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Tracheostomy Practices in Pediatric Intensive Care Unit, Single Center Experience

Çocuk Yoğun Bakım Ünitesinde Trakeostomi Uygulamaları, Tek Merkez Deneyimi

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Abstract

Aim: Tracheostomy is one of the most frequently performed surgical procedures in the pediatric intensive care unit (PICU). While it used to be an emergency treatment method in patients with laryngeal obstruction, it is now mostly used in patients with prolonged mechanical ventilation under elective conditions. In this study, we aimed to evaluate patients who underwent tracheostomy in our PICU, indications, and complications.

Material and Method: This retrospective study was conducted from February 2018 through April 2022. Data was collected from the patient's records and analyzed.

Results: Forty-three patients were included in the study. The median age of the patients was 5±4.99 (0-17 years) and 30 patients (69.8%) were male. During the four-year study period, the tracheostomy rate was 2.4% and the decannulation rate was 7%. The most common indication for tracheostomy was prolonged mechanical ventilation (88.3%). The median time of mechanical ventilation before tracheostomy was 68.33±27.22 (range 0-240) days. No surgical complications were observed during the PICU follow-up. All patients were discharged from PICU with a home-type mechanical ventilator. The median number of outpatient controls after discharge was 7.28±1.89 (range 3-10), and the median number of annual cannula replacements was 3.62±0.76 (range 1-5). 14 patients died after discharge from the PICU. The median time of death was 30±13.97 (range 11-56) months after discharge from the PICU. When the surviving and deceased patients were compared according to age, mechanical ventilation time, and length of stay in the PICU, no significant difference was found (p=0.291, p=0.115, and p=0.291, respectively).

Conclusion: In our study, long mechanical ventilation time was the most common indication for tracheostomy, and our result is consistent with the literature. Although the timing of tracheostomy was long, no significant correlation was observed with mortality.

Keywords: Pediatric intensive care, tracheostomy, decannulation, prolonged mechanical ventilation

Öz

Amaç: Trakeostomi çocuk yoğun bakım ünitesinde (ÇYBÜ) sık uygulanan cerrahi girişimlerden biridir. Önceleri laringeal obstruksiyonu olan hastalarda acil tedavi yöntemi iken günümüzde daha çok elektif şartlarda uzamış mekanik ventilasyon süresi olan hastalarda uygulanmaktadır. Bu çalışmada, ÇYBÜ'mizde trakeostomi uygulanan hastaları, endikasyonları, ve komplikasyonları değerlendirmeyi amaçladık.

Gereç ve Yöntem: Bu retrospektif çalışma Şubat 2018'den Nisan 2022'ye kadar gerçekleştirildi. Veriler hasta kayıtlarından toplandı ve analiz edildi.

Bulgular: Kırk üç hasta çalışmaya alındı. Hastaların ortanca yaşı 5±4.99 (aralık 0-17 yaş) ve 30 hasta (%69.8) erkek idi. Dört yıllık çalışma döneminde trakeostomi oranı %2,4 ve dekanülasyon oranı %7 bulundu. En sık trakeostomi uygulama endikasyonu uzamış mekanik ventilasyondu (%88.3). Trakeostomi öncesi entübasyon süresi ortanca 68.33±27.22 (aralık 0-240) gündü. Çalışmada yoğun bakım izlem sürecinde cerrahi komplikasyon izlenmedi. Tüm hastalar yoğun bakımdan ev tipi mekanik ventilatör ile taburcu edildi. Taburculuk sonrası poliklinik kontrol sayısı ortancası 7.28±1.89 (aralık 3-10), yıllık kanül değişim sayısı ortancası 3.62±0.76 (aralık 1-5) idi. 14 hasta ÇYBÜ'den taburcu olduktan sonra kaybedildi. Ölüm zamanının ortancası ÇYBÜ' den taburculuk sonrası 30±13.97 (aralık 11-56) aydı. Hayatta kalan ve ölen hastalar yaş, mekanik ventilasyon süresi ve ÇYBÜ' de kalış süresine göre karşılaştırıldığında arada anlamlı fark bulunmadı (sırasıyla p=0.291, p=0.115 ve p=0.291).

Sonuç: Bizim çalışmamızda uzun mekanik ventilasyon süresi trakeostomi açılması için en sık endikasyon olup sonucumuz literatür ile uyumludur. Trakeostomi zamanlaması uzun olsa bile mortalite ile arada anlamlı ilişki görülmemiştir.

Anahtar Kelimeler: Çocuk yoğun bakım, trakeostomi, dekanulasyon, uzamış mekanik ventilasyon

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INTRODUCTION

Tracheotomy refers to a surgical incision in the trachea. Tracheostomy, on the other hand, is a surgical procedure in which a stoma is created between the trachea and the skin. Tracheostomies have been performed since ancient times for various clinical conditions. Although it was not incorporated into routine clinical practice until the 19th century, it later became an emergency treatment method for patients with acute laryngeal obstruction due to diphtheria. [1] Initially used as a last resort for acute airway obstruction, this method had a high mortality rate in the early period. However, with the introduction of standard procedures and increased support for follow-up treatment by Chevalier Jackson in the early 20th century, mortality and morbidity significantly decreased. [2, 3]

Following the Copenhagen poliomyelitis epidemic in 1952, tracheostomy became the standard procedure for virtually all patients with respiratory failure. [4] As modern medicine advanced, tracheostomy, which was initially used routinely in patients with upper airway obstruction due to diphtheria and epiglottitis, began to be employed for various indications. In both adults and children, tracheostomy is used for acute or chronic upper airway obstruction, facilitating patient care in cases requiring long-term ventilation support, protection from aspiration, prevention of laryngotracheal stenosis in patients requiring prolonged intubation, and aiding weaning from a ventilator by eliminating the dead space created by the endotracheal tube. Common indications for tracheostomy in children include congenital and acquired airway stenosis, neurological conditions requiring prolonged intubation, bilateral vocal cord failure, and laryngeal stenosis due to infectious upper respiratory tract infection.[5-8] The timing, indications, techniques, and home care conditions for tracheostomy vary widely.[9-11] The outcomes of tracheostomy generally depend on factors such as age, comorbidities, patient anatomy, experience of the unit, timing of tracheostomy, and techniques used. [12-14] In this study, we aimed to evaluate patients who underwent tracheostomy, indications, and complications in our single-center experience.

MATERIAL AND METHODS

This retrospective study was conducted from February 2018 through April 2022. The study included patients aged 1 month to 18 years who were followed up in the pediatric intensive care unit (PICU) and underwent tracheostomy for the first time. Patients who had previously undergone tracheostomy in another hospital or department, as well as those under 1 month and over 18 years of age, were excluded from the study. Data regarding demographics (age, gender, race, underlying disease, genetic diagnosis), tracheostomy indications, time elapsed until tracheostomy after the indication, factors affecting the time between the indication and the procedure, location of the operation (operating room / PICU bedside), procedure duration, postoperative complications, tube replacement frequency, and reasons, infection details, and mortality were recorded. Indications, timing, early and late complications, and tracheostomy outcomes were collected and analyzed. Indications, timing, early and late complications, and tracheostomy outcomes were collected and analyzed. Patients were followed up at the hospital every two months for at least 6 months after discharge.

The decision for tracheostomy was made by a pediatric intensivist for all patients. A pediatric surgeon performed all of the tracheostomy procedures. A pediatric surgeon conducted all tracheostomy procedures, determining the timing of the procedure after obtaining informed consent from the parents in collaboration with the intensivist. A standardized tracheostomy procedure was followed in all cases. Most tracheostomies were performed in the operating room, with only a few emergency cases being performed bedside in the PICU.

Parents and caregivers actively participated in the care of tracheostomized patients. They received education on routine tracheostomy care, including suctioning and tube changing through demonstrations. Information brochures on care were provided to patients. Given that the PICU comprised isolated rooms allowing parents to stay with the patient, suitable hours were arranged for educational sessions. Parents and caregivers were also trained on equipment use such as suction catheters, suction machines, and pressure setup before discharge.

Statistical Analysis

Statistical analysis was done using the SPSS 25.0 (Statistical Program Social Sciences) program. In the evaluation of the data, the frequencies and percentages were given for the qualitative (qualitative) data. From quantitative descriptive statistical methods, mean and standard deviation were used for normally distributed data, while median widths and averages were used for non-normally distributed data. Data were expressed as means (SD), medians (interquartile range [IQR]), and proportions as appropriate. Kolmogorov-Smirnov test was used to determine the normal distribution of the data. The Mann-Whitney U test was used for comparisons between two groups of quantitative variables that did not show normal distribution. For all tests, a p-value <0.05 was considered statistically significant.

RESULTS

A total of 3822 patients were admitted to the PICU during the 4 years. 1722 patients were followed up with a mechanical ventilator. When these patients were examined according to prolonged mechanical ventilation time, the number of intubated patients for more than 14 and 28 days were 664 and 94, respectively. Tracheostomy was performed in 43 (2.4%) patients out of 1722 intubated patients. Considering

the prolonged mechanical ventilation period, tracheostomy was performed in 6.4% of the patients who remained on mechanical ventilation for more than 14 days and in 45.7% of those who remained on mechanical ventilation for more than 28 days. Intubated patients followed by PICU are shown in **Figure**.

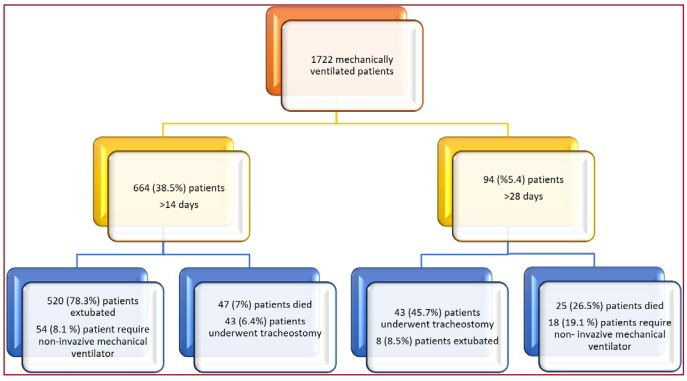

Figure: Detailed evaluation of the patients who were intubated in the PICU for 4 years, according to the length of stay on mechanical ventilator for 14 days and 28 days.

Of the 44 patients, 30 (69.8%) were male. The median age of the patients was 5±4.99 [Interquartile range (IQ) 0-17 years]. The median body weight of the patients was 18.51±4.99 (IQ range, 0-70) kilograms. There was a chronic disease in 38 patients (86.3%). Eleven patients (25.5%) had tracheostomy performed within the first year of life. The most common indication for tracheostomy was prolonged mechanical ventilation secondary to cerebral palsy and neuromuscular diseases. The clinical features of patients and tracheostomy indications are given in **Table 1**. Tracheostomy was performed in 39 (90.7%) patients in the operating room under elective conditions, and in three patients (1.3%) in the PICU due to emergency. The indication for tracheostomy was prolonged mechanical ventilation (PML) in 38 (88.4%) patients and anatomical defect in five (7%) patients. The distribution of the patients according to the underlying diseases is given in **Table 1**. The median duration of tracheostomy after admission to the PICU was 115.51±14.39 (IQ range, 0-70) days; it was 68.33±27.22 (range 0-240) (IQ range, 0-240) days after undergoing the mechanical ventilator. The reason for the late implementation of the tracheostomy was that the parents did not give their consent to the medical staff due to their anxiety and fear about tracheostomy care. Only 3 patients were accidentally decannulated in the early period, and other complications such as wound infection, bleeding, or trachea-innominate artery injury were not observed in the study. After discharge, wounds occurred at the entrance area in 3 patients and granulation tissue in 4 patients. The median length of stay in the PICU after tracheostomy was 31 days (IQ range, 9-182)

Table 1: Demographics and clinical features of patients who underwent tracheostomy

	N (%)
Gender	
Female	13 (30.2)
Male	30 (69.8)
Age	
< 1 year	11 (25.5)
1-5 years	18 (41.8)
> 5 years	14 (32.5)
Underlying chronic disease	38 (88.3)
Cerebral palsy	15 (34.8)
Neuromuscular disease- neurologic disorder	8 (18.6)
Diagnosed genetic disorder	5 (11.6)
Metabolic disorder	5 (11.6)
Congenital cardiac defect	3 (6.9)
Chronic lung disease (bronchopulmonary dysplasia, pulmonary alveolar proteinosis)	2 (4.6)
Previously healthy child	5 (11.6)
Traumatic craniofacial anomaly	3 (6.9)
Anatomical defect (laryngeal stenosis, thoracic tumor)	2 (4.6)
Tracheostomy Indications	
Prolonged mechanical ventilation	38 (88.4)
Upper airway obstruction	2 (4.6)
Traumatic craniofacial anomaly	3 (6.9)

All patients were discharged from the PICU. Only three (7%) patients were able to be decannulated at follow-up. The median number of one-year visits to the outpatient clinic for tracheostomy care in the post-discharge period was 7.2±1.8 (IQ range, 3-10), and the median number of one-year cannula replacements was 3.6±0.7 (IQ range, 1-5) times. In the study, 14 (32.6%) patients died, the median time of death was 30±13.9 (IQ range,11-56) months after tracheostomy placement. All patients died after discharge. Although the rate of patients who died in infancy was higher, there was no statistically significant difference. In the study, when the surviving and non-survived patients were compared according to their ages, length of stay in PICU, and mechanical ventilation periods, no statistically significant difference was found (p values p=0.102, p=0.291, p=0.115, respectively) (**Table 2**). The median survival time of 29 patients who survived after tracheostomy was 39.28±9.14 (IQ range, 16-54) months.

Table 2: Comparison of surviving and deceased patients by age, duration of mechanical ventilation, and length of stay in the PICU

	Total N (%)	Survived N (%)	Non-survived N (%)	p
Age				
0-2 years old	20 (46.5)	13 (65)	7 (35)	0.102
2-17 years old	23 (53.8)	16 (69.5)	7 (30.4)	
Duration of mechanical ventilation				
<28 days	4 (9.3)	13 (33.3)	1 (25)	0.115
>28 days	39 (90.6)	26 (66.6)	3 (75)	
Length of stay in PICU				
<21 days	2 (4.6)	1 (3.4)	1 (71.4)	0.291
>21 days	41(95.3)	28 (96.5)	13 (92.8)	

PICU: Pediatric intensive care unit

DISCUSSION

In recent years, there has been a notable increase in the rate of tracheostomies performed on children, a trend closely linked to advancements in neonatal and pediatric intensive care. While tracheostomy was initially employed as an emergency life-saving measure, a significant portion of tracheostomized

children now constitute a highly complex patient group heavily reliant on tracheostomy and associated medical technologies for their long-term survival. [1-5, 13] In our study, tracheostomy was carried out as an emergency treatment in only 6.9% of cases. The majority of patients underwent tracheostomy due to the necessity for prolonged mechanical ventilation. Notably, our study showed a smaller proportion of patients with upper airway obstruction compared to other studies (4.6%). [7,14]

All patients in our study were discharged from the PICU after undergoing tracheostomy. The discharge rate observed in our study was higher than reported in other studies.[14, 15, 16] The ability to discharge 45.7% of patients intubated for more than 28 days is of significant importance for PICU operations. This allows for the admission of new patients and aids in cost management, particularly in regions where specialized palliative care centers are scarce and there is a limited number of intensive care beds Presently, a distinct objective is to transition patients to palliative care centers by implementing tracheostomy at an early stage, particularly in cases of chronic diseases where significant improvement is not anticipated. This transition aims to alleviate PICU occupancy rates and optimize healthcare resource utilization.

The literature strongly advocates for performing tracheostomies in pediatric patients during the early stages of their care. Various publications emphasize that prolonged ventilation before tracheostomy is linked with increased morbidity and extended stays in the PICU. Early tracheostomy has been proposed to offer substantial benefits without affecting mortality rates. [17, 18] However, in this study, the timing of tracheostomies was notably delayed. The primary reason for this delay was the absence of a pediatric intensive care specialist during the initial year and the extended intubation periods experienced. This delay was attributed to the fear, panic, and anxiety of families in this regard. Educating families is crucial to mitigate these concerns. In developed countries, tracheostomy care relies on skilled multidisciplinary teams, encompassing physicians, nurses, respiratory physical therapists, speech therapists, dietitians, and psychologists, with extensive professional expertise. [19-21] In our country, specialized teams of this nature are lacking, leading families to feel uncomfortable and insecure about the procedure.

The majority of the cases in this study involved boys (69.8%) aligning with similar findings in other studies. [14, 19, 20] Existing literature notes that a significant proportion of patients undergoing tracheostomy are under the age of one. [14,19, 21,22] However, in our study, a lower number of infants were observed, with 74.3% of patients being over one year old. Several factors may contribute to this observation, including the patient population studied, the occurrence of tracheostomies in neonatal intensive care units for patients with congenital defects (thus not being included in our study), and cultural or ethnic reasons, which sometimes prompt families to consent to tracheostomy at a later stage.

In our study, the rate of the patients being decannulated was notably low compared to the other studies in Turkey. [17, 23-28] This discrepancy is believed to be attributed to the high number of patients with underlying chronic conditions in our study. The literature does not provide specific guidance on the duration between cannula changes in pediatric patients. However, it is generally deemed safe to change the cannula after the third day. [29, 30] Subsequently, we observed that the average time for cannula changes after discharge was notably prolonged.

In our study, all patients were discharged home with a home ventilator, and no serious complications were observed during the follow-up period in the intensive care unit. The absence of tracheostomy-related fatalities aligns with findings from comparable studies in our country. [16, 20, 27, 31] Prolonged mechanical ventilation remains the most common indication, consistent with other studies. [16, 20, 27, 28] Upon examining the underlying chronic conditions of our patients, a notable proportion had hypoxic-ischemic encephalopathy and cerebral palsy which significantly contributes to this trend. Comparing patients with survived and those who did not, there were no significant differences in terms of age, duration of mechanical ventilation, and length of stay in the PICU. Interestingly, despite the extensive tracheostomy use and prolonged PICU stay observed in our study, the lack of significant differences can be attributed to the relatively low incidence of sepsis due to resistant bacterial infections, a common complication of extended hospitalization. The isolated room set up in our PICU and the comprehensive care training of our medical team (including nurses and allied health personnel) also played a role. Additionally, families often refrained from giving informed consent for tracheostomy in patients with no life expectancy, regardless of the duration of mechanical ventilation.

Our study has some limitations. First, it is a single-center retrospective study. Second, the number of patients is insufficient to assess the outcome of patients in different subgroups (upper airway obstruction).

CONCLUSION

In conclusion, our study aligns with other research regarding tracheostomy indications and the patient population. Tracheostomy remains the primary option for patients with chronic underlying diseases who necessitate prolonged mechanical ventilation and need to be discharged from the PICU. Similar to previous studies, our findings demonstrate that tracheostomy, when performed under intensive care conditions, carries a low mortality and morbidity rate. A notable challenge in our study was the prolonged timing of tracheostomy and the extended length of stay in the PICU. This issue underscores the critical role of pediatric intensivists and their involvement in patient management. We believe that addressing this challenge requires proactive engagement with parents, encouraging them to consider tracheostomy.

This proactive approach can ensure better post-discharge healthcare team support, organized by healthcare providers, and educate parents on proper care for their children at home once the clinical situation has stabilized.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Mersin University Clinical Researches Ethics Committee (Date:15.12.2021. Decision Number: E-1854281).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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