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Bronchoscopy guided percutaneous dilatational tracheostomy; performed by anesthesiology residents

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ABSTRACT

Aims: Percutaneous dilatational tracheostomy can be performed safely at the bedside in critical patients today. Clinical studies on tracheostomy were mostly carried out by experienced healthcare professionals. This study was designed to investigate the differences of percutaneous dilatational tracheostomy performed by anesthesiology residents using two different methods.

Methods: Patients hospitalized in anesthesia intensive care unit who underwent percutaneous tracheostomy were examined. All tracheostomy procedures were performed by anesthesiology residents using the "Griggs" or "Ciaglia" method. The procedure time, difficulty and complications of both methods were recorded.

Results: 38 patients were included in the study. It was observed that 22 of the patients had tracheostomy with the Griggs technique, and 16 with the Ciaglia technique. Tracheostomy application time was measured as 6.05 minutes with the Griggs technique and 6.35 minutes with the Ciaglia technique (p=0.939). There was no difference in complications and technical difficulties between the two methods.

Conclusion: In this study, where bedside bronchoscopy guided percutaneous dilatational tracheostomies were applied by two different methods by anesthesiology residents, no difference was found between the two methods in terms of complications and technical difficulties. We believe that "Griggs" and "Ciaglia Blue Rhino", two of the percutaneous dilatational tracheostomy methods, are not superior to each other in terms of ease of use and complications in anesthesiology education.

Keywords: Anesthesiology, bronchoscopy, critical care, education, tracheostomy

Preliminary data for this study were presented as a poster presentation at the National Congress of the Turkish Society of Intensive Care, online conference 10-15 September 2020.

INTRODUCTION

Percutaneous dilatational tracheostomy (PDT) is a procedure that can be performed safely at the bedside in critical patients today. It is mostly applied in patients who require mechanical ventilation due to respiratory failure. There are various views related to PDT indications, timing, and ideal technique selection. Many PDT methods are used today, and each of them has complications at various levels.[1,2]

The single-step dilatation method and forceps dilatation method are among the most used methods. The single-step dilatation method is referred to as "Ciaglia Blue Rhino Single-step" (CBR), and it has been used since 2004.[3] The forceps dilatation method is called the "Griggs Technique", and it was defined in 1990.[4] There are many studies in the literature comparing the two methods.[5,6] In some of these studies, bronchoscopy was used during PDT.[7,8]

When the literature on percutaneous dilatational tracheostomy was reviewed, it was seen that the tracheostomy procedure was mostly carried out by experienced healthcare professionals.[9,10]

The hypothesis of this study is that there are significant differences between the Griggs technique and the CBR method in bronchoscopy-guided PDT procedures, in terms of procedure success, complication rates, and execution times. The comparison of these two methods, conducted by anesthesiology residents, can provide clearer information for the selection of the ideal technique and may have significant implications in the care of critically ill patients.

In this study, we aimed to retrospectively evaluate patients who underwent bedside bronchoscopy guided percutaneous dilatational tracheostomy with Griggs and Ciaglia Blue Rhino methods by anesthesiology residents and to examine the differences between the two methods.

METHODS

The study was approved by the appropriate University of Health Sciences Dr. Abdurrahman Yurtaslan Ankara Oncology Health Practice and Research Center Clinical Researches Ethics Committee (Date: 13.01.2021, Decision No: 2021-01/940). Written informed consent obtained from all patients or their legal proxy. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Files of all the patients who electively underwent bronchoscopy guided percutaneous dilatational tracheostomy between June 2018 and December 2019 in Anesthesiology Intensive Care Unit, were examined retrospectively. The groups were named as "Griggs group" and "CBR group".

In our clinic, all bedside tracheostomies were performed by anesthesiology residents through percutaneous dilatation using Griggs or CBR technique. The procedure was accompanied by an anesthesiologist experienced in PDT, and bronchoscopy was carried out by a third anesthesiologist. The demographic data of the patients, PDT indications, APACHE II and SOFA scores of the procedure day, pre-procedure hemoglobin, thrombocyte, fibrinogen, aPTT and INR results were recorded from the intensive care follow-up forms. The tracheostomy follow-up form of the patient who was applied tracheostomy was examined from the patient records. From the tracheostomy follow-up form, information about cardiac arrhythmia, pulse oximetry and invasive or non-invasive blood pressure monitoring, arterial blood gas results before and after the procedure, ventilator parameters (PIP; peak inspiratory pressure, PEEP; positive end-expiratory pressure, Cdyn; dynamic compliance), MAP (mean arterial pressure) before the procedure, the lowest and highest MAP during the procedure, and the lowest SpO_2 during the procedure, ephedrine requirement, amount of bleeding, complications, technical difficulties related to the procedure and hemoglobin value of the patient, which was measured twenty-four hours after the procedure, were recorded. It was observed that anesthesia and analgesia were provided adequately during the procedure (midazolam, fentanyl, propofol and rocuronium). As the percutaneous tracheostomy kit, Portex (Blue Line Ultra, Percutaneous Tracheostomy Kit) was used for the Griggs method and Rüsch (PercuQuick set Worthley) for the CBR method. It was observed that all the patients were administered a mixture of local anesthesia and adrenaline (60 mg lidocaine, 30 mcg adrenaline) during the procedure. The time between the skin puncture of the needle and the placement of the tracheal cannula was recorded as duration of procedure.

Statistical Analysis

Statistical analysis was performed with SPSS 24.0. The normal distribution of continuous data was evaluated with the Kolmogorov-Smirnov test, and homogeneity was evaluated via the One-way ANOVA test. Independent t-test and Mann-Whitney test were applied in the analysis of the independent variables. The Wilcoxon test was used in the analysis of dependent variables. The Chi-square test was used in categorical data. $p<0.05$ was considered statistically significant in all tests.

RESULTS

38 patients were included in the study. It was observed that 22 of the patients had PDT with the Griggs technique, and 16 with the CBR technique. When the reasons for performing tracheostomy were reviewed, it was understood that PDT was performed in thirty-three patients (86.8%) due to prolonged mechanical ventilator therapy, in four patients (10.5%) due to their neurological condition, and in one patient (2.6%) for tracheobronchial aspiration. The mean time during which the patients were followed up in intubation before tracheostomy was 10.9 (±4.5) days; the APACHE II mean score was calculated as 23.6 (±6.6), SOFA mean score as 6.0 (±2.6), and mean age as 66.4 (±15.3) years.

Age, gender, body mass index (BMI), intubation time, APACHE II and SOFA score, dynamic compliance, PaO_2/FiO_2 ratio, platelet count, aPTT, INR and fibrinogen values of the groups are shown in Table 1.

Table 1. Demographic data, laboratory results (mean values)

	Griggs (n=22) (min-max)	CBR (n=16) (min-max)	p
Age; year	65.2 (40-89)	67.9 (38-89)	0.525
Gender (female: male)	12:10	9:7	0.590
BMI; kg/m^2	26.1 (17-34)	26.0 (20-34)	0.824
Intubation duration; day	10.6 (3-22)	11.4 (6-16)	0.556
APACHE II	23.1 (14-36)	24.2 (14-43)	0.618
SOFA	6.7 (2-13)	5.0 (3-8)	0.052
Cdyn; mL cmH_2O^{-1}	36.5 (17-96)	28.5 (10-45)	0.190
PaO_2/FiO_2; cmH_2O	205 (88-359)	203 (113-385)	0.935
Platelet; 1000 mm^3	217 (75-387)	217 (113-385)	0.500
aPTT; second	28.7 (18-80)	28.4 (21-51)	0.291
INR	1.2 (0.9-1.8)	1.1 (0.7-1.5)	0.073
Fibrinogen; mg dl^{-1}	341 (88-622)	473 (193-803)	0.045

CBR; Ciaglia Blue Rhino, BMI; body mass index, APACHE; acute physiological and chronic health assessment, SOFA; sequential organ failure evaluation, Cdyn; dynamic compliance, PaO_2; partial arterial oxygen pressure, FiO_2; Fraction of inspired oxygen, aPTT; activated partial thromboplastin time, INR; international normalized ratio.

The comparisons of hemoglobin values in both groups before and after the procedure are shown in Figure.

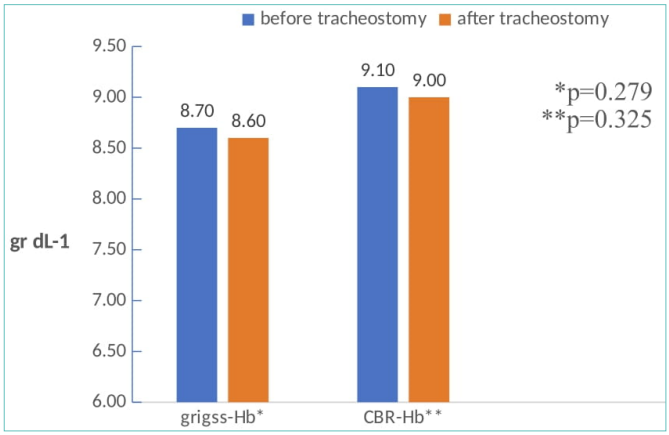

Figure. The comparisons of hemoglobin values

The hemodynamic, neurological, laboratory and ventilation values of the Griggs and CBR groups before and after the procedure and the data related to the anesthetic and analgesic drugs used during the procedure and the duration of procedure are given in Table 2. PDT procedure time was measured as 6.05 minutes with the Griggs technique and 6.35 minutes with the CBR technique (p=0.939). Data showing the complications of the Griggs and CBR techniques are given in Table 3.

Table 2. Hemodynamic, neurological, laboratory and ventilation values before and after the procedure, drugs used, duration of the procedure in Griggs and CBR groups (mean values)

	Griggs (n=22) (min-max)	CBR (n=16) (min-max)	p
Procedure time; minute: second	6:05 (3:40-10:00)	6:35 (4:20-13:00)	0.939
GCS, pre-procedure	10.1 (4-15)	11.5 (2-15)	0.976
GCS, post-procedure	10.9 (4-15)	11.4 (5-15)	0.803
MAP, pre-procedure; mmHg	83.2 (60-104)	76.7 (60-101)	0.203
MAP, lowest value during procedure; mmHg	67.7 (37-102)	63.0 (36-100)	0.391
MAP, highest value during procedure; mmHg	92.7 (56-125)	90.0 (68-120)	0.813
Peak inspiratory pressure, pre-procedure; cmH_2O	23.2 (12-35)	31.8 (17-57)	0.017
Peak inspiratory pressure, post-procedure; cmH_2O	22.9 (10-33)	33.5 (12-56)	0.004
PEEP, pre-procedure; cmH_2O	8.3 (5-12)	8.7 (5-14)	0.729
PEEP, post-treatment; cmH_2O	8.6 (6-12)	8.6 (5-13)	0.962
PaO_2/FiO_2, pre-procedure	205 (88-359)	203 (113-385)	0.918
PaO_2/FiO_2, post-procedure	185 (85-337)	190 (90-348)	0.929
pH, pre-procedure	7.47 (7.22-7.56)	7.47 (7.34-7.59)	0.929
pH, post-procedure	7.45 (7.20-7.60)	7.41 (7.20-7.60)	0.173
Lactate, pre-procedure; mmol L^{-1}	1.7 (0.5-5.7)	1.2 (0.3-2.5)	0.104
Lactate, post-procedure; mmol L^{-1}	1.6 (0.6-5.0)	1.3 (0.3-2.4)	0.519
Hemoglobin, pre-procedure; g dl^{-1}	8.7 (7.9-10.2)	9.1 (7.0-12.0)	0.771
Hemoglobin, post-procedure 24th hour; g dl^{-1}	8.6 (6.9-10.7)	9.0 (6.8-14.0)	0.988
The lowest SpO_2 during the procedure; %	92 (74-99)	94 (84-98)	0.363
Ephedrine; mg	2.5 (0-20)	7.2 (0-40)	0.250
Fentanyl; mcg	68 (15-100)	88 (50-150)	0.027
Propofol; mg	115 (50-200)	145 (80-250)	0.142
Rocuronium; mg	56 (50-130)	63 (50-100)	0.225

CBR; Ciaglia Blue Rhino, GCS; Glasgow coma score, MAP; mean arterial pressure, PEEP; positive end-expiratory pressure, PaO_2; partial arterial oxygen pressure, FiO_2; Fraction of inspired oxygen, SpO_2; oxygen saturation measured by pulse oximetry

Table 3. Complications of Griggs and Ciaglia Blue Rhino groups

	Griggs (n=22) (%)	CBR (n=16) (%)	p
Arrhythmia, number	1 (4.5)	0	0.579
Number of patients receiving noradrenaline	4 (18.2)	1 (6.3)	0.286
Bleeding >10 ml	2 (9.1)	1 (6.3)	0.604
Bleeding; major	0	0	-
Subcutaneous emphysema	0	0	-
Pneumothorax	1 (4.8)	1 (6.3)	0.685
Esophageal perforation	0	0	-
Tracheal posterior wall damage	0	0	-
Guide wire curling	4 (19.0)	0	0.091
Tracheal ring damage	6 (28.6)	4 (25)	0.555
Excessive stoma dilatation	0	0	-
Switching to another technique	0	0	-
Difficult cannula placement	1 (4.8)	2 (12.5)	0.396
Difficult stoma dilatation	3 (14.3)	4 (25)	0.342
Tracheal stenosis	1 (4.8)	0	0.568
Stoma infection	0	0	-
Late bleeding	0	0	-
Transfer to service	6 (27.3)	2 (12.5)	0.245
Exitus	15 (68.2)	10 (62.5)	0.490

CBR; Ciaglia Blue Rhino

DISCUSSION

In this study, where the patients who were applied bronchoscopy guided percutaneous dilatational tracheostomy with the Griggs and Ciaglia Blue Rhino methods by anesthesiology residents were retrospectively evaluated, no difference was found between the two methods in terms of duration of procedure and complications.

Elective tracheostomy is a common procedure applied frequently for prolonged mechanical ventilation in critically ill patients in intensive care. With the emergence of the Seldinger guidewire technique, PDT has almost replaced surgical tracheostomy. Many percutaneous tracheostomy techniques are used today. Ciaglia Blue Rhino and Griggs techniques are also among the methods preferred frequently.[11]

Many authors defend the use of bronchoscopy to view the correct placement of the needle, guidewire, dilator, and tracheostomy cannula. Moreover, the use of bronchoscopy may prevent the damage likely to occur on the posterior tracheal wall. Decreased ventilation, carbon dioxide retention, increased airway pressure, and increased cost can be counted among the disadvantages of bronchoscopy. Furthermore, it is necessary to be careful in patients with acute neurological symptoms or requiring high ventilator pressure and oxygen adjustment. In some European countries such as Germany and UK, the rate of using bronchoscopy during PDT is above 80%. In Spain, the rate of using bronchoscopy drops to 16%.[12] In Turkey, the rate of using bronchoscopy during PDT is 24%.[12]

In our study, we observed that PDT was applied to 33 of 38 tracheostomy patients due to prolonged mechanical ventilator therapy. When the data in Europe and the world are reviewed, it is seen that prolonged mechanical ventilator treatment is in the first place among the reasons for applying tracheostomy.[12,13]

There is no consensus on the time of performing tracheostomy[14] In a meta-analysis on approximately two thousand patients from nine studies, it was shown that early tracheostomy did not cause any decrease in mortality, length of stay in intensive care unit, ventilator-associated pneumonia and mechanical ventilation day compared to late tracheostomy[15] In a review published by Adly et al. in 2017, early tracheostomy (<7 days) in adult patients was shown to reduce nosocomial pneumonia, mortality, length of stay in intensive care unit and mechanical ventilation day[16] The average follow-up of the patients in our study with an endotracheal tube before tracheostomy was found as 10.9 days (±4.4).

In the publications where the Griggs and CBR techniques, which are the two methods we used in our study, were compared, we saw that PDT was previously performed by people who were experienced in this field.[5-7] In these studies, the mean duration of PDT with the Griggs method was between 6.5 and 11.7 minutes whereas the PDT duration with the CBR method was between 7.5 and 13.9 minutes. In all three studies, no significant difference was observed between the two techniques in terms of duration. In another study, which was conducted by Karvandian et al.[8] a 5-minute limitation was set to evaluate the time difference between the two methods, and it was observed that PDT was applied in less than 5 minutes in significantly more patients in the Griggs method compared to CBR.

In our study PDTs were carried out by individuals who were anesthesiology residents and had no previous PDT experience, or those who had less than five experiences, and the PDT application time with the Griggs technique was measured as 6.05 minutes on average, and with the CBR technique as 6.35 minutes (p>0.939). We anticipate that both methods can be applied in tracheostomy training without delay in the procedure.

When the complications and technical difficulties of both methods were reviewed, it was shown in a meta-analysis that the Griggs technique was technically more difficult than CBR (difficult cannula placement, difficult dilatation), and the amount of bleeding was higher; however, there was no difference in terms of mid-to-late complication rates.[11] In another review, it was demonstrated that the rate of tracheal ring fracture and minor bleeding was higher in CBR than the Griggs technique, but it was stated that CBR was technically easier.[10] In our study, it was observed that the most common complication in the Griggs method was tracheal ring damage (28.6%), which was followed by guidewire curling (19%). In the CBR method, the most common complication was tracheal ring damage (25%), which was followed by pneumothorax and bleeding more than 10 mL (6.3%). No significant difference was found between the two techniques in terms of complications. The rate of encountering technical difficulties were similar in both methods.

The incidence of tracheal ring damage, which was the most common complication in both methods, was calculated as 27% in total. In the literature, tracheal ring fracture rate varies between 2.9% and 36%.[11]

While the Griggs method is not primarily preferred as the PDT method in most European countries, it is preferred in our country by 70%.[12] We think that it is preferred more in terms of cost.

Pneumothorax is a serious complication which can be seen during PDT. In our study, pneumothorax was encountered in two patients (5.4%). In the literature, the incidence of pneumothorax during PDT is usually less than 1%, but there are also studies revealing a rate of 17%.[17,18] PDT-related mortality has been demonstrated to be 0.67%.[19] In our study, no PDT-related mortality was observed.

In most of the studies published on bedside elective percutaneous tracheostomy, PDTs are applied by experienced people. There is no sufficient evidence in tracheostomy training to determine the minimum number of procedures required to apply tracheostomy independently. PDT can be safely performed by the physicians of non-surgical branches, intensive care and chest diseases, anesthesiologists, emergency doctors and otolaryngologists.[2] As in any other procedure, it requires adequate training. The American College of Chest Physician recommends at least twenty procedures,[20] and the European Respiratory Society recommends at least 5-10 procedures before performing PDT independently[21] It is also recommended to continue to perform at least 10 procedures per year to sustain competency. In a study conducted by Nates et al.[23] no difference was discovered in terms of complications in PDTs performed by experienced and inexperienced people. In our study, the PDT procedure was carried out by individuals who were anesthesiology residents and had not performed PDT before or performed less than five PDTs in company with an experienced physician.

Limitations

The study faces several limitations that are important to address. Firstly, being a single-centered study, it may not adequately represent diverse geographical, cultural, or demographic groups, thus limiting its sample diversity and representativeness. Secondly, there are variations in the experience levels of the anesthesiology residents performing the procedures, coupled with a lack of standardized procedures, which could potentially influence the outcomes. Additionally, the study primarily focuses on short-term outcomes without including long-term follow-up data, which limits the scope of understanding the prolonged effects of the procedures. There are also potential impacts due to technical variations and differences in the equipment used for the tracheostomy procedures, which could affect the study's results. Lastly, as a retrospective study, it is subject to limitations such as inconsistencies in data collection and record-keeping processes, which might impact the accuracy and completeness of the data gathered.

CONCLUSION

Bronchoscopy guided percutaneous dilatational tracheostomy is a safe procedure performed at the bedside. It can be applied in different ways by physicians from various specialties. There is no recommended tracheostomy method to be used in tracheostomy training.

In this study, in which bedside bronchoscopy guided percutaneous dilatational tracheostomies were opened by anesthesiology residents with the "Griggs" and "Ciaglia Blue Rhino" methods and the two methods were compared, no difference was found between the two methods in terms of complications and technical difficulties.

We believe that "Griggs" and "Ciaglia Blue Rhino", two of the percutaneous dilatational tracheostomy methods, are not superior to each other in terms of ease of use and complications in anesthesiology education.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of University of Health Sciences Dr. Abdurrahman Yurtaslan Oncology Health Practice and Research Center Clinical Researches Ethics Committee (Date: 13.01.2021, Decision No: 2021-01/940).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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