BMC Anesthesiology

RESEARCH

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Comparison of the percutaneous dilatational tracheostomy with and without flexible bronchoscopy guidance in intensive care units

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Abstract

Backgrounds The benefit of fiberoptic bronchoscopy (FOB) guidance during percutaneous dilatational tracheostomy (PDT) remains unclear. We aimed to compare PDT performed with and without FOB guidance in terms of procedure duration, number of attempts, and perioperative complications.

Methods A total of 103 patients were divided into two groups, and the PDT procedure was performed either with or without FOB guidance. The primary outcome of our study was the duration of the tracheostomy procedure (PDT procedure time) and the number of attempts. The secondary outcome was the major/minor complications that might develop during and after tracheostomy.

Results The mean PDT procedure time was 8 (4-14) minutes in the FOB (-) group and 7 (3-14) minutes in the FOB (+) group, with no statistically significant difference between them ($p=0.081$). The mean number of PDT attempts was the same in both the FOB (-) and FOB (+) groups, 1 (1-3) ($p=0.079$). Hypoxemia/desaturation occurred in 1 (2%) patient in the FOB (-) group and in 1 (1.9%) patient in the FOB (+) group ($p=0.748$). Cardiac arrhythmia occurred in 2 (3.9%) patients in the FOB (-) group and in 2 (3.8%) patients in the FOB (+) group ($p=0.684$). No cases of pneumothorax or pneumomediastinum were observed in either group ($p>0.999$).

Conclusion No difference was found between the two groups in terms of procedure duration, number of attempts, and perioperative complications when performing PDT in the intensive care unit with or without fiberoptic bronchoscopy guidance. PDT can be performed effectively and safely in critically ill patients using a standardized approach by an experienced team, with or without bronchoscopy guidance. However, further investigation and advanced studies are needed to evaluate both methods in more detail.

Trial registration Retrospectively registered. Clinical trial number was not applicable.

Keywords Bronchoscopy, Tracheostomy, Safety, Effectiveness, Critical care

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Introduction

Although the history of tracheostomy is considered to be as old as human history, the percutaneous dilatational tracheostomy (PDT) as we know it today was first described in 1955, and various PDT methods have been developed since then [1, 2]. Initially, tracheostomy was a complex surgical procedure performed in the operating room, but over time it has become a procedure that can be performed percutaneously in the intensive care unit (ICU) [3]. Numerous meta-analyses have reported various advantages of PDT performed in ICUs compared to surgical tracheostomy [4].

In patients who have been followed on mechanical ventilation (MV) for a long period, complications such as laryngeal injury, vocal cord paralysis, glottic and subglottic stenosis, infection, and tracheal damage (tracheomalacia and tracheal dilatation/stenosis) can occur [1]. It has been reported that an intubation duration of more than fifteen days can lead to impaired swallowing functions and healthcare-associated pneumonia in approximately 40% of patients [5]. Various authors have reported a reduction in the incidence of ventilator-associated pneumonia, an increase in the number of days free from MV, and a reduction in ICU length of stay with PDT [6]. PDT is performed to provide a secure airway, reduce laryngeal injury, facilitate aspiration of the airways, enable oral feeding, and facilitate the transfer of the patient from the ICU [7]. Additionally, PDT is known to have significant benefits such as reducing airway resistance and respiratory workload and increasing patient comfort [8]. Today, PDT is one of the most commonly performed surgical procedures in critically ill patients under MV [9]. The development of various PDT techniques has facilitated the spread and application of the procedure in ICUs [10].

Researchers have examined various methods to guide the PDT procedure, such as applications with fiber-optic bronchoscopy (FOB) or ultrasound guidance [11]. The use of fiber-optic bronchoscopy during tracheostomy has been shown to be beneficial in demonstrating the correct interval for the physician and preventing contact with the posterior wall of the trachea during dilation [12]. While studies have shown that performing PDT under FOB guidance reduces the incidence of complications, there is no consensus in the literature regarding its routine use [13]. The main disadvantage of FOB is hypoventilation, hypercapnia, and respiratory acidosis [1]. Hypercapnia and hypoventilation caused by FOB can worsen clinical outcomes in some patients [14]. Additionally, the lack of availability of FOB in every clinic, its cost, and the requirement for expertise limit its widespread use [15].

Therefore, assuming that there may be clinics where FOB is not available or difficult to apply for various reasons, we hypothesized that performing PDT without FOB guidance could be safe and effective. We aimed to compare the safety and effectiveness of PDT performed with and without FOB guidance.

Materials and methods

Study design

This study is a prospective, descriptive, and cross-sectional research. Approval for the study was obtained from the Dokuz Eylul University Clinical Research Ethics Committee (approval number:2023/08–12, approval date:20.04.2024). This research was conducted in accordance with institutional guidelines and the latest version of the 1975 Helsinki Declaration. Clinical trial number was not applicable. Written consent for participation in the study was obtained from all patients participating in the study. Informed consent was obtained to publish the information/images in an online open access publication. One hundred and three patients who were followed on mechanical ventilation in the ICUs of the Medical Faculty and met the inclusion criteria for PDT within one year were included in the study. All PDT procedures in the study were performed by intensivists (Ö.Ö, M.Ç.G, E.K.Ö. and E.Y) with at least ten years of experience. All Fiber optic bronchoscopy procedures were performed by the same intensivist (S.D) who had special training in bronchoscopy. Karl Storz 11,302 BDX (Germany) flexible intubation video endoscope device was used in all bronchoscopy procedures. The indication for tracheostomy for the patient was decided by the attending physician to avoid disrupting routine operations. In our unit, which is a tertiary intensive care unit in the university hospital; Percutaneous Tracheostomy procedure is applied to the following patients: Patients who are endo-tracheally intubated, mechanically ventilated, over the age of 18, patients who have failed to wean from mechanical ventilation due to various reasons, patients who need long-term mechanical ventilation due to neuro-muscular diseases, patients whose bronchial secretions cannot be sufficiently cleared, and patients who have difficulty maintaining airway integrity and safety. In addition, for all Percutaneous Tracheostomy procedures; written informed consent is obtained from the patient and/or first-degree relatives/legal guardians. In our unit, Percutaneous tracheostomy procedure is not applied to the following patients and these patients are directed to surgical tracheostomy. An anatomy that is not suitable for PDT opening: Having a short neck, having tracheal deviation, cervical anatomical anomaly, previous cervical surgery, cervical trauma, cervical tumors, the neck cannot be extended at all.

Inclusion criteria for the study were: being over 18 years of age, undergoing PDT due to tracheostomy indications (failure to wean, patients requiring long-term mechanical ventilation due to neurological diseases, situations where bronchial secretions cannot be adequately

cleared, conditions necessary to maintain airway integrity and safety), and providing written informed consent for the PDT procedure. Exclusion criteria were: the presence of an unsuitable anatomy for PDT, previous cervical surgery, cervical trauma or tumors, pregnancy or lactation, and the patient or their first-degree relatives not providing written consent.

The PDT procedure for all patients included in the study was performed using the forceps dilatation technique described by Griggs et al. [16], which is routinely applied in our clinic and with which the team is experienced. Cases were divided into two groups: those undergoing PDT with FOB guidance and those undergoing PDT without FOB guidance. For this study, the treatments, PDT indications, and post-procedure follow-up of the patients were applied according to the instructions of their primary physicians, with no changes made for this study.

The primary outcome of our study was the duration of the PDT procedure time and the number of attempts. The secondary outcome was the major/minor complications observed during and after tracheostomy.

Patient population

The demographic data of the cases, critical illness score (APACHE II), pre- and post-procedure laboratory parameters, and lung imaging were recorded. In our unit, each patient is screened for lungs with bedside lung ultrasonography and X-ray imaging before and after the PDT procedure. In accordance with the guideline on PDT, sedo-analgesia and neuromuscular blockers were administered to the patients, and then the PDT procedure was performed with or without FOB guidance [17]. No randomization was performed for the study. All patients treated in the ICU and indicated for tracheostomy were consecutively included in the study. The identity information of the patients was kept confidential and not shared.

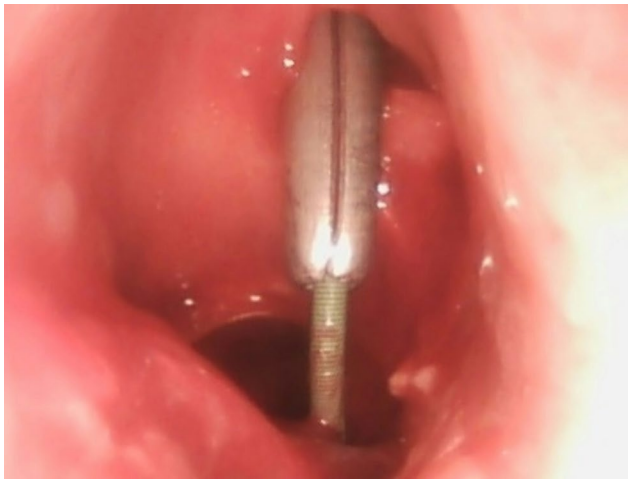

Fig. 1 While entering with forceps during the PDT procedure

Study efficacy and safety parameters

In the presented study, efficacy was defined as the successful performance of PDT with or without FOB guidance without the need for surgical tracheostomy or any other procedure, and the duration of the procedure. Safety was defined as the absence of any complications during and after the procedure.

Major complications were defined as follows

procedure-related death, cardiac arrest, tracheal wall injury, creation of a false passage during cannulation, pneumothorax, pneumomediastinum and tracheostomy cannula obstruction, esophageal injury, tracheoesophageal fistula, conversion to surgical tracheostomy, persistent hypotension (systolic blood pressure remaining below 90 mmHg for more than 5 min requiring fluid infusion, vasopressor bolus, or infusion to increase blood pressure), persistent acute hypoxemia (oxygen saturation remaining below 90% for more than 5 min), major bleeding (causing hypoxemia and/or requiring emergency transfusion or surgical repair, or formation of an intratracheal or tracheovascular fistula), and tracheostomy-related sepsis (where the identifiable sole source of infection is the stoma).

Minor complications were defined as follows

transient hypotension (systolic blood pressure remaining below 90 mmHg for less than 5 min requiring a single bolus of fluids or vasopressors to raise blood pressure), transient acute hypoxemia (oxygen saturation falling below 90% for less than 5 min), and the detection of atelectasis on post-procedure chest radiography.

Statistical analysis

SPSS 24.0 (Chicago, IL) software was used for statistical analyses. All values are expressed as numbers (percentages) or median (interquartile range). Categorical data were presented as median (interquartile range). Mann-Whitney U test was used to compare categorical data in the study. Frequency data were presented as numbers and percentages (%), and chi-square test was used to compare frequency data. Spearman correlation test was used to determine correlations. A p value of <0.05 was considered statistically significant.

Results

A total of 103 patients meeting the inclusion criteria were included in the study. One group of patients underwent PDT with FOB guidance (Figs. 1 and 2). In the study, PDT was performed with FOB guidance on 52 (50.48%) patients, while PDT was performed without

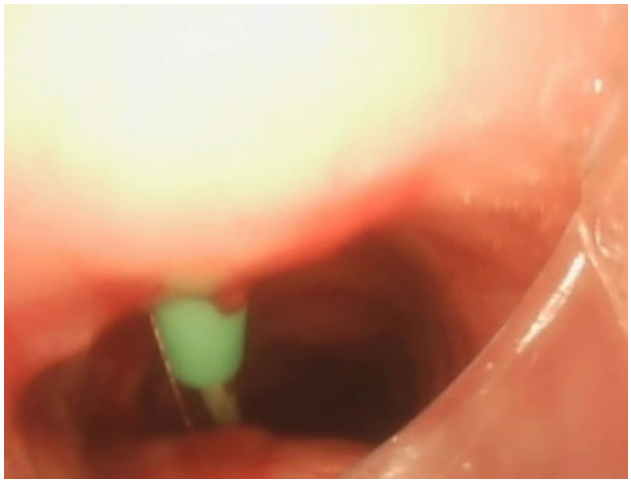

Fig. 2 Dilator insertion during PDT procedure

FOB guidance on 51 (49.51%) patients. The median age in the FOB (-) group was 71 (34–95), while the median age in the FOB (+) group was 75 (22–91) ($p = 0.282$). The median APACHE II score was 20 [12–35] in the FOB (+) group ($p = 0.818$). The demographic data of both groups are summarized in Table 1.

The mean PDT procedure time was 8 [4–14] minutes in the FOB (-) group and 7 [3–14] minutes in the FOB (+) group, with no statistically significant difference between them ($p = 0.081$). The mean number of PDT attempts was the same, 1 [1–3], in both the FOB (-) and FOB (+) groups ($p = 0.079$) (Table 1).

There was no statistically significant difference in pre- and post-procedure laboratory findings between the FOB (-) and FOB (+) groups (Table 2).

Complications observed during and after the PDT procedure were as follows (Table 3):

Hypoxemia/desaturation occurred in 1 (2%) patient in the FOB (-) group and in 1 (1.9%) patient in the FOB (+) group ($p = 0.748$).

Cardiac arrhythmia occurred in 2 (3.9%) patients in the FOB (-) group and in 2 (3.8%) patients in the FOB (+) group ($p = 0.684$).

Pneumothorax and pneumomediastinum were not observed in either group ($p > 0.999$).

Subcutaneous emphysema was not observed in the FOB (-) group but was seen in 1 (1.9%) patient in the FOB (+) group, although there was no statistically significant difference between them ($p = 0.505$).

Minor bleeding occurred in 3 (5.9%) patients in the FOB (-) group and in 2 (3.8%) patients in the FOB (+) group ($p = 0.491$). No major bleeding or tracheal posterior wall perforation was observed in any patient during the study.

Table 1 Clinical characteristics of patients undergoing percutaneous dilatational tracheostomy

Clinical characteristics:	All Patients	FOB (-) PDT	FOB (+) PDT	*p*-value
	(*n* = 103)	(*n* = 51)	(*n* = 52)	
Age	72(22–95)	71(34–95)	75(22–91)	0.282
Sex:				0.453
Female	42(40.8%)	20(39.2%)	22(42.3%)	
Male	61(59.2%)	31(60.8%)	30(57.7%)	
Weight (kg)	75(40–130)	75(45–130)	77.5(40–100)	0.65
Height (cm)	170(150–185)	170(150–185)	170(155–185)	0.183
Body mass index (kg /m^2)	25(15–45)	25.7(17.5–46)	26.1(15.8–34.9)	0.505
APACHE II Score	21(8–35)	20(12–35)	21(8–31)	0.818
Time intubated (days)	14(3–49)	14(3–49)	13(3–30)	0.253
Tracheostomy opening time (minute)	7 (3–14)	8(4–14)	7(3–14)	0.081
Number of attempts to open	1(1–3)	1(1–3)	1(1–3)	0.079
a tracheostomy				
Number of attempts to open a tracheostomy:				
1	-79(76.7%)	-43(84.3%)	-36(69.2%)	0.184
2	-19(18.4%)	-6(11.8%)	-13(25%)	
3	-5(4.9%)	-2(3.9%)	-3(5.8%)	
Endotracheal Intubation tube no:				
7.5:	4(3.9%)	4(7.8%)	0(0%)	0.113
08:00	94(91.3%)	45(88.2%)	49(94.2%)	
8.5:	5(4.9%)	2(3.9%)	3(5.8%)	
Tracheostomy cannula no:				
7.5:	4(3.9%)	4(7.8%)	0(0%)	0.113
08:00	94(91.3%)	45(88.2%)	49(94.2%)	
8.5:	5(4.9%)	2(3.9%)	3(5.8%)	
Laryngeal Mask:				0.043
Yes:	4(3.9%)	0(0%)	4(7.7%)	
No:	99(96.1%)	51(100%)	48(92.3%)	

All values are expressed as numbers (percentages) or median (interquartile range)

Abbreviations APACHE: Acute physiology and chronic health evaluation, CCI: Charlson Comorbidity Index. SOFA: Sequential Organ Failure Assessment score, Aml: Acute myeloid leukemia, All: acute lymphoblastic leukemia, Mm: Multiple myeloma, Mds reab 2: Myelodysplastic syndrome reab 2

Discussion

In this study investigating the efficacy and safety of PDT in the intensive care unit (ICU) with and without the guidance of fiberoptic bronchoscopy (FOB), no differences were found between the two groups in terms of procedure duration, number of attempts, days to tracheostomy, laboratory parameters, and complication rates.

As in the presented study, most percutaneous tracheostomy methods utilize a modification of the Seldinger technique, which involves puncturing the trachea, placing a guidewire, and dilating the tracheostomy tract [18]. During PDT, FOB guidance is used as a safety measure to

Table 2 Laboratory findings of patients 1 h before and 1 h after percutaneous dilatational tracheostomy

	All Patients (*n* = 103)	**FOB (-) PDT (*n* = 51)**	**FOB (+) PDT (*n* = 52)**	***p*-value**
Hemoglobine -				
Before -pdt	-9.7(7-14.10)	-9.6(7-12.8)	-9.8(7.5–14.1)	0.350
After-pdt	-9.2(6.9–13.8)	-9.2(6.9–13)	-9.2(7.1–13.8)	0.961
Hematocrite				
Before -pdt	-27.8(21.10–42)	-28.8(21.1–36.9)	-27.3(21.7–42)	0.616
After-pdt	-28.7(20.4–41)	-28.7(20.4–39.7)	-28.95(20.4–41)	0.877
Platetet:				
Before -pdt	-227(71–663)	-254(71–663)	-199(81–663	0.452
After-pdt	– 255(109–643)	-264(109–643)	-233(111–641)	0.575
INR:				
Before -pdt	-1.1(0.8–1.89)	-1.1(0.8–1.89)	-1.16(0.8–1.61)	0.472
After-pdt	-1.16(0.67–1.8)	-1.18(0.67–1.69)	-1.15(0.8–1.8)	0.968
AST, IU/L:	-42(13–96)	-43(15–80)	-39(13–96)	0.630
Before -pdt	-39(19–104)	-36(19–104)	-39(22–98)	0.782
After-pdt				
ALT, IU/L:				
Before -pdt	-33(14–100)	-39(14–98)	-29(14–100)	0.303
After-pdt	-37(18–118)	-38(20–115)	-36(18–118)	0.997
Blood urea nitrogen, mg/dL:				
Before -pdt	-46(22–244)	-56.7(23–244)	-40.75(22–150)	0.14
After-pdt	-53.6(8-186)	-56.4(15–186)	-52.8(8-186)	0.573
Creatinine, mg/dL:				
Before -pdt	-1.12(0.6–2.7)	-1.15(0.6–2.7)	-1.10(0.6–2.6)	0.586
After-pdt	-1(0.34–2.70)	-0.98(0.37–2.70)	-1(0.34–2.59)	0.797
C-reative protein:				
Before -pdt	-96.3(1-236.7)	-97.1(1-222)	-96.1(25–236)	0.555
After-pdt	-107(34–305)	-107(44–305)	-104(34–298)	0.812
Procalsitonin:				
Before -pdt	-1.2(0.27–3.4)	-1.17(0.4–3.4)	-1.28(0.27–3.4)	0.69
After-pdt	-1.6(0.65-6)	-1.67(0.67-6)	-1.32(0.65-6)	0.673
pH:	-7.43(7.31–7.63)	-7.42(7.31–7.61)	-7.43(7.34–7.63	0.588
Before -pdt	-7.46(7.31–7.6)	-7.48(7.34–7.6)	-7.45(7.31–7.60)	0.091
After-pdt				
pO_2:				
Before -pdt	-95(57–159)	-98(57–159)	-98(57–159)	0.687
After-pdt	-103(68–163)	-103(68–163)	-104.5(68–159)	0.953
pCO_2:	-38(27–69)	-38(28–69)	-37.5(27–54)	0.188
Before -pdt	-37(27–64)	-37(27–64)	-36.5(27–64)	0.809
After-pdt				
Lactat:				
Before -pdt	-1.6(0.6–4.2)	-1.5(0.6–4.2)	-1.8(0.7–3.6)	0.032
After-pdt	-1.5(0.7-5)	-1.5(0.7-5)	-1.5(0.7-5)	0.837
HCO_3:				
Before -pdt	-27.9(11.9–38.8)	-28(22–38)	-27.8(11.9–37)	0.544
After-pdt	-28(21–39)	-28(21–39)	-28(21–38)	0.746
$Sp0_2$:				
Before -pdt	-98(88–100)	-98.5(91.5–100)	-98(88–100)	0.011
After-pdt	-99(90–100)	-99(90–100)	-98(90–100)	0.493

Abbreviations: ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; PaO2: Arterial partial oxygen pressure; PaCO2: Arterial partial carbon dioxide pressure; CRP: C-Reactive protein; FiO2: Fraction of inspired oxygen; HCO3: Bicarbonate; LDH: Lactate dehydrogenase; sCr: Serum creatinine

facilitate the selection of the correct anatomical site, confirmation of intratracheal guidewire and dilator placement, and positioning of the tracheal cannula [19]. However, the necessity of FOB guidance is currently questioned due to its potential to prolong the procedure, causing carbon dioxide retention and hypoxia, and due to its cost [20]. In a study comparing the FOB-guided PDT technique with a mini-surgical procedure,

Table 3 Complications developing in patients undergoing percutaneous dilatational tracheostomy

Complications	All Patients (*n* = 103)	FOB (-) PDT (*n* = 51)	FOB (+) PDT (*n* = 52)	*p* value
Hypoxemia/Desaturation:				
Yes:	2(1.9%)	1(2%)	1(1.9%)	0.748
No:	101(98.1%)	50(98%)	51(98.1%)	
Cardiac Arrytmia:				
Yes:	4(3.9%)	2(3.9%)	2(3.8%)	0.684
No:	99(96.1%)	49(96.1%)	50(96.2%)	
Pneumothorax:				
Yes:	0(0%)	0(0%)	0(0%)	> 0.999
No:	103(100%)	51(100%)	52(100%)	
Pneumomediastinum:				
Yes:	0(0%)	0(0%)	0(0%)	> 0.999
No:	103(100%)	51(100%)	52(100%)	
Subcutaneous Emphysema:				
Yes:	1(1%)	0(0%)	1(1.9%)	0.505
No:	102(99%)	51(100%)	51(98.1%)	
Bleeding:				
Yes:	5(4.9%)	3(5.9%)	2(3.8%)	0.491
No:	98(95.1%)	48(94.1%)	50(96.2%)	

it was found that the duration of FOB-guided PDT was significantly longer [21]. This may be due to the time required to obtain optimal FOB imaging and ventilation [21]. Similarly, Hashemian et al. [22] found that the mini-surgical procedure involving blunt dissection was shorter than FOB-guided PDT. However, in this non-percutaneous rapid procedure, blind dissection was performed. Another study on PDT performed with FOB guidance found that the average procedure duration was almost twice as long as without FOB guidance [11]. This duration can be a significant factor in patients with increased airway pressure and inotropic requirements [21]. A shorter procedure duration can minimize exposure to procedure-related risks [21]. It may be possible to shorten the procedure duration by having a fixed team perform the same procedure each time [21]. In the present study, no difference was found between the PDT duration with and without FOB guidance. Similarly, no difference was found between the two groups in terms of the number of attempts. This may be attributed to the application of a safety checklist for the preparation of each patient in our clinic, the standardization of the procedure, and the fact that PDT/FOB procedures were not performed within the clinical team's learning curve. On the other hand, correlation analysis revealed a positive correlation between the number of attempts and procedure duration in the FOB (+) group. This finding is important as it indicates that an increased number of attempts prolongs the procedure duration in this group.

Although some studies in the literature report that FOB-guided PDT may be beneficial in preventing complications, it is also reported that airway obstruction and hypoventilation can occur during FOB placement [23]. The use of FOB requires technical knowledge and experience [13]. Kost et al. [24] reported no cases of pneumothorax or pneumomediastinum during FOB-guided PDT and attributed this to the use of FOB. On the other hand, the incidence of pneumothorax during PDT procedures has been reported to be as high as 5.6% [19]. Pneumothorax development during PDT can result from direct pleural injury, mediastinal injury, or alveolar bleb rupture [25]. Moreover, due to its adjacency to the parietal pleura, para-tracheal placement of the tracheostomy tube or injury to the posterior tracheal wall can lead to pneumothorax [26]. Additionally, prolonged presence of the fiberoptic bronchoscope (FOB) within the endotracheal tube can elevate airway pressures [27]. Kumar et al. [21] reported a pneumothorax incidence of 3.3% during PDT performed with FOB guidance. Tobler et al. [28] documented a pneumothorax incidence of approximately 1.6% during PDT in their study. In our study, however, no cases of pneumothorax or pneumomediastinum occurred. All patients were evaluated pre- and post-procedure with X-ray and ultrasonography. In our study, subcutaneous emphysema was not observed in Group FOB (-), whereas it was seen in only 1 (1.9%) patient in Group FOB (+). Consistent with our findings, another study reported an incidence of subcutaneous emphysema ranging from 1.4 to 1.8% [29]. Subcutaneous emphysema during PDT can be attributed to multiple punctures of the anterior tracheal wall, excessive dilation of the trachea, para-tracheal tube placement, posterior tracheal tears, and accompanying pleural injuries [30]. In our case of subcutaneous emphysema, we considered that multiple interventions during the procedure may have been the cause, as no other reason was identified during follow-up. This condition did not progress to any hemodynamic changes, respiratory distress, or conditions like air-leak syndrome, required no additional treatment, and resolved spontaneously within 48 h. No instances of perforation of the posterior tracheal wall were observed during the study.

Another significant complication encountered during PDT is bleeding [31] A meta-analysis by Simon et al. [19] identified arterial bleeding as a leading cause of mortality associated with PDT. Shen et al. [12] reported minor bleeding in 20% of patients undergoing FOB-guided PDT procedures. In the same study, procedures performed without FOB resulted in minor bleeding in 33.3% and major bleeding in 4.4% of patients. Atlas et al. [32] found minor bleeding in 10.3% of patients during FOB-guided PDT procedures. Sarıtaş et al. [11] reported minor bleeding in 3.3% and major bleeding in 10% of patients during FOB-guided PDT procedures. Uluç et al. [1], in 114 PDT cases performed with FOB guidance, identified one case of major bleeding and one case of bleeding around the stoma. In our study, minor bleeding occurred in 3

(5.9%) patients in Group FOB (-) and 2 (3.8%) patients in Group FOB (+), with no statistically significant difference between them. However, in Group FOB (+), a negative correlation was found between PDT procedure duration and post-procedure hemoglobin levels (r=-0.281, $p<0.001$). We hypothesized that this could be due to increased bleeding during tracheal dilation under FOB guidance during PDT. Nevertheless, none of our patients experienced bleeding requiring surgical intervention, suture ligation, or blood transfusion. All identified bleedings were classified as minor. Similarly, Hameed et al. [33] reported a clinically significant bleeding incidence of 4.05% in FOB-guided PDT, suggesting that FOB did not confer any benefit in reducing bleeding during PDT. Studies in the literature also indicate no significant difference in mild to moderate bleeding between dissection-based and FOB-guided PDTs [34, 25].

Another important complication recorded during PDT procedures is hypoxemia/desaturation. One study found that the incidence of desaturation was nearly doubled in PDT cases performed with FOB guidance [35]. Topcu et al. [36] reported hypoxemia in 7 out of 44 patients (15.9%) during PDT performed without fiberoptic bronchoscope (FOB) using anatomical landmarks. In another study involving FOB-guided PDT, hypoxemia occurred in 3 (2.6%) patients [1]. Indeed, during PDT procedures, steps such as retracting the endotracheal tube to the level of the vocal cords, tracheal dilation, and cannula placement can increase the risk of desaturation [37]. Additionally, the presence of the FOB itself covering much of the endotracheal tube can pose a risk for desaturation [38]. In our study, the incidence of hypoxemia/desaturation was 1 (2%) in Group FOB (-) and 1 (1.9%) in Group FOB (+), with no statistically significant difference between them. This could possibly be attributed to using a larger diameter endotracheal tube allowing continued ventilation during PDT procedures guided by FOB in the ICU. Moreover, smaller caliber endotracheal tubes unsuitable for FOB passage were replaced with larger ones to facilitate FOB passage. We did not encounter any airway loss or safety issues during this process. However, the necessity to change the endotracheal tube to allow FOB passage may complicate PDT procedures in patients with difficult airways compared to those with less complex airways. Furthermore, there was no statistical difference in procedure duration and number of attempts between both groups in our study. It could be expected that as procedure duration and number of interventions increase in FOB-guided procedures, the incidence of hypoxia may align with literature findings. We considered that the experience of the team might mitigate this.

Another potentially serious complication of PDT is cardiac arrhythmia. In a study with and without FOB guidance, 13 patients in the non-FOB group and 4 patients in the FOB group were reported to have cardiac arrhythmia [21]. Another study reported deaths due to cardiac arrest in three PDT procedures and emphasized that PDT using Grigg's forceps dilation technique caused the most intra-procedural arrhythmia [19]. In our study, cardiac arrhythmia was observed in 2 (3.9%) patients in Group FOB (-) and 2 (3.8%) patients in Group FOB (+), with no statistically significant difference between them. These arrhythmias did not require active treatment, did not lead to hemodynamic instability, and resolved spontaneously. During PDT procedures, whether with or without FOB, the cause of arrhythmia may be attributed to autonomic fluctuations due to manipulation of the airway and dissection over the anterior tracheal wall while the endotracheal tube remains in place [39].

Limitations

Our study has some limitations. First of all, it reflects the experience of a single center, it is observational, and there is a lack of long-term follow-up to evaluate late complications after intensive care. In addition, fiberoptic bronchoscopy was performed by an intensive care specialist who received special training in bronchoscopy. This may have led to the fact that the PDT opening time under FOB guidance was not long and that the complications were not statistically different between the two groups. In addition, another limitation of our study is that a second bronchoscopy procedure was not performed to search for posterior wall puncture of the trachea after tracheostomy. The reasons for this situation include; although the posterior wall was evaluated with fiberoptic bronchoscopy during tracheostomy and no complications developed during follow-up periods (pneumothorax, pneumomediatinum, mediastinitis, etc.), the lack of a second evaluation after the procedure is a limitation of the study.

On the other hand, the strengths of this study are that it is a prospective study including a significant number of consecutive patients. These results can be generalized to clinics where a safety checklist is applied for patient preparation, the procedure is always performed by the same team and is standardized.

Conclusion

In this study, no difference was found between the two groups in terms of procedure duration, number of attempts, and perioperative complications when performing PDT in the intensive care unit with or without fiberoptic bronchoscopy guidance. Bronchoscopy guidance did not increase the tracheostomy procedure time or the number of attempts. However, tracheostomy procedures performed without bronchoscopy guidance also did not show an increase in perioperative complications. PDT can be performed effectively and safely in critically

ill patients using a standardized approach by an experienced team, with or without bronchoscopy guidance. However, further investigation and advanced studies are needed to evaluate both methods in more detail.

Abbreviations

FOB	Fiberoptic bronchoscopy
PDT	Percutaneous dilatational tracheostomy
ICU	Intensive care unit
MV	Mechanical ventilation
APACHE II score	Acute Physiology And Chronic Health Evaluation

Acknowledgements
Not applicable.

Author contributions
A.N.G and E.Y. wrote the main manuscript text. S.D., E.K.Ö. and M.Ç. G prepared figures and tables. V.H. and B.E. prepared Statistics paragraph. All authors reviewed the manuscript.

Funding
No funding were used for the reported research.

Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.Consent for publication: Written consent for participation in the study was obtained from all patients participating in the study. Informed consent was obtained to publish the information/images in an online open access publication.

Declarations

Ethical approval
Approval for the study was obtained from the Dokuz Eylul University Clinical Research Ethics Committee (approval number:2023/08–12, approval date:20.04.2024).

Consent to participate
Written consent for participation in the study was obtained from all patients participating in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 19 August 2024 / Accepted: 21 March 2025
Published online: 31 March 2025

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