ORIGINAL ARTICLE

https://doi.org/10.1590/1806-9282.20230832

First management of percutaneous dilatational tracheostomy in severe acute respiratory syndrome coronavirus 2 akin to the vital head and neck region and thyroid gland bed: trust, but be careful whom (you trust)?

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SUMMARY

OBJECTIVE: The objective of this study was to compare the clinical outcomes of percutaneous dilatational tracheostomy in COVID-19 and non-COVID-19 patients.

METHODS: A total of 48 patients who underwent percutaneous dilatational tracheostomy, with 24 COVID-19 patients (Group C) and 24 non-COVID-19 patients (Group N), were included in the study. Patients' demographic features including age and gender, time to intubation, duration of intubation, Acute Physiology and Chronic Health Evaluation scores, comorbidities, duration of opening tracheostomy, complications, duration of mechanical ventilation, length of stay in the intensive care units, and mortality were recorded and compared between the groups.

RESULTS: There was no statistically significant difference between the groups regarding age and gender (p=0.558 and p=0.110, respectively). Time to intubation was significantly more prolonged, and intubation follow-up duration was significantly shorter in Group C compared to Group N (p=0.034 and p=0.002, respectively). The Acute Physiology and Chronic Health Evaluation score was statistically significantly higher in Group N compared with Group C (p=0.012). The most common comorbidity was hypertension in 29 (60.4%) patients, followed by cerebrovascular disease in 19 (39.6%) patients. There was no statistically significant difference between the groups regarding mortality (p=0.212).

CONCLUSION: This study suggests that percutaneous dilatational tracheostomy can be performed safely in COVID-19 and non-COVID-19 patients. However, COVID-19 patients may have a longer time to intubation and shorter intubation follow-up duration than non-COVID-19 patients. The study also found a higher incidence of complications in COVID-19 patients undergoing percutaneous dilatational tracheostomy. These results emphasize the importance of careful patient selection, meticulous technique, and close postoperative monitoring in patients undergoing percutaneous dilatational tracheostomy, particularly in those with COVID-19.

KEYWORDS: Tracheostomy. Mechanical ventilation. Intensive care. COVID-19. Complications. Thyroidology.

INTRODUCTION

Percutaneous dilatational tracheostomy (PDT) was developed by Ciaglia et al.[1] over a guidewire in 1985. Since then, many renditions of this technique have come to the forefront, but none has been as famous as the original method[2]. PDT involves blunt dissection of tissues followed by dilatation of the trachea over the guidewire and placement of the tracheal cannula[3,4]. Proponents of PDT suggest that the limited dissection results in less damage lowers the risk of bleeding and wound infection and can be performed at the bedside in the intensive care units (ICUs), which may overcome the risk associated with transporting critically ill patients[5]. PDT is indicated to protect airways in patients at risk of aspiration, in anticipated prolonged mechanical ventilator stay, to facilitate

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Conflicts of interest: the authors declare there is no conflicts of interest. Funding: none.
Received on July 02, 2023. Accepted on July 04, 2023.

weaning in difficult-to-wean patients, and to minimize the need for sedation[6,7]. Complications related to the PDT procedure include bleeding, pneumothorax, incorrect cannula insertion, thyroid injury, and subcutaneous emphysema, with most of these minor complications. Absolute contraindications to PDT include cervical instability, infection at the planned insertion site, and uncontrolled coagulopathy[8-11]. The onset of the COVID-19 pandemic has resulted in an increased number of patients with severe acute respiratory distress syndrome in ICUs worldwide[12,13]. Patients with COVID-19 pneumonia often require mechanical ventilation in the ICU, and prolonged ventilation and difficulty in weaning warrant tracheostomy in these patients. With COVID-19, a new dimension has been added to the debate on the timing of PDT, given that tracheostomy can be an aerosol-generating procedure with a risk of spreading the infection to involved healthcare personnel. However, increasing evidence now suggests that the risk of a surgical team is shallow if the protective measures are carefully implemented[14-16]. To the best of our knowledge, this is the first study in the English-language literature comparing tracheostomy procedures between patients with and without COVID-19, concerning the vital head and neck region.

METHODS

Ethical aspects

This study was conducted according to the Declaration of Helsinki and approved by the Clinical Research and Ethics Committee linked to Giresun University, under the approval number E-90139838-000-148666.

Study design

The study population consisted of a total of 48 cases who had undergone PDT between September 2020 and January 2023, with 24 cases with and 24 without COVID-19. Patients over 18 years who had undergone PDT were included, whereas exclusion criteria were (i) under 18 years, (ii) severe hypercapnia, (iii) surgical tracheostomy, and (iv) missing data. Patients' demographic features including age, sex, time to intubation, Acute Physiology and Chronic Health Evaluation (APACHE) score, comorbidity, time for tracheostomy procedure, complication, time for mechanical ventilation, length of stay (LOS) in the ICU, and mortality were recorded and compared between the groups. The diagnosis of COVID-19 was established with the polymerase chain reaction test. The medical staff who performed tracheostomy in COVID-19 cases had used full personal protective equipment (PPE), face shield, N95 mask, and sterile surgical gloves.

Percutaneous dilatational tracheostomy procedure

The endotracheal tube replacement and oral aspiration were performed before the procedure. The patients were provided with adequate analgesia, sedation, and muscle relaxation, and the head and neck regions were then hyperextended in the supine position. The anterior cervical area was sterilized and covered, and 2 mL of the local anesthetic agent (lidocaine 20 mg+epinephrin 12.5 µg) was used before the incision of the procedure. An approximately 2 cm incision was performed between the cricoid cartilage and the suprasternal notch. Afterward, subcutaneous tissue was separated with a hemostat until the tissue surrounding the trachea was exposed. The trachea was separated from the muscles and a 5 mL syringe with a guidewire was filled with 3 mL saline. Of note, a small-diameter dilator over the guidewire widened the tracheal opening, and the skin and subcutaneous tissue were dilated at least twice with dilatation forceps. The dilatation forceps were then inserted gently into the trachea over the guidewire, and dilatation was performed. Finally, a lubricated tracheostomy cannula was placed over the guidewire and into the trachea after providing bleeding control and adequate patency. After ventilation of the patient was observed, a pressure dressing was applied, and tube fixation was performed by surgical suturing.

Statistical analysis

The data of all patients were entered into a Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) spreadsheet and statistically analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0 (SPSS, IBM Inc., Chicago, IL, USA) software. The normality of the variables was tested using the Shapiro-Wilk test. Continuous variables were expressed as mean, standard deviation, or median (25–75 percentile) according to their distribution status, and categorical variables were expressed as numbers and percentages. The independent-sample t-test was used where parametric test assumptions were met in the analysis of continuous variables; otherwise, the Mann-Whitney test was used. The chi-square or Fisher's exact test was used to analyze categorical variables, and $p<0.05$ values were considered statistically significant.

RESULTS

This retrospective study incorporated 48 patients who had undergone PDT from April 2023 to May 2023. A sum of 24 cases with COVID-19 ($wCVD_{19}$) pneumonia was assigned to Group C, while those without COVID-19 ($woCVD_{19}$) pneumonia were set to Group N. No statistically significant difference between them in terms of age and sex based

on their demographic features was recognized (p=0.558 and p=0.110, respectively). However, the time to intubation was significantly more prolonged, and the intubation follow-up duration was significantly shorter in Group C compared with Group N (p=0.034 and p=0.002, respectively). The APACHE score was statistically significantly higher in $woCVD_{19}$ compared with $wCVD_{19}$ (p=0.012) (Table 1). The most common comorbidity was hypertension in 29 (60.4%) cases, followed by CVD in 19 (39.6%). There was no statistically significant difference between the two groups in terms of comorbidities (for all, p>0.05) (Table 2). The duration of the tracheostomy procedure was statistically significantly longer in wCVD19 (p<0.001). A total of 18 cases in wCVD19 and 6 in $woCVD_{19}$ had developed complications, i.e., 3 developed pneumothorax and 12 had bleeding, while 3 had subcutaneous emphysema in $wCVD_{19}$. In comparison, two developed pneumothorax, three had bleeding, and one had subcutaneous emphysema in $woCVD_{19}$. A statistical significance between the groups based on the complication status and bleeding parameters has been recognized as the tracheostomy complications were evaluated in detail (p<0.05). Contrarily, "pneumothorax" and "subcutaneous emphysema" parameters were detected to be similar between them (p>0.05) (Table 3). The duration of mechanical ventilation and LOS in the ICU was significantly higher in $woCVD_{19}$ (p=0.001 and p=0.002, respectively). The mortality rate was 62.5% (n=15) in wCVD19, whereas it was 37.5% (n=9) in $woCVD_{19}$. However, no significant difference was noticed between them regarding discharge events (p=0.212) (Table 3).

Table 1. The intubation statuses with demographic characteristics of the cases.

Characteristic features	$wCVD_{19}$	$woCVD_{19}$	p-value
Sex, n (%)			
Male	15 (62.5%)	13 (54.2%)	0.558
Female	9 (37.5%)	11 (45.8%)	
Age (years)	61 (47–77)	76 (56–85)	0.110
Time to intubation (days)	8 (5–13)	5 (2–10.5)	0.034
Intubation follow-up (days)	14.8±6.7	20.8±6.3	0.002
APACHE score	12 (6–19)	19 (15–23)	0.012

The categorical variables were presented as n (%), while continuous variables were expressed as mean±SD or median (25–75 percentiles), The χ^2 test was used for categorical variables, while the t-test or Mann-Whitney U test was used for continuous variables.

DISCUSSION

The coronavirus disease was initiated when the Wuhan Municipal Health Commission reported 27 pneumonia cases with an unknown etiology on December 31, 2019, and Chinese scientists named this phenomenon that led to atypical pneumonia, i.e., severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This disease, which originates from coronavirus, was named COVID-19 by the World Health Organization (WHO), on February 11, 2020, and accepted as a pandemic on March 11 which had spread quickly in more than 150 countries, has created an international public health problem.

The preliminary outcomes of this study revealed that the time to intubation was longer (8 vs. 5 days), while the duration of intubation was shorter (14.8 vs. 20.8 days) in wCVD19

Table 2. Comorbidities of the cases in accordance with the study groups.

Comorbidity		$wCVD_{19}$	$woCVD_{19}$	p-value
Hypertension, n (%)	No	10 (41.7%)	9 (37.5%)	0.768
	Yes	14 (58.3%)	15 (62.5%)	
CVD, n (%)	No	15 (62.5%)	14 (58.3%)	0.768
	Yes	9 (37.5%)	10 (41.7%)	
COPD, n (%)	No	22 (91.7%)	17 (70.8%)	0.137
	Yes	2 (8.3%)	7 (29.2%)	
DM, n (%)	No	19 (79.2%)	19 (79.2%)	1
	Yes	5 (20.8%)	5 (20.8%)	
CAD, n (%)	No	21 (87.5%)	21 (87.5%)	1
	Yes	3 (12.5%)	3 (12.5%)	
Epilepsy, n (%)	No	20 (83.3%)	18 (75.0%)	0.724
	Yes	4 (16.7%)	6 (25.0%)	

The χ^2 test or Fisher's exact test was used for categorical variables, and the categorical variables were shown as n (%). CVD: cerebrovascular disease; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; CAD: coronary artery disease.

Table 3. The procedures of tracheostomy with their supportive appendages.

Characteristics	Group C	Group N	p-value
Tracheostomy opening duration (min)	19.9±3.6	14.9±1.7	<0.001
Tracheostomy complication, n (%)			
No	6 (25.0%)[a]	18 (75.0%)[b]	0.006
Pneumothorax	3 (12.5%)[a]	2 (8.3%)[a]	
Bleeding	12 (50.0%)[a]	3 (12.5%)[b]	
Subcutaneous emphysema	3 (12.5%)[a]	1 (4.2%)[a]	
Mechanical ventilation duration (days)	41.3±20.7	68.2±31.6	0.001
Length of stay in the ICU (days)	50.6±24.7	79.5±34.9	0.002
Discharge, n (%)			
Other ICU	6 (25.0%)	9 (37.5%)	0.212
Mortality	15 (62.5%)	9 (37.5%)	
Ward	3 (12.5%)	6 (25.0%)	

While continuous variables were expressed as mean±SD, categorical variables were presented as n (%). The chi-square test was used for categorical variables, while the t-test was used for continuous variables. Each same superscript (a, b) denotes a subset of group categories that are not statistically significantly different from each other at the p=0.05 level.

compared with woCVD19. In a study by Tang et al.[16], the intubation time was 17.5 days in wCVD19. Similar to our study, some authors reported that the duration from intubation to tracheostomy was 15.24 days in woCVD19. In addition, we declared that the median APACHE II score was 12 in wCVD19, while it was 19 in woCVD19, and the APACHE score was significantly lower in wCVD19 (p=0.012). In the study by Koc, the median APACHE II score was 32.35 in $woCVD_{19}$[17]. Different study results might be due to diverse patient populations and methodology.

The incidence of comorbidities increases with aging. In our study, the most common comorbidity was hypertension, followed by CVD. The other comorbidities included chronic obstructive pulmonary disease, diabetes mellitus, coronary artery disease, and epilepsy. In a study by Battaglini et al. with $wCVD_{19}$ undergoing tracheostomy, the most common comorbidity was hypertension, followed by diabetes mellitus and chronic cardiac disease[18]. Our result was similar to the previous studies. The mean duration of mechanical ventilation was 41.3 days in $wCVD_{19}$ and 68.2 days in $woCVD_{19}$, while in a study by Mahmood et al.[19] with 118 $wCVD_{19}$ undergoing tracheostomy, the median duration of mechanical ventilation was 36 days. Different results among the studies were attributed to differences in patient populations.

In this study, the mean LOS in the ICU was 50.6 in $wCVD_{19}$ and 79.5 in $woCVD_{19}$. Similarly, in a study by Koc et al.[17] with $woCVD_{19}$, the mean LOS in the ICU was found as 53.5 days, while in a study by Battaglani et al.[18] with $wCVD_{19}$ receiving PDT, the median LOS was reported as 30 days. Minimizing complications of endotracheal intubation and mechanical ventilation in the ICU is essential. These complications should be detected quickly, and necessary surgical intervention should be performed through neck exploration without delay. PDT is preferred in prolonged intubation cases to ensure the patients' airway safety and comfort. PDT is preferred for its advantages, including low complication rates and short opening time[20]. In this study, the most common complications of PDT were pneumothorax, bleeding, and subcutaneous emphysema[21], while in a study by Battaglani et al.[18], the most common complications were bleeding, stoma infection, and pneumothorax. In a study by Mahmood et al.[19], the most common complications in $wCVD_{19}$ receiving tracheostomy included bleeding, dislodgement of tracheostomy, and pneumothorax.

The mortality rate of this study was 62.5% in $wCVD_{19}$ and 37.5% in $woCVD_{19}$. There was no significant difference between the patients in terms of mortality, while in a study by Mahmood et al.[19], the mortality rate in $woCVD_{19}$ receiving PDT was 15.2%. Our higher mortality rate in $wCVD_{19}$ was attributed to the relatively small number of patients.

Study limitations

The main limitations of this study include the small number of patients and is conducted as a retrospective study in a single center. In addition, early and late PDT could not be examined separately. On the contrary, the strength is that this is the first study in the literature comparing the PDT procedure between $woCVD_{19}$ and $woCVD_{19}$ undergoing PDT.

CONCLUSION

Our study provides important insights into the safety and efficacy of PDT in $wCVD_{19}$ and $woCVD_{19}$. We recommend that clinicians follow the guidelines for tracheostomy in $wCVD_{19}$, including appropriate PPE and a multidisciplinary approach. Future studies with larger sample sizes are needed to confirm our findings and optimize the management of critically ill patients requiring tracheostomy during the COVID-19 pandemic. In summary, our study adds to the growing body of evidence on managing $wCVD_{19}$ and underscores the importance of continued research to improve patient outcomes in this challenging population.

AUTHORS' CONTRIBUTIONS

TA: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft. **HY:** Investigation, Methodology, Project administration, Validation, Visualization. **DS:** Investigation, Methodology, Software, Supervision, Visualization, Writing – original draft, Writing – review & editing. **IS:** Investigation, Methodology, Software, Supervision, Visualization, Writing – review & editing. **MA:** Investigation, Validation, Visualization. **SE:** Investigation, Validation, Visualization. **AM:** Investigation, Validation, Visualization. **EC:** Investigation, Validation, Visualization.

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