January of 2017 and December of 2022 with LTS who underwent surgical treatment were included. Patients with history of laryngectomy were excluded. Patients were identified using ICD-10 codes for supraglottic, glottic, subglottic or tracheal stenosis who underwent surgical intervention. We documented demographic data including age, sex, race/ethnicity, BMI, smoking history, and comorbidities (hypertension, type 2 diabetes mellitus, heart disease, asthma, chronic obstructive pulmonary disease (COPD), malignancy, obstructive sleep apnea (OSA), rheumatologic disease, GERD, and psychiatric conditions). We documented the location of stenosis and the etiology, as well as duration of symptoms prior to presentation, history of prior tracheotomy, timing of presentation relative to the COVID-19 pandemic, and history of COVID-19 infection. Details regarding treatment course including surgical approach and treatment modalities, tracheotomy placement or maintenance of a previous tracheotomy at the conclusion of the procedure, decannulation, and need for multiple procedures were recorded and analyzed. The collected variables are summarized in Table 1.

We compared the data points highlighted above between patients in the pre-pandemic group to the post-pandemic group. Statistical analysis was performed using R studio (version 3.5.1, <https://cran.r-project.org>). Shapiro testing was performed to assess the normality of the data. Pairwise comparisons were made with Wilcoxon Rank Sum test for continuous variables, and Chi-Squared tests for dichotomous or categorical variables. Due to the number of pairwise comparisons, a Bonferroni correction was applied.

## Results

Variable	Total (n=204)	Pre-Pandemic (n=131)	Post-Pandemic (n=73)	p-value
Approach				0.8203
Endoscopic	187 (91%)	119 (92%)	67 (92%)	
Open	18 (9%)	12 (8%)	6 (8%)	
Endoscopic Procedure				
Laser	167 (82%)	103 (79%)	64 (88%)	0.1080
Dilation	119 (58%)	70 (53%)	49 (67%)	0.0573
Cold excision	35 (17%)	25 (19%)	10 (14%)	0.3167
Triamcinolone injection	68 (33%)	28 (21%)	40 (55%)	<0.00001**
Mitomycin	22 (11%)	19 (15%)	3 (4%)	0.0218*
Trach				
New trach	61 (30%)	34 (26%)	27 (37%)	0.0990
Trach present	72 (35%)	43 (33%)	29 (40%)	0.3228
Decannulation	33 (16%)	17 (13%)	16 (22%)	0.0964
Second procedure	110 (54%)	79 (61%)	31 (42%)	0.0143*
Total procedures	2 [0-13]	2 [0-13]	1 (1-12)	0.0008**

Table 2. Summary of outcome measures.

## Discussion

The pandemic led to a significant increase in respiratory disease requiring intubation and tracheotomy, and profoundly impacted routine patient follow-up for chronic conditions. We hypothesized that following the onset of the pandemic, rates and severity of iatrogenic LTS would significantly increase. However, the rate of LTS surgeries declined (0.12 procedures per day to 0.07 procedures per day). We believe this decline in procedure rate reflects an overall decrease in operative interventions during the early stages of the pandemic, rather than an actual decrease in disease prevalence. Due to restrictions in operating room time and jet-ventilation capabilities during the early pandemic, many of these patients were managed and temporized with office-based injections in lieu of surgery.

The severity of LTS was also not noted to be significantly different pre- and post-pandemic. No significant differences were found between the rate of open procedures, tracheotomy placement, or decannulation. This could reflect an improved ability to manage these patients endoscopically. Pre-pandemic patients were more likely to have a higher number of total procedures, likely from these patients having a longer period of follow-up. Acquired LTS from tracheotomy increased following the onset of the pandemic, likely as a result of COVID-19 infections, but this difference was not statistically significant at the adjusted  $\alpha$ . Post-pandemic patients were also significantly more likely to have intraoperative triamcinolone injection. This demonstrates a practice change made at our institution in 2018-2019, following reports describing the effect of serial office-based steroid injections for the management of idiopathic subglottic stenosis, and likely not a result of the pandemic.<sup>8-10</sup>

## Discussion

After the onset of the pandemic, patients were more likely to have anxiety or depression. This is consistent with studies that demonstrated increased levels of anxiety and depression in many countries.<sup>11</sup> Anxiety is frequently associated with dyspneic patients, including those with airway stenosis. We found increased rates of hypertension post-pandemic. Early studies demonstrated patients with hypertension were at higher risk for more severe COVID-19 infection.<sup>12</sup> As a result, more patients may have pursued diagnosis and treatment of hypertension. Higher levels of anxiety may also contribute to elevated blood pressure.

This study was limited by the retrospective nature, and relatively small sample size of patients. We were not able to accurately record and incorporate the severity of stenosis in this population due to incomplete and inconsistent documentation of grade. Previous literature suggests that stenosis severity is a major predictor of outcomes, including decannulation rate and need for additional procedures.<sup>13</sup> Our inability to include this variable limits the impact of the results of our current study. The current study window may simply be too short to fully appreciate the impact of the pandemic on the population of patients with LTS, and further research over a longer period of follow-up may be needed. Our region was significantly affected by the pandemic, but not to the same degree as some other major metropolitan areas. Further study on a larger population from other major metropolitan areas or geographic regions, or even comparing urban to suburban or rural healthcare systems is warranted to determine if there truly was a difference in LTS presentation and severity following the pandemic.

## Conclusions

- The COVID-19 pandemic had significant impact on the population.
- When comparing patients with LTS pre- and post-pandemic, there were no significant differences between patient presentation or outcomes.
- We did find an increased rate of tracheotomy acquired stenoses post-pandemic, though this difference failed to achieve statistical significance when correcting for the number of pairwise comparisons performed.
- Further study is warranted in a larger patient population from multiple cities to truly understand the impact of COVID-19 on LTS.

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