



Percutaneous Dilatational Tracheostomy Applications in Our Intensive Care Units: A 10-Year Retrospective Study

Yoğun Bakım Ünitelerimizde Perkütan Dilatasyonel Trakeostomi Uygulamalarımız: 10 Yıllık Retrospektif Çalışma

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ABSTRACT

Objectives: Percutaneous dilatational tracheostomy (PDT) is an interventional procedure that is widely used in intensive care units (ICUs). This application, which has low complication rates, increases patient comfort and facilitates airway management. However, early and late complications can be seen during and after the procedure. The objective of this study was to perform the clinical evaluation of PDT interventions applied in the ICU over a 10-year period.

Methods: A total of 275 patients over the age of 18 who were hospitalized in the Surgical ICU and Anesthesia ICU and underwent PDT between 2010 and 2020 were included in the study. Patients' age, gender, diagnosis of hospitalization, comorbid diseases, APACHE-II and Glasgow Coma Scale (GCS) scores, hospitalization and discharge dates, time to open tracheostomy, early and late complications encountered during and after the procedure, decannulation, transplantation, and mortality were retrospectively reviewed.

Results: The mean age of the patients was 71.6±14.6 years. During ICU admission, APACHE II scores were 23.3±7.6 and GCS scores were 7.5±3.5. The highest mortality (22%) was in the ischemic or hemorrhagic cerebral injury group. The duration of mechanical ventilation in the ICU was 34.2±19.4 days, and the length of stay in the ICU was 37.2±20.5 days. Time to open a tracheostomy was found as 16.3±7.7 days. PDT was performed in the early (≤10 days) period in 33% of the patients, and in the late (>10 days) period in 67% of the patients. Twenty-seven (9.8%) of the 275 patients develop complications with bleeding being the most commonly seen complication by 4.4%.

Conclusion: PDT is a safe procedure due to its low complication rates. However, we think that fiber optic bronchoscopy and ultrasonography, which are frequently used in different applications in ICUs, may also be effective in reducing complications in PDT applications.

Keywords: Complication, intensive care unit, percutaneous dilatational tracheostomy

ÖZ

Amaç: Perkütan dilatasyonel trakeostomi, yoğun bakım ünitelerinde yaygın olarak kullanılmakta olan girişimsel bir işlemdir. Komplikasyon oranları düşük olan bu uygulama hasta konforunu artırır ve hava yolu yönetimini kolaylaştırır. Ancak işlem sırasında ve sonrasında erken ve geç dönem komplikasyonlar görülebilmektedir. Çalışmanın amacı, 10 yıllık süre içinde yoğun bakım ünitesinde uygulanan perkütan dilatasyonel trakeostomi girişimlerinin klinik değerlendirmesinin yapılmasıdır.

Yöntem: Çalışmamıza 2010-2020 yılları arasında cerrahi yoğun bakım ünitesinde ve anestezi yoğun bakım ünitesinde yatan ve perkütan dilatasyonel trakeostomi açılmış 18 yaş üstü 275 hasta dahil edildi. Hastaların yaşı, cinsiyeti, yatış tanıları, komorbid hastalıkları, APACHE-II ve Glasgow koma skoru puanları, yatış ve taburculuk tarihleri, trakeostomi açılma tarihleri, işlem sırasında ve sonrasında karşılaşılan erken ve geç dönem komplikasyonlar, dekanülasyon, nakil ve mortalite durumları retrospektif olarak tarandı.

Bulgular: Hastaların yaş ortalaması 71,6±14,6 yıl olarak tespit edildi. Yoğun bakım ünitesi yatış günlerine ait APACHE-II puanları 23,3±7,6 ve Glasgow koma skoru puanları 7,5±3,5 idi. En yüksek mortalite (%22) iskemik veya hemorajik serebral hasar grubunda idi. Yoğun bakım ünitesinde mekanik ventilasyonda geçirilen süre 34,2±19,4; yoğun bakım ünitesinde geçirilen süre 37,2±20,5 gün olarak belirlendi. Trakeostomi açılma zamanı 16,3±7,7 gün olarak bulundu. Hastaların %33'üne erken (≤10 gün), %67'sine geç (>10 gün) dönemde perkütan dilatasyonel trakeostomi açıldı. İki yüz yetmiş beş hastanın 27'sinde (%9,8) komplikasyon gelişti. En sık görülen komplikasyonu kanama oluşturdu (%4,4).

Sonuç: Perkütan dilatasyonel trakeostomi düşük komplikasyon oranları nedeniyle güvenli bir uygulamadır. Ancak yoğun bakım ünitelerinde farklı uygulamalarda sıklıkla kullanılan fiberoptik bronkoskopi ve ultrasonografinin perkütan dilatasyonel trakeostomi uygulamalarında da komplikasyonları azaltmada etkili olabileceğini düşünmekteyiz.

Anahtar sözcükler: Komplikasyon, perkütan dilatasyonel trakeostomi, yoğun bakım ünitesi

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Introduction

Tracheostomy is an interventional procedure that is widely used in intensive care units (ICU). Surgical or percutaneous dilatational tracheostomy (PDT) techniques can be used for the procedure. PDT is a procedure in which blunt dissection of pretracheal tissues is followed by dilation of the trachea over the guidewire and placement of the tracheal cannula with the Seldinger technique.^[1,2] It is frequently preferred in ICUs, especially in cases where elective tracheostomy will be performed, because it can be applied easily and in a short time at the patient's bed, and its complication rates and cost are low.^[3,4]

PDT applications increase patient comfort, reduce the need for sedation, shorten and ensure safer execution of the weaning process, improve oral hygiene, allow oral nutrition, facilitate patient self-expression, and airway care outside the ICU.^[5,6] Although timing for tracheostomy applications is still controversial, early (<10 days) tracheostomy placement is associated with better outcomes.^[7,8]

However, some complications such as bleeding, hypercapnia, hypoxia, subcutaneous emphysema, pneumothorax, tracheal wall and esophageal injury, paratracheal placement, aspiration, sudden death, decannulation, tracheoesophageal fistula, and tracheal stenosis can be seen during and after the procedure.^[9,10]

The aim of this study is to make a clinical evaluation of PDT interventions applied in an ICU over a 10-year period. Thus, comparable data will be obtained with the aim of reducing complications and improving practices.

Methods

Our study included 319 patients aged over 18 years who were hospitalized in the Surgical ICU and Anesthesia ICU and underwent PDT between 2010 and 2020. Forty-four patients were excluded due to missing data. The study was approved by the Recep Tayyip Erdoğan University Non-Invasive Clinical Research Ethics Committee. (Date: 08/04/2021; Decision No: 2021/54).

Patients' age, gender, diagnosis of admission, comorbid diseases, APACHE-II and Glasgow Coma Scale (GCS) scores, hospitalization and discharge dates, time to open tracheostomy, early and late complications encountered during and after the procedure, decannulation, transplantation, and mortality were retrospectively reviewed. The screening was carried out through archived ICU epicrisis and hospital information management system. Relatives of the patients who were discharged with a home type mechanical ventilator were contacted by phone and learned about the patients' health status, decannulation status, and whether they were using a mechanical ventilator.

PDT Protocol in Our Clinic

Enteral feeding of all patients was stopped 6 h before the procedure. Routine monitoring was provided with electrocardiography, pulse oximetry, end-tidal carbon dioxide pressure, and blood pressure during the procedure. FiO_2 was set to 100% at controlled mode in the mechanical ventilator. The patients were administered intravenous (iv) fentanyl 2 μ g/kg, midazolam 0.1 mg/kg, and rocuronium 0.6 mg/kg. for anesthesia. While the patients were lying in the supine position, the head was extended with a support placed under the shoulder. In our clinic, forceps dilatation method (Griggs guidewire dilating forceps) is used in PDT procedures. During the procedure, the assistant standing at the patient's bedside deflated the endotracheal tube balloon and pulled the tube under the vocal cords. The spacing between the second and third tracheal rings was determined by palpation and local anesthesia was administered with 2% lidocaine (2-3 mL) containing 1/100,000 adrenaline. A transverse incision of approximately 1 cm was made utilizing a scalpel and a 14 G needle was advanced into the tracheal lumen with a saline-filled syringe until air aspiration was observed. When the trachea was reached, a guidewire was inserted into the lumen through the needle. The entry site was dilated by passing an 8F dilator over the guide wire. After the dilator was removed, the skin, subcutaneous layer and trachea were dilated with a forceps and a #7.5 or #8 tracheotomy cannula was inserted into the trachea. Respiratory sounds were listened, patients were closely monitored for early complications over 24 h and control chest radiographs were evaluated.

Statistical Analysis

Statistical analysis was performed with SPSS 22.0 (Statistical Package for the Social Sciences) package software. In the evaluation of the data, qualitative data are expressed as frequency and percentage, and quantitative data as mean \pm standard deviation. To compare variables Chi-square test and Student's t-test were used. p-values below 0.05 were considered statistically significant.

Results

Between 2010 and 2020, PDT was applied to 319 patients in the Surgical ICU and Anesthesia ICU. Among these, screening data were obtained for 275 patients. Of all patients, 56.6% were male. The mean age of all patients was 71.6 ± 14.6 years and the body mass index was 26.5 ± 4.7 kg/m². Of the patients, 53.6% were admitted from the emergency department, 39.5% from other services, and 6.5% from another secondary ICU. The most common comorbid diseases observed in the patients were hypertension (47.5%), chronic obstructive pulmonary disease (30.1%),

Table 1. Distribution of tracheostomized patients according to clinical diagnosis and mortality rates

Cause of hospitalization	90-Day				Total	
	Survived		Died		n	%
	n	%	n	%		
Ischemic or hemorrhagic cerebral injury	24	8	60	22	84	30
Acute or chronic pulmonary pathologies	18	7	50	18	68	25
Infectious diseases	12	4	22	8	34	12
Coronary ischemic pathology	12	4	18	7	30	11
Surgical complications	5	2	16	6	21	8
Multi-traumas	6	2	14	5	20	7
Cancers and diseases that cause immunodeficiency	1	1	9	3	10	4
Chronic organ failures	2	1	6	2	8	3
Total	80	29	195	71	275	100

and diabetes mellitus (27.2%). The 90-day mortality rate of all patients included in the study was 71%. The highest mortality (22%) was in the ischemic or hemorrhagic cerebral injury group (Table 1).

The duration of mechanical ventilation in the ICU was 34.2 ± 19.4 days, and the length of stay in the ICU was 37.2 ± 20.5 days. The length of stay in the ICU according to the clinical diagnosis of the patients is given in Table 2.

The earliest PDT was performed on the 2nd day and the latest PDT was performed on the 63rd day of ICU admission. Time to open a tracheostomy was determined as 16.3 ± 7.7 days. PDT was performed in the early (≤ 10 days) period in 33% of the patients and in the late (> 10 days) period in 67% of the patients (Table 3). In the patient group with early tracheostomy, the APACHE II and GCS scores of the ICU hospitalization days were determined as 24.43 ± 7.37 and 7.04 ± 3.16 , respectively. In the group of patients with late tracheostomy, the APACHE II and GCS scores of the ICU hospitalization days were determined as 22.69 ± 7.61 and 7.7 ± 3.74 , re-

Table 2. The length of stay in the intensive care unit according to the clinical diagnosis of the patients

Clinical diagnosis	Days of hospitalization in the ICU Mean \pm SD
Ischemic or hemorrhagic cerebral injury	37.7 \pm 18.9
Acute or chronic pulmonary pathologies	35.1 \pm 16.5
Infectious diseases	31.5 \pm 12.9
Coronary ischemic pathology	34.6 \pm 17.5
Surgical complications	47.3 \pm 31.9
Multi-traumas	36.2 \pm 14.4
Cancers and diseases that cause immunodeficiency	32.7 \pm 24.3
Chronic organ failures	37.4 \pm 21.6

ICU: Intensive care unit; SD: Standard deviation.

spectively. There was no statistically significant difference between the early and late tracheostomy groups in terms of APACHE II and GCS scores ($p > 0.05$, $p = 0.73$, and $p = 0.151$).

Table 3. Day to tracheostomy application according to the clinical diagnosis of the patients

Clinical diagnosis	Number of patients according to the time to tracheostomy, n		Total	
	≤ 10 days	> 10 days	n	%
Ischemic or hemorrhagic cerebral injury	25	59	84	30
Acute or chronic pulmonary pathologies	19	49	68	25
Infectious diseases	10	24	34	12
Coronary ischemic pathology	14	16	30	11
Surgical complications	6	15	21	8
Multi-traumas	8	12	20	7
Cancers and diseases that cause immunodeficiency	5	5	10	4
Chronic organ failures	4	4	8	3
Total	91	184	275	100

Table 4. Tracheostomy complications and rate

Complication type	Patients	
	n	%
Early	25	9.1
Hemorrhage	12	
Subcutaneous emphysema	8	
Pneumothorax	3	
Cannula length insufficiency	2	
Late	2	0.7
Tracheal granuloma	1	
Tracheoesophageal fistula	1	
Total	27	9.8

The 90-day mortality was 64.8% in the early tracheostomy group and 73.9% in the late tracheostomy group. However, there was no significant difference between the groups in terms of 90-day mortality ($p=0.124$).

Twenty-seven (9.8%) of the 275 patients develop complications (Table 4). The most common complication was bleeding (4.4%). In tracheostomies with bleeding complications, it was observed that bleeding developed from the incision area or around the tracheostomy within the first 48 h. In 11 of the patients who developed bleeding, it was determined that the bleeding was stopped by cauterization, suturing or pressure dressing with adrenaline. In a patient who developed bleeding, surgical support was requested, bleeding was controlled, and then the PDT procedure was completed. Among the early complications, three patients developed pneumothorax and underwater drainage was applied for treatment. It was observed that eight patients who developed subcutaneous emphysema after PDT did not need any intervention. It was determined that a patient who developed tracheal granuloma was followed up with endotracheal intubation for 22 days, and then diagnosed by bronchoscopic evaluation due to recurrent airway pressure increases on the 36th day of tracheostomy, and the patient was followed-up with an adjustable length cannula and died due to septic clinical picture.

Of the patients who underwent tracheostomy, 11 were referred to external centers without switching to a home ventilator, and 21 patients were transferred to the relevant services in spontaneous breathing with easy breath and 92 patients in assisted/controlled breathing with a home ventilator. Only 12 (4.4%) of the patients were decannulated during follow-up.

Discussion

In our study, we examined 275 patients who underwent PDT during a 10-year period in the ICU. The mean age of

the patients was 71.6 ± 14.6 years, and 56.6% were male. The most common indications for PDT according to clinical diagnosis were ischemic/hemorrhagic cerebral injury and acute/chronic pulmonary pathologies. The intubation duration of the patients was 16.3 ± 7.7 days and the total length of stay in the ICU was 37.2 ± 20.5 days. Early and late complications related to PDT developed in 9.8% of the patients. The most common complications during the application were early bleeding and subcutaneous emphysema. In the late period, tracheal granuloma and tracheoesophageal fistula were detected.

It is important to minimize the complications of endotracheal intubation and mechanical ventilation in ICU. In cases of prolonged endotracheal intubation, tracheostomy is applied to ensure the airway safety and comfort of the patients.^[11] PDT is preferred for its advantages such as low complication rates and short opening time.^[1,3,12-15] Similar to our study, there are studies in the literature reporting that early and late complications related to PDT are less common,^[16,17] as well as studies that found the opposite.^[18,19]

Karasu et al.^[14] evaluated 132 patients who underwent PDT and reported that 37.5% of them were hospitalized for neurological disorders. Other studies have stated that the most common diagnosis of ICU admission was neurological disorders, followed by respiratory failure.^[15,20,21] In our study, the most common hospitalization diagnoses of our patients who underwent PDT were ischemic/hemorrhagic cerebral injury and acute/chronic pulmonary pathologies.

There are recommendations regarding the days on which tracheostomy should be performed in patients with mechanical ventilation in the ICU. However, PDT procedures performed within 8-10 days are associated with better results. The time from hospitalization to the day of tracheostomy application varies among studies.^[13,22] In our study, the number of patients who underwent tracheostomy in less than or more than 10 days was 91 (33%) and 184 (67%), respectively. We thought that factors such as the mean age of the patients in the geriatric age group, the inability to obtain consent for tracheostomy from the relatives of the patients in a short time, and the use of anticoagulant drugs were effective in this result.

Minor hemorrhages, which are among the early complications of PDT, usually originate from the anterior tracheal wall. These hemorrhages can be controlled by pressure or suturing during the application. The previous studies reported minor bleeding, which is one of the early complications of PDT, at a rate of 1.5-5.2%.^[11,20,21] In our study, minor bleeding occurred at a rate of 4.3% during the procedure. Major bleedings are venous bleedings at a rate of 0.17-2.6%.^[23-25] In our study, major bleeding was observed

in one case. These complications should be detected in a short time and surgical intervention should be performed by performing neck exploration without delay.

The use of fiberoptic bronchoscopy (FOB) during PDT procedures prolongs the procedure time, but can reduce complications.^[26] However, a recent study demonstrated that the use of real-time ultrasonography (USG) during PDT provides an advantage over conventional PDT using bronchoscopy in reducing the incidence of minor bleeding.^[27] In our clinic, we prefer surgical tracheostomy in cases such as morbid obesity, goiter, cervical pathology, and anatomical difficulties. Therefore, we found low early complication rates in our study. However, we think that the use of USG and FOB can provide a safer application area in specific patients.

Tracheal stenosis and granuloma, tracheoesophageal fistula, and stromal infection can be seen as late complications of PDT. Tracheoesophageal fistula complication is encountered in 1% of PDT cases in the late period. In general, this complication occurs due to iatrogenic damage and ischemia of the posterior tracheal wall.^[28] In our study, tracheoesophageal fistula complication occurred in one patient. It is known that late complications are related to cuff pressure apart from PDT techniques. Sanwal et al.^[29] stated that fistula develops when cuff pressure increases more than 20 cm H₂O and volume more than 6-8 ml. The cuff pressure and volume of our tracheostomy cannulas were not regularly monitored in our ICUs. If follow-up can be carried out at regular intervals, late complications related to PDT can be reduced.

PDT is a commonly performed procedure in ICUs and provides many benefits for the patient. However, there is no consensus on optimal timing in previous studies. In a Cochrane review of eight studies involving 1977 patients that evaluated the clinical outcomes of early (≤ 10 days) and late (> 10 days) tracheostomy, the early tracheostomy group was found to have a lower risk of mortality (95% CI, 0.70-0.98%), $p=0.03$.^[30] In other studies, it was stated that early tracheostomy did not provide any benefit in terms of mortality.^[31-34] A meta-analysis of 13 studies, including 2,434 patients, found that all-cause mortality in patients who underwent early (≤ 7 days) PDT; showed that it was not significantly lower than in patients who underwent late (> 7 days) PDT.^[35] In our study, it was observed that there was no difference in mortality between the patient groups with early and late tracheostomy.

Primary limitation of our study was its retrospective design and lack of the standardization of PDT applications. Our secondary limitation was that tracheostomy cuff pressure and volume were not evaluated in our clinic. If tracheostomy cuff pressure and volume were examined at regular intervals, late complications related to PDT could be predicted.

Conclusion

PDT is an easy method that can be applied at the bedside in a short time in ICU patients who need mechanical ventilation for a long time. PDT is a safe practice due to its low complication rates. However, we think that FOB and USG, which are frequently used in different applications in ICUs, may also be effective in reducing complications in PDT applications.

Disclosures

Ethics Committee Approval: The study was approved by The Recep Tayyip Erdoğan University Faculty of Medicine Non-Invasive Clinical Research Ethics Committee (Date: 08/04/2021, No: 2021/54).

Informed Consent: Patient consent was not deemed necessary because of the retrospective study design.

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