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COVID-19 Tracheostomy Outcomes

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Abstract

Objectives. (1) Assess overall COVID-19 mortality in ventilated patients with and without tracheostomy. (2) Determine the impact of tracheostomy on mechanical ventilation duration, overall length of stay (LOS), and intensive care unit (ICU) LOS for patients with COVID-19.

Study Design. Case series with planned chart review.

Setting. Single-institution tertiary care center.

Methods. Patients with COVID-19 who were ≥18 years old and requiring invasive positive pressure ventilation (IPPV) met inclusion criteria. Patients were stratified into 2 cohorts: IPPV with tracheostomy and IPPV with intubation only. Cohorts were analyzed for the following primary outcome measures: mortality, LOS, ICU LOS, and IPPV duration.

Results. An overall 258 patients with IPPV met inclusion criteria: 46 (18%) with tracheostomy and 212 (82%) without (66% male; median age, 63 years [interquartile range, 18.75]). Average LOS, time in ICU, and time receiving IPPV were longer in the tracheostomy cohort ($P < .01$). Ability to wean from IPPV was similar between cohorts ($P > .05$). The number of deaths in the nontracheostomy cohort (54%) was significantly higher than the tracheostomy cohort (29%, $P < .01$).

Conclusions. While tracheostomy placement in patients with COVID-19 did not shorten overall LOS, mechanical ventilation duration, or ICU LOS, patients with a tracheostomy experienced a significantly lower number of deaths vs those without. One goal for tracheostomy is improved pulmonary toilet with associated shortened IPPV requirements. Our study did not identify this advantage among the COVID-19 population. However, this study demonstrates that the need for tracheostomy in the COVID-19 setting does not portent a poor prognostic factor, as patients with a tracheostomy experienced a significantly higher survival rate than their nontracheostomy counterparts.

Keywords

COVID-19, tracheostomy, mechanical ventilation

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus causing coronavirus disease (COVID-19), created an unprecedented pandemic with many unknowns surrounding optimal management. While the majority of patients are asymptomatic or present with mild flu-like symptoms, approximately 20% to 25% experience severe acute respiratory distress syndrome, requiring admission to an intensive care unit (ICU) for respiratory support.[1] The rapid and sudden influx of patients, potentially requiring a high level of care, created a challenge for hospitals and health care systems. In response to the influx of patients with this novel illness, guidelines for COVID-19 care necessitated continual updating by the Centers for Disease Control and Prevention, World Health Organization, hospitals, and individual societies from around the world.

The potential need for intubation and respiratory support for long periods in patients with COVID-19 prompted extensive discussions surrounding the best protocol for tracheostomy. Tracheostomy has known benefits to patients requiring long-term mechanical ventilation: improved pulmonary toilet, reduced mechanical ventilation requirement, decreased laryngeal injury, and ability to improve comfort management by reducing the need for sedatives and paralytics.[2] As such, multiple protocols were published regarding tracheostomy in patients with COVID-19. These protocols largely focus on the timing of tracheostomy, as well as patient and provider safety with emphasis on limiting the spread of the virus during the procedure and postoperative tracheostomy care.[3] Early studies evaluated outcomes of patients with COVID-19 requiring tracheostomy; however, a direct comparison of mechanically ventilated cases with and without tracheostomy is lacking.[4,5] To better understand the implications of tracheostomy for intubated patients, this study aims to investigate the impact of tracheostomy on patients with COVID-19 requiring invasive positive pressure ventilation (IPPV) with respect to mortality, mechanical ventilation duration, and hospital as well as ICU length of stay (LOS).

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Methods

This case series with planned chart review was approved by the Temple University Institutional Review Board (protocol 27116). Data were collected via chart review at a single tertiary care center between February 2020 and December 2020. Patients were initially identified by *ICD-10* code U07.1 (COVID-19 diagnosis). Patients were included if they were at least 18 years of age, had a positive objective test result for COVID-19, and required IPPV. Objective COVID-19 testing consisted of a positive nasal or throat swab or computed tomography (CT) chest consistent with COVID-19. All chest CT scans were read by a faculty member from the Department of Radiology and graded as category 1 to 3: category 1, consistent with multifocal pneumonia, including viral/atypical pneumonia (ie, COVID-19); category 2, indeterminate; category 3, consistent with other diagnosis. This grading system was institution specific and formulated by the most common CT scan findings seen in patients with COVID-19 at the time of the study period.[6-8] For the purpose of this study, patients were included by CT scan alone if there was a radiologist's interpretation of category 1.[6-8] Patients were excluded if they had a preexisting tracheostomy or did not have adequate data available for primary outcome measures.

Patients were divided into 2 cohorts: patients requiring IPPV who underwent tracheostomy (tracheostomy cohort) and those who required IPPV but did not undergo tracheostomy (nontracheostomy cohort). Tracheostomies were performed by various services, such as cardiothoracic surgery, general surgery, and otolaryngology. The decision for tracheostomy placement was made by the attending physician on the consulting service. The primary indications consisted of prolonged intubation and ventilator-dependent respiratory failure based on hospital practices at the time. Descriptive statistics were used to define each cohort based on race, sex, smoking status, body mass index (BMI), and comorbidities (hypertension, diabetes mellitus, coronary artery disease, asthma, and malignancy).

Primary outcome variables were included mortality, overall hospital LOS, ICU LOS, and days requiring mechanical ventilation. A comparison of the 2 cohorts was conducted with Fisher's exact test for categorical data and 2-tailed Student's *t* test for continuous variables via an online calculation tool.[9] A *P* value of .05 was required to reach statistical significance.

Results

An overall 258 patients met inclusion criteria. The majority of patients were treated with IPPV alone, with 46 (18%) requiring tracheostomy. Demographics of the entire sample and a cohort comparison based on tracheostomy status are summarized in **Table 1**. There were 89 females (34%) and 169 males (66%). The median age was 63 years, and the interquartile range (IQR) was 18.75. The majority of patients were African American (n = 129, 50%) and never smokers (n = 150, 58%). The most common comorbidity was coronary artery disease (n = 141, 55%), followed by diabetes mellitus (n = 140, 54%). The median BMI for the sample was 29.5 (IQR, 11.1). There was no significant difference between groups with regard to age, ethnicity, sex, smoking status, or BMI. There were significantly more patients with diabetes in the tracheostomy cohort (n = 34, 74%) as compared with the nontracheostomy cohort (n = 106, 50%; $P = .003$). The majority of patients had a CT viral screen of category 1 (n = 170, 66%), followed by category 2 (n = 39, 15%) and category 3 (n = 22, 9%).

COVID-19–related treatments per group are summarized in **Table 2**. The majority of patients received corticosteroids (80%) and azithromycin (78%). Overall, 23% of patients requiring IPPV were treated on clinical trial. There were significantly more patients in the tracheostomy cohort treated with hydroxychloroquine (n = 18, 38%) vs the nontracheostomy cohort (n = 47, 22%; $P < .05$). Similarly, significantly more patients in the tracheostomy cohort were enrolled in a clinical trial (n = 24, 50%) when compared with the nontracheostomy cohort (n = 35, 17%; $P < .05$).

Tracheostomy-specific characteristics and outcomes are summarized in **Table 3**. Forty-six patients (18%) underwent tracheostomy placement. To limit patient transport, most tracheostomies were placed via a percutaneous approach in the ICU bedside setting. Only 2 patients required a cricothyrotomy prior to tracheostomy placement. The median time on mechanical ventilation prior to tracheostomy was 14 days (IQR, 6). Following tracheostomy placement, the majority of patients (54%) were weaned off mechanical ventilation at an average a median of 13 days (IQR, 10).

Outcome comparisons between the nontracheostomy and tracheostomy cohorts are summarized in **Table 4**. Median hospital LOS was 13 days (IQR, 12) and 30 days (IQR, 23), respectively ($P < .001$). Median ICU LOS was 6 days (IQR, 9) and 21 days (IQR, 16; $P < .001$). The number of deaths was 115 (54%) in the nontracheostomy cohort and 14 (29%) in the tracheostomy cohort ($P < .01$). Patients without a tracheostomy were intubated for a median 4 days, and 131 (62%) were weaned off the ventilator prior to discharge. Patients with a tracheostomy were intubated for a median 14 days (IQR, 6) prior to tracheostomy placement. Following tracheostomy, 25 patients (54%) were weaned off the ventilator at a median 13 days (IQR, 10) following tracheostomy placement. Total time intubated and total time on mechanical ventilation were significantly decreased in the nontracheostomy group ($P < .0001$). The number of patients weaned off mechanical ventilation did not differ between the cohorts ($P = .329$).

Outcome comparisons between early and late tracheostomy placement are summarized in **Table 5**. Early tracheostomy was defined as tracheostomy placement on or before day 13 of intubation (n = 21); the remaining 25 patients were classified as late tracheostomy. A statistically significant difference between groups was not identified with respect to overall LOS, ICU LOS, number of deceased patients, total time on the ventilator, ability to wean off the ventilator, and time on the ventilator following tracheostomy placement.

Table 1. Demographics and Clinical Characteristics.

	Patients, No. (%)			
	All (N = 258)	Nontracheostomy (n = 212)	Tracheostomy (n = 46)	*P* value
Age, y[a]	63 (18.75)	64 (18.25)	62.5 (15.75)	.96
Ethnicity (>1 allowed)				
Caucasian	43 (17)	37 (17)	6 (13)	>.99
African American	129 (50)	103 (49)	26 (56)	.41
Hispanic	57 (22)	47 (22)	10 (22)	>.99
Asian	48 (18)	40 (19)	8 (17)	>.99
Other	13 (6)	13 (6)	0	.13
Sex				
Female	89 (34)	71 (33)	18 (39)	.50
Male	169 (66)	141 (67)	28 (61)	.50
Smoking status				
Current	45 (17)	38 (18)	7 (15)	.83
Former	63 (24)	48 (22)	15 (33)	.18
Never	150 (58)	126 (60)	24 (52)	.41
Comorbidity				
Hypertension	112 (43)	90 (42)	22 (48)	.52
Diabetes	140 (54)	106 (50)	34 (74)	.003[b]
Coronary artery disease	141 (55)	118 (56)	23 (50)	.52
Asthma	31 (12)	28 (13)	3 (7)	.32
Malignancy	21 (8)	18 (8)	2 (4)	.75
Body mass index[a]	29.5 (11.1)	29.0 (10.7)	31.4 (10.3)	.10
Chest viral screen[c]				
Category 1	170 (66)	134 (63)	36 (78)	.06
Category 2	39 (15)	37 (17)	2 (4)	.02[b]
Category 3	22 (9)	21 (10)	1 (3)	.14
None available	27 (10)	20 (10)	7 (15)	.29

[a]Median (interquartile range).
[b]$P < .05$.
[c]Computed tomography.

Table 2. COVID-19 Treatments.

	Patients, No. (%)			
	All (N = 258)	Nontracheostomy (n = 212)	Tracheostomy (n = 46)	*P* value
Azithromycin	202 (78)	160 (75)	42 (88)	.02[a]
Remdesivir	35 (14)	25 (12)	10 (21)	.10
Corticosteroids	206 (80)	168 (79)	38 (79)	.69
Hydroxychloroquine	35 (14)	17 (8)	18 (38)	<.001[a]
Intravenous immunoglobulin	65 (25)	47 (22)	18 (38)	.02[a]
Clinical trial	59 (23)	35 (17)	24 (50)	<.001[a]

[a]$P < .05$.

Discussion

This study is one of the first to compare the outcomes of patients with COVID-19 requiring IPPV who did and did not undergo tracheostomy placement. This comparison in essential when determining the risk-benefit ratio of tracheostomy in the COVID-19 population. The benefit of tracheostomy in patients with prolonged intubation is well known, but in the setting of COVID-19, this has to be balanced with the risk of exposing health care workers, as well as the risk that the patient undergoes with this procedure, especially in the setting of low pulmonary reserve.

Table 3. Tracheostomy Characteristics (46 Patients).

	No. (%)
Tracheostomy technique	
Open	12 (26)
Percutaneous	34 (74)
Tracheostomy setting	
Operating room	17 (37)
Bedside	29 (63)
Required cricothyrotomy prior to tracheostomy	2 (4)
Time from intubation to tracheostomy, d[a]	14 (6)
Weaned from ventilator	25 (54)
Time on ventilator following tracheostomy, d[a]	13 (10)

[a]Median (interquartile range).

Table 4. Comparison Nontracheostomy vs Tracheostomy Groups.

	Patients, No. (%)			
	All (N = 258)	Nontracheostomy (n = 212)	Tracheostomy (n = 46)	*P* value
LOS, d[a]				
Hospital	14 (18.75)	13 (12)	30 (23)	<.001[b]
ICU	7 (13)	6 (9)	21 (16)	<.001[b]
Disposition				
Home	56 (22)	54 (25)	2 (4)	<.001[b]
Skilled nursing facility	32 (12)	26 (12)	6 (13)	.81
LTAC	17 (7)	0	17 (38)	<.001[b]
Death	129 (50)	115 (54)	14 (29)	.0053[b]
Hospice	8 (3)	7 (3)	1 (2)	>.99
Rehabilitation	11 (4)	5 (2)	6 (15)	.005[b]
Left AMA	5 (2)	5 (2)	0	.59
Total time, d[a]				
Intubated for nondeceased patients	5 (9)	4 (8)	14 (6)	.0001[b]
On ventilator	6 (14)	4 (8)	26 (13)	.0001[b]
Weaned off the ventilator	156 (60)	131 (62)	25 (54)	.41

Abbreviations: AMA, against medical advice; ICU, intensive care unit; LTAC, long-term assisted care.
[a]Median (interquartile range).
[b]$P < .05$.

Table 5. Outcomes Early vs Late Tracheostomy Placement.

	Patients, No. (%)		
	Early[a] (n = 21)	Late (n = 25)	*P* value
LOS, d[b]			
Hospital	32 (21)	36 (30)	.13
ICU	25.7 (10.8)	24 (14)	.44
Deaths	5 (24)	9 (36)	.52
Time on ventilator, d[b]	27.3 (22.3)	25.5 (13.8)	.84
Weaned off ventilator	13 (62)	12 (48)	.39
Time on ventilator after tracheostomy, d[b]	16 (16)	12 (9)	.09

Abbreviations: ICU, intensive care unit; LOS, length of stay.
[a]By day 13 of intubation.
[b]Median (interquartile range).

With respect to surgical intervention, the majority of tracheostomies in this study were placed via a percutaneous approach. Recent literature suggests increased aerosolization during this approach vs an open approach due to more extensive airway manipulation.[10] Chao et al, however, demonstrated the absence of health care worker transmission of COVID-19 with either approach as long as the appropriate personal protective equipment was utilized (airborne, contact, and droplet precaution level).[4] The majority of tracheostomies in this study were performed at the bedside, which is supported by prior literature if done in a negative pressure room, due to avoidance of unnecessary transport of patients and repeated connection and disconnection of ventilatory circuits during transfer.[10]

The current study suggests that, when compared with nontracheostomy status, tracheostomy placement did not shorten the total length of hospital stay, days on positive pressure ventilation, or length of ICU stay. While tracheostomy in patients without COVID-19 has traditionally been associated with improved pulmonary toilet and shortened IPPV requirements,[2] our study did not identify this advantage among the COVID-19 population.

Although need for surgical tracheostomy in the setting of IPPV is often associated with patients having declining clinical status and ultimately a higher mortality, the current data suggest that patients with COVID-19 and a tracheostomy experienced significantly fewer deaths than those who did not undergo tracheostomy. Therefore, the need for tracheostomy and use of early tracheostomy intervention in the COVID-19 setting should not be deemed a poor prognostic factor, as patients with a tracheostomy experienced a significantly higher survival rate vs their nontracheostomy counterparts.

Chao et al studied a cohort of 53 patients with COVID-19 who underwent a tracheostomy. They found an average time of 19 days from intubation to tracheostomy; furthermore, 56% of patients were able to be weaned from the ventilator, and the average time from tracheostomy to ventilator wean was 11.8 days.[4] The current study utilized a shorter average time from intubation to tracheostomy (13 days), and it identified a similar number of patients with a tracheostomy able to wean off the ventilator (54%) although at a slightly longer time following tracheostomy (14 days).

Kwak et al evaluated the outcomes of 148 patients with COVID-19 who underwent tracheostomy.[5] They found an average time of 12 days from intubation to tracheostomy placement, 33 days from intubation to time weaned off the ventilator, and 51 days for total length of hospital stay, as well as a mortality rate of 20%. We report a shorter LOS in our tracheostomy group (30 days; IQR, 23), which may be due to the higher percentage of patients (50%) on clinical trial. In addition, our findings differ from Kwak et al in that we found a higher death rate at 29%. Kwak et al also evaluated the effect of timing of tracheostomy placement on outcomes. They indicated that early tracheostomy (before day 10 of intubation) was noninferior to later tracheostomy placements. Early tracheostomy placement was associated with a shorter LOS, and the late tracheostomy group was 16% less likely to wean off mechanical ventilation.[5] The current study compared early tracheostomy placement (within 13 days of intubation) vs late and similarly found that early was noninferior to later placement. More so, there was no significant difference in outcomes between early and late placement. This finding may be due to the difference in definition of early and late tracheostomy placement between studies. Last, our study adds to the current literature by detailing tracheostomy characteristics, including the technique of tracheostomy placement (percutaneous vs open) and surgical setting (operating room vs bedside).

This study is limited by a lack of follow-up data after hospital discharge; therefore, late complications to include laryngotracheal stenosis and overall pulmonary status were not captured. This study commenced at the onset of our COVID-19 pandemic, and set criteria for associated surgical intervention with tracheostomy were not established. The decision for tracheostomy was made by the individual attending on the consulting service, which included 3 disciplines (cardiothoracic surgery, general surgery, otolaryngology). Because this is a post hoc study based on chart review, it is subject to the inherent selection bias of a nonrandomized study. While we tried to elucidate such biases by comparing patient demographics and characteristics to include BMI and comorbidities (**Table 1**), we acknowledge the potential for perceived healthier patients to receive the surgical intervention. Future randomized prospective studies would be helpful in further assessing this topic. Subtyping by COVID-19 variant was not available for comparison. In addition, the electronic medical record did not allow investigation of the rate of COVID-19 conversion, if any, among the surgeons and health care providers caring for the tracheostomy cohort.

In conclusion, this study is one of the first to directly compare outcomes of intubated patients with COVID-19 with and without tracheostomy placement. This study suggests that while tracheostomy placement does not appear to decrease length of hospital or ICU stay or time to wean from mechanical ventilation, placement of a tracheostomy does not portend a worse prognosis in the COVID-19 setting as compared with IPPV alone. Specifically, this subset of patients had an improved mortality rate vs their IPPV counterparts who did not undergo tracheostomy placement. Therefore, the surgical and medical team should proceed to tracheostomy placement based on individual patient needs and anticipated prognosis, similar to algorithms applied in the non–COVID-19 setting. As the pandemic continues with the introduction of new COVID-19 variants and we begin to understand the late sequela of the virus, future studies with larger sample sizes and longer follow-up will be essential to continue to understand the outcomes of patients with COVID-19 who undergo tracheostomy placement.

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Authors Contributions

Nicole Molin, design, conduct, analysis, presentation of research, writing of manuscript; **Keith Myers**, design, conduct, analysis, writing of manuscript; **Ahmed M.S. Soliman**, design, conduct, writing of manuscript; **Cecelia E. Schmalbach**, design, conduct, analysis, writing of manuscript.

Disclosures

Competing interests: Cecelia E. Schmalbach—AAO-HNS/F coordinator for research and quality; *Otolaryngology–Head and Neck Surgery*, editorial board and editor in chief–elect; teaching honorarium, AO North America CMF (nonprofit trauma teaching consortium).

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