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Percutaneous dilatational tracheostomy in a tertiary intensive care unit: A ten-year experience from a university hospital in Türkiye

Üçüncü basamak yoğun bakım ünitesinde perkütan dilatasyonel trakeostomi: Türkiye'de bir üniversite hastanesinden on yıllık deneyim

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ABSTRACT

Aim: Tracheostomy provides airway patency by inserting an intratracheal cannula through a window in the anterior tracheal wall. Patients treated in intensive care units often require tracheostomy owing to prolonged endotracheal intubation and mechanical ventilation. This study aimed to evaluate the complication rates, safety, and clinical outcomes of percutaneous dilatational tracheostomy performed by anesthesiologists over a ten-year period in a tertiary intensive care unit.

Material and Methods: This retrospective study was conducted between 2015 and 2024 in the Anesthesiology Intensive Care Unit of Duzce University. Among patients older than 18 years who received treatment for more than 48 h in intensive care unit, 85 who underwent bedside percutaneous dilatational tracheostomy using the Griggs technique performed by anesthesiologists were included. The patients were evaluated for demographic and clinical features, duration of ventilation and hospitalization, complications, and mortality.

Results: The mean age of the patients was 72.81±16.15 years, and 65.9% were male. The most common complications were bleeding (23.5%), hypoxemia (10.6%), and pneumothorax (4.7%). None of the patients required conversion to surgical tracheostomy. Use of ultrasound, fiberoptic bronchoscopy, and laryngeal mask airway guidance was associated with a significantly lower incidence of hypoxemia (p=0.016).

Conclusion: Percutaneous dilatational tracheostomy performed by anesthesiologists in the intensive care unit is a safe, practical, and effective bedside procedure, with a low rate of major complications. Ultrasound, fiberoptic bronchoscopy, and laryngeal mask airway guidance enhance procedural safety and reduce the risk of complications. Routine implementation by experienced anesthesiologists is recommended in critically ill patients requiring prolonged mechanical ventilation.

Keywords: Anesthesiologists, bronchoscopy, complications, laryngeal mask airway, tracheostomy, ultrasonography

ÖZ

Amaç: Trakeostomi, ön trakeal duvarda bir pencere açılarak intratrakeal bir kanül yerleştirilmesiyle havayolu açıklığını sağlar. Yoğun bakım ünitelerinde tedavi gören hastalar, uzamış endotrakeal entübasyon ve mekanik ventilasyon nedeniyle sıklıkla trakeostomiye ihtiyaç duyar. Bu çalışmanın amacı, üçüncü basamak bir yoğun bakım ünitesinde anesteziyologlar tarafından gerçekleştirilen perkütan dilatasyonel trakeostomi işlemlerinin on yıllık süreçteki komplikasyon oranlarını, güvenliğini ve klinik sonuçlarını değerlendirmektir.

Gereç ve Yöntemler: 2015–2024 yılları arasında Düzce Üniversitesi Anesteziyoloji Yoğun Bakım Ünitesi'nde retrospektif olarak yapılan bu çalışmaya, yoğun bakımda 48 saatten uzun süre tedavi gören 18 yaş üstü hastalar arasından, anesteziyologlar tarafından Griggs tekniğiyle yatak başında perkütan dilatasyonel trakeostomi uygulanan 85 hasta dahil edilmiştir. Hastalar demografik ve klinik özellikleri, ventilasyon ve yatış süreleri, komplikasyonlar ve mortalite açısından değerlendirilmiştir.

Bulgular: Hastaların yaş ortalaması 72,81±16,15 olup, %65,9'u erkekti. İşlem sırasında kanama (%23,5), hipoksemi (%10,6) ve pnömotoraks (%4,7) en sık komplikasyonlar olarak saptandı. Hiçbir vakada acil cerrahi trakeostomiye geçiş gereksinimi olmadı. Ultrason, fiberoptik bronkoskopi ve laringeal maske rehberliğinin kullanıldığı olgularda hipoksemi oranı anlamlı derecede daha düşüktü (p=0,016).

Sonuç: Yoğun bakımda anesteziyologlar tarafından uygulanan perkütan dilatasyonel trakeostomi, düşük majör komplikasyon oranı ile güvenli, pratik ve etkili bir işlemdir. Ultrason, bronkoskopi ve laringeal maske kılavuzluğu, işlemin güvenliğini artırmakta ve komplikasyon oranlarını azaltmaktadır. Uzun süreli mekanik ventilasyon gerektiren kritik hastalarda, deneyimli anestezistler tarafından rutin olarak uygulanması önerilmektedir.

Anahtar Kelimeler: Anesteziyolog, bronkoskopi, komplikasyonlar, laringeal maske airway, trakeostomi, ultrasonografi

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Highlights

- This ten-year retrospective study demonstrates that percutaneous dilatational tracheostomy (PDT) performed by anesthesiologists in a tertiary intensive care unit is safe and effective with a low rate of major complications.
- Guidance techniques such as ultrasound, fiberoptic bronchoscopy, and laryngeal mask airway significantly reduced the incidence of hypoxemia compared with the anatomical landmark method.
- Bleeding, hypoxemia, and pneumothorax were the most frequently observed complications, with no need for conversion to surgical tracheostomy in any patient.
- Procedure-related mortality was very low, while overall mortality reflected the severity of underlying critical illness rather than the PDT procedure itself.
- The findings support the routine use of PDT by experienced anesthesiologists in critically ill patients requiring prolonged mechanical ventilation.

INTRODUCTION

Tracheostomy provides airway patency by creating a window in the anterior tracheal wall and by inserting an intratracheal cannula. Patients treated in intensive care units (ICU) often require tracheostomy owing to prolonged endotracheal intubation and mechanical ventilation. Tracheostomy is a procedure performed under elective conditions in patients who have been, or are expected to be, on mechanical ventilation for more than 7–10 days, have weaning failure, mechanical airway obstruction, or are unable to clear their secretions spontaneously (1). The advantages of tracheostomy include easier clearance of secretions and maintenance of oral and pulmonary hygiene, reduced respiratory workload and improved oxygen delivery, better patient comfort, effective communication, decreased duration of mechanical ventilation, incidence of ventilator-associated pneumonia, length of ICU stay, and the need for sedation (1–5). It can be performed surgically under general anesthesia in the operating room or as a bedside procedure in the intensive care unit by physicians with adequate knowledge and experience. Percutaneous tracheostomy is generally performed by anesthesiologists and intensive care specialists (1).

The tracheostomy procedure, which dates back to the 16th century, has various techniques that are described today. The most commonly used bedside percutaneous tracheostomy techniques are the Ciaglia (Seldinger) and Griggs (forceps dilatation) methods. Bedside percutaneous dilatational tracheostomies (PDTs) are generally considered safer and appear to have advantages compared to surgical tracheostomy (1,2). The procedure duration is shorter, it is cost-effective, bleeding and infection complications are minimal, and operating room occupancy is reduced. The disadvantages include an increased risk of posterior tracheal wall injury, perforation, and anterior tracheal ring fracture (1,5). It is important that the practitioner clearly recognizes the indications and contraindications, performs a thorough preoperative evaluation, assesses coagulation status, and ensures that adequate laboratory tests are completed. Preprocedural ultrasonography (USG) to visualize anatomical landmarks and vascular structures, determination of the optimal introducer needle entry site, postprocedural control of pneumothorax, and real-time visual guidance using bronchoscopy provide advantages in terms of complication management (2,3). The most important complications are bleeding, pneumothorax, subcutaneous emphysema, posterior tracheal wall injury, malposition of the cannula, tracheoesophageal fistula, tracheal stenosis, and tracheomalacia (6).

Although many retrospective studies from both Türkiye and other countries have compared PDT procedure durations, complications, and outcomes, long-term retrospective analyses spanning ten years or more are limited in number. The aim of our study was to evaluate, based on ten years of experience, the complication rates, safety, and clinical outcomes of PDT performed by anesthesiologists in a tertiary ICU.

MATERIAL and METHODS

After obtaining approval from the Duzce University Non-Invasive Health Research Ethics Committee (Approval No: 2024/245, Date: December 02, 2024), this retrospective observational study was conducted in the Anesthesiology Intensive Care Unit of Duzce University Health Research and Practice Center, Duzce, Türkiye, between January 1, 2015, and December 31, 2024. Written informed consent was exempted due to the retrospective nature of the study and the use of anonymized patient data.

During the study period, the ICU was operated with 6–9 beds and temporarily converted to a COVID-19 unit during the pandemic. In our study, the electronic hospital information management system was screened, and all patients aged over 18 years who were treated in the ICU for more than 48 h during the specified period (n=5953) were identified. Among these patients, those who underwent surgi-

cal tracheostomy or were hospitalized with a diagnosis of COVID-19 pneumonia were excluded from the study. A total of 85 patients who underwent bedside PDT performed by anesthesiologists working in the ICU were included in the study. According to routine PDT practices in our ICU, FiO_2 was set to 1.0 with patient ventilated manually, and sedation with midazolam–fentanyl was used during the procedure. Neuromuscular blockade with rocuronium was applied in all cases to prevent coughing and movement.

The patients included in the study were evaluated in terms of demographic and clinical findings, comorbidities, duration of mechanical ventilation, length of ICU and hospital stay, timing of tracheostomy, tracheostomy-related complications and outcomes, morbidity, and mortality. Hypoxemia was defined as SpO_2<90%, minor bleeding was defined as bleeding controlled with local pressure or adrenaline-soaked gauze and major bleeding was defined as bleeding requiring surgical or transfusion intervention. Other complications (such as pneumothorax, subcutaneous emphysema, stoma infection, and tracheal stenosis) were identified according to the relevant clinical diagnostic criteria used in routine intensive care practice.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics (version 22.0; IBM Corp., Armonk, NY, USA). The normality of continuous variables was evaluated using the Kolmogorov-Smirnov test, along with skewness and kurtosis values. Descriptive statistics were expressed as mean±standard deviation for normally distributed variables or as median (interquartile range, 25th-75th percentiles) [min-max] for non-normally distributed variables. Categorical variables were presented as numbers and percentages. Comparisons between groups were performed using the Chi-square, Fisher's exact, or Fisher-Freeman-Halton test for categorical variables according to the expected counts, and the Student's t-test or Mann-Whitney U test for continuous variables, as appropriate. A two-tailed p value <0.05 was considered statistically significant.

RESULTS

A total of 85 patients who underwent PDT using the Griggs technique were included in the study. The procedures were performed by anesthesiology faculty members with 10–25 years of experience and residents with more than four years of training in a tertiary ICU. The mean age of the patients was 72.81±16.15 years, and 65.9% were male. The median duration of mechanical ventilation before tracheostomy was 16 days and the median length of ICU stay was 65 days. All tracheostomies were performed for prolonged mechanical ventilation and airway protection (Table 1).

When procedural details were examined, all PDTs were performed using the Griggs technique. Of these, 55.3%

Table 1: Demographic and clinical characteristics of the patients.

	(n=85)
Age (years)	72.81±16.15 [19-97]
Gender, n (%)	
Male	56 (65.9)
Female	29 (34.1)
Reason for ICU admission, n (%)	
Pulmonary	32 (37.6)
Neurologic	27 (31.8)
Postoperative	14 (16.5)
Sepsis	3 (3.5)
Cardiac	9 (10.6)
Comorbidities, n (%)	
Hypertension	45 (52.9)
Diabetes mellitus	33 (38.8)
Malignancies	8 (9.4)
Respiratory insufficiencies	29 (34.1)
APACHE II	19.98±6.98 [4-39]
GCS	8 (4-11) [3-15]
SOFA	3 (2-4) [0-12]
Length of Hospital stay (days)	66 (37-104) [16-603]
Length of ICU stay (days)	65 (42-107) [15-603]
Intervention in ICU, n (%)	
CVP	49 (57.6)
CVP+PEG	36 (42.4)
NIMV, n (%)	17 (20.0)
NIMV duration (days) (n=17)	13 (9-30) [4-41]
IMV duration (days)	16 (10-23) [16-603]
Tracheostomy timing (days)	18 (12-26) [4-105]
Tracheostomy, n (%)	
Early (<7days)	9 (10.6)
Late (>8 days)	76 (89.4)
Tube thoracostomy, n (%)	6 (7.1)
Tube thoracostomy duration (days)(n=6)	4 (2-7) [1-11]
Bronchoscopy, n (%)	13 (15.3)
Number of bronchoscopies per patient (n) (n=13)	2 (1-2) [1-7]
Transfusion, n (%)	72 (84.7)
Number of transfusions per patient(n) (n=72)	6 (2-8) [1-36]
Use of vasopressors, n (%)	51 (60.0)
Post-tracheostomy MV duration(days) (n=84)	42 (22-85) [0-582]

Data are presented as mean ± SD or median (IQR) [min–max]. p < 0.05 was considered statistically significant.
APACHE II: Acute Physiology and Chronic Health Evaluation II; **GCS:** Glasgow Coma Scale; **SOFA:** sequential Organ failure assessment; **CVP:** central venous pressure catheter; **PEG:** percutaneous endoscopic gastrostomy; **NIMV:** noninvasive mechanical ventilation; **IMV:** invasive mechanical ventilation; **MV:** mechanical ventilation

were performed using anatomical landmarks without any adjunctive technique, 29.4% under USG and fiberoptic bronchoscopy (FOB) guidance, and 15.3% under USG guidance with the aid of a laryngeal mask airway (LMA). None of the patients required conversion to an emergency surgical tracheostomy during the procedure. The ICU mortality rate among patients who underwent PDT was 70.6%, reflecting the severity of the illness in this critically ill population (Table 2).

Table 2: Distribution of guidance techniques and patient outcomes.

	(n=85)
Guidance, n (%)	
Anatomical landmarks	47 (55.3)
USG+FOB	25 (29.4)
USG+LMA	13 (15.3)
Decannulation, n (%)	2 (2.4)
Discharge, n (%)	
Home	10 (11.8)
Ward/Other ICU	15 (17.6)
Death	60 (70.6)

USG: Ultrasonography; **FOB:** Fiberoptic bronchoscopy; **LMA:** Laryngeal mask airway; **ICU:** Intensive care unit

Complications were observed in 30.6% of patients. The most common complications were bleeding (23.5%), hypoxemia (10.6%), and pneumothorax (4.7%). In one patient, paratracheal placement occurred along with bleeding, hypoxemia, and subcutaneous emphysema, leading to termination of the procedure. While the patient was being monitored for a planned surgical tracheostomy, she died before the procedure could be performed. This case was included among the 85 patients as a PDT attempt. Postprocedural complications included stoma infection (3.5%), subcutaneous emphysema (2.3%), and tracheal stenosis (5.9%). In one patient who experienced esophageal rupture during the procedure, a tracheoesophageal fistula developed as a post-procedural complication. Additionally, one patient (1.2%) experienced intraoperative mortality related to the procedure (Table 3, Figures 1 and 2).

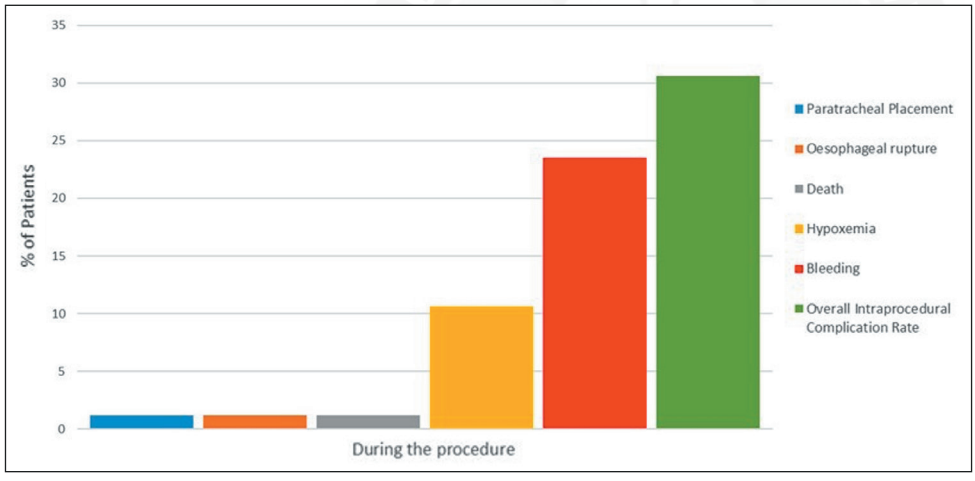

Figure 1: Complications that developed during the procedure.

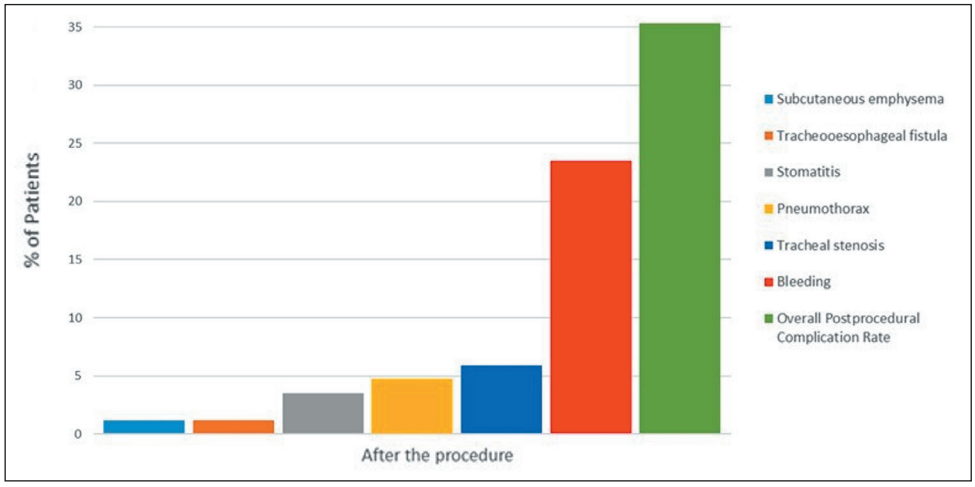

Figure 2: Complications that developed after the procedure.

Table 3: Complications observed during and after the procedure.

	(n=85)		(n=85)
Complications during the procedure, n (%)	26 (30.6)	Complications after the procedure, n (%)	30 (35.3)
Hypoxemia, n (%)	9 (10.6)	Subcutaneous emphysema, n (%)	1 (1.2)
Bleeding, n (%)	20 (23.5)	Bleeding, n (%)	20 (23.5)
Perioperative death, n (%)	1 (1.2)	Pneumothorax, n (%)	4 (4.7)
Paratracheal placement, n (%)	1 (1.2)	Stomatitis, n (%)	3 (3.5)
Oesofageal rupture, n (%)	1 (1.2)	Trachea-oesophageal fistula, n (%)	1 (1.2)
		Tracheal stenosis, n (%)	5 (5.9)

Table 4: Comparison of complications and outcomes according to guidance techniques.

	Anatomical landmarks (n=47)	USG+FOB (n=25)	USG+LMA (n=13)	p
Complications during the procedure, n (%)	17 (36.2)	7 (28.0)	2 (15.4)	0.336
Hypoxemia, n (%)	9 (19.1)	0 (0.0)	0 (0.0)	0.016
Bleeding, n (%)	12 (25.5)	6 (24.0)	2 (15.4)	0.746
Perioperative death, n (%)	0 (0.0)	1 (4.0)	0 (0.0)	0.447
Paratracheal placement, n (%)	1 (2.1)	0 (0.0)	0 (0.0)	1.000
Oesofageal rupture, n (%)	1 (2.1)	0 (0.0)	0 (0.0)	1.000
Complications after the procedure, n (%)	19 (40.4)	5 (20.0)	6 (46.2)	0.152
Subcutaneous emphysema, n (%)	1 (2.1)	0 (0.0)	0 (0.0)	1.000
Bleeding, n (%)	12 (25.5)	3 (12.0)	5 (38.5)	0.168
Pneumothorax, n (%)	3 (6.4)	0 (0.0)	1 (7.7)	0.376
Stomatitis, n (%)	2 (4.3)	1 (4.0)	0 (0.0)	1.000
Trachea-oesophageal fistula, n (%)	1 (2.1)	0 (0.0)	0 (0.0)	1.000
Tracheal stenosis, n (%)	4 (8.5)	1 (4.0)	0 (0.0)	0.691
Decannulation, n (%)	2 (4.3)	0 (0.0)	0 (0.0)	0.671
Discharge, n (%)				
Home	5 (10.6)	2 (8.0)	3 (23.1)	
Ward/Other ICU	9 (19.1)	5 (20.0)	1 (7.7)	0.676
Death	33 (70.2)	18 (72.0)	9 (69.2)	

$p < 0.05$ was considered statistically significant. **USG:** Ultrasonography; **FOB:** Fiberoptic bronchoscopy; **LMA:** Laryngeal mask airway; **ICU:** Intensive care unit

When the procedures were evaluated according to the use of adjunctive guidance methods, hypoxemia was observed significantly more frequently in patients who underwent the anatomical landmark technique without USG, LMA, or FOB guidance (p=0.016). No other statistically significant differences were found in the subgroup comparisons (Table 4).

DISCUSSION

In this ten-year retrospective study, we evaluated the outcomes, complications, and safety profiles of PDTs performed by anesthesiologists in a tertiary intensive care unit. Our results demonstrated that PDT can be safely and effectively performed at the bedside, with a high procedural success rate and acceptable complication rates comparable to those reported in the literature. In the present study, the overall complication rate was 30.6%, with bleeding (23.5%) being the most common intraprocedural complication, followed by hypoxemia (10.6%), and pneumothorax (4.7%). None of the patients required conversion to surgical tracheostomy. These rates fall within the range reported in previous studies, where overall complication rates for PDT procedures have been described between 15% and 35%, with bleeding being the most frequent event (1–3,7). Similar to our findings, Khaja et al. (1) reported an overall complication rate of 25%, whereas Ghattas et al. (3) observed minor bleeding in 22% of patients and major complications in less than 5%. Studies by Memmedova et al. demonstrated that, compared to surgical tracheostomy, PDT has comparable complication rates (8).

In many recent reviews, the role of USG and FOB as adjunctive tools during PDT has been emphasized (2,3,6,9). In

PDTs performed under USG guidance with the aid of a LMA, it has been shown that the procedure duration, equipment damage, cost, and complication rates are reduced compared to the combined use of USG and FOB (10). In our study, the use of these guidance methods was associated with a lower incidence of hypoxemia than the anatomical landmark technique (p=0.016), indicating that real-time imaging contributes to increased procedural safety. Although USG and FOB guidance increase procedural complexity, they provide better control over puncture site localization and facilitate early detection of complications (2). USG vascular mapping has been shown to reduce the risk of bleeding, whereas FOB has been associated with improved tracheal entry and fewer airway-related complications (9). It has been demonstrated that PDT performed under USG guidance reduces complications compared with the anatomical landmark technique (11,12). Although the study by Öner et al. did not demonstrate superiority of FOB use over the anatomical landmark technique in terms of procedure duration, success rate, or complication development, it is noteworthy that this finding was observed when PDTs were performed by an experienced team (13). In our study, the team consisted of anesthesiology residents with at least four years of experience, supervised by an experienced faculty anesthesiologist. This may explain why, except for hypoxemia, complications did not differ significantly with or without the use of guidance techniques or their combination. Considering that hypoxemia may also be associated with the duration of the procedure, one of the limitations of our study is the lack of recorded procedure times in retrospective data. Similarly, previous studies have shown that PDT complications are increased in critically ill obese patients compared to non-obese patients (14). Due to unrecorded data, it was not possible to perform a subgroup comparison of patients based on body mass index.

In our study, the bleeding rate (25%) was near the upper limit reported in the literature. In the literature, the overall bleeding rate associated with PDT ranges from 5% to 25%, with major bleeding reported in less than 5% of cases (15–18). We believe that the reason for this high rate is that, within the ten-year dataset we reviewed, intraoperative reports often lacked sufficient detail; therefore, all patients for whom adrenaline-impregnated sponges were used during the perioperative period, as noted in the discharge summaries, were included in the group classified as having bleeding complications. Since the experience and habitual practices of the healthcare personnel involved during that period could not be included in our analysis, we assumed that all bleeding events, ranging from nonsignificant to major, were added to the total number of complications. The inability to make this distinction is one of the limitations that may have affected the results of our study.

The mortality rate in our cohort (70.6%) reflects the high severity of the illness among patients requiring prolonged mechanical ventilation and tracheostomy. Similar mortality rates have also been reported in other studies focusing on critically ill populations (7,19). This also indicates that mortality was related to the severity of the underlying disease rather than to the tracheostomy procedure itself. The APACHE II and SOFA scores included in our study to assess disease severity were consistent with the literature and indicated a high mortality expectation among ICU patients (19). Furthermore, in our series, procedure-related mortality occurred in only one patient (1.2%), confirming that PDT is safe and feasible even in high-risk patients.

Our findings are consistent with those in the literature, in which PDT is routinely performed by anesthesiologists or intensive care specialists. The strengths of this study include a relatively large sample size, a homogeneous group of operators, and a long observation period covering both the pre- and post-pandemic years. These factors enhance data reliability and allow procedural consistency to be assessed over time. However, this study has several limitations. The retrospective, single-center design may limit the generalizability of the results, and incomplete documentation (such as procedure duration, presence of obesity, and characteristics of bleeding) may restrict some analyses. Additionally, subgroup comparisons (USG+FOB, USG+LMA, anatomical landmarks) were limited owing to unequal group sizes.

Despite these limitations, our ten-year experience supports the conclusion that PDT is safe, effective, and feasible when performed by experienced anesthesiologists or under their supervision in the ICU. The broader implementation of the USG, FOB, and LMA techniques may further reduce procedure-related complications and improve patient outcomes.

Conclusion

In this ten-year single-center experience, the overall complication rate remained within the range reported in the international literature. The use of USG, FOB, and LMA guidance was associated with a reduced incidence of hypoxemia, emphasizing the importance of procedural imaging and operator experience. Procedure-related mortality was low, whereas overall mortality primarily reflected the severity of underlying conditions rather than the tracheostomy procedure itself. Although the retrospective and single-center nature of this study limits the generalizability of the findings, the results support the routine use of percutaneous tracheostomy by trained anesthesiologists in critically ill patients requiring prolonged mechanical ventilation.

Author Contributions

Study conception and design: **Ozlem Ersoy Karka, Gizem Demir Senoglu;** data collection: **Ozlem Ersoy Karka, Gizem Demir Senoglu, Irfan Tufan Baki, Gulbin Sezen, Yavuz Demiraran;** analysis and interpretation of results: **Ozlem Ersoy Karka, Gizem Demir Senoglu, Mehmet Ali Sungur;** draft manuscript preparation: **Ozlem Ersoy Karka, Gizem Demir Senoglu, Irfan Tufan**

Baki, Mehmet Ali Sungur, Gulbin Sezen, Yavuz Demiraran. The authors reviewed the results and approved the final version of the article.

Conflicts of Interest

The authors have no conflict of interest to declare.

Ethical Approval

The local ethics committee of Duzce University (Duzce University Non-Invasive Health Research Ethics Committee) with Approval No: 2024/245, Date: December 02, 2024.

Use of Artificial Intelligence

During the preparation of this work, the authors used Paperpal in order to improve language and readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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