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Pediatric tracheotomy: Results of a single center study on 46 patients

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Abstract

In this study, we aimed to present our tracheotomy experiences in pediatric patients in our hospital. We reviewed the data by analyzing pediatric tracheotomy retrospectively in terms of indications, follow-up and complications. Forty-six pediatric patients who underwent tracheotomy between 2014 and 2021 were included. The indications were examined under five headings according to the diagnoses that led to the tracheotomy of the patients. These were prolonged intubation, upper airway obstruction, craniofacial anomalies, neuromuscular disorders, and postoperative-traumatic sequelae. Twenty-three (50%) of these patients were girls, and 23 (50%) were boys. The mean age of the patients was 53.8±62.9 months. The youngest patient was a 1-day-old newborn, while the oldest patient was 15 years old. Pediatric tracheotomy was performed in 14 patients for prolonged intubation, 12 patients for craniofacial anomalies, 7 patients for upper airway obstruction, 7 patients for postoperative-traumatic sequelae and 6 patients for neuromuscular disorders. Preoperative or postoperative complications were seen in 10 of the patients. The intubation time of the patients who underwent elective tracheotomy was calculated as 25.7±17.1 days. Of these patients, the shortest duration of intubation was 6 days, and the longest duration was 90 days. The smallest diameter of the tracheostomy cannula inserted in the patients was 2.5 mm, while the largest was 7 mm, and the mean was 4.5 mm. In the follow-ups, it was observed that only 6 of the patients were decannulated, 11 of them died, and the remaining 29 continued their lives with tracheostomy. As a result, although pediatric tracheotomy is rare, it is a life-saving surgical procedure for the appropriate indications and can be successfully performed with manageable complications, contrary to expectations, with the appropriate surgical technique and adequate postoperative care.

Keywords: Pediatric tracheotomy, indications, complications

Introduction

Tracheotomy is a surgical method that has been applied since the ancient Greek era as a life-saving procedure, in the 100s BC, when the trachea was discovered [1]. The first successful pediatric tracheotomy was performed in the early 17th century [2]. Trousseau started the practice of pediatric tracheotomy in the modern sense by publishing 50 pediatric cases on which he performed tracheotomy due to diphtheria in 1836 [3]. Tracheotomy in pediatric patients poses greater challenges and is associated with higher morbidity and mortality than in adults. The younger the patient is at the time of tracheotomy, the greater the risk [4].

Although pediatric tracheotomy has been a successful surgical procedure for many years, there have been serious changes in processes from indication to decannulation in the last 40 years. Until the 1980s, pediatric tracheotomy used to be an emergency procedure used in acute upper respiratory tract obstruction due to Hemophilus influenza and Corynebacterium Diphtheria infections, and with the initiation of vaccination against these infections, there has been a serious change in pediatric tracheotomy indications [5,6]. With this situation, the number of emergency tracheotomy operations in pediatric patients decreased significantly. However, the overall number of pediatric tracheotomy operations did not decrease gradually, but rather increased. The reason for this is the increase in survival time and rates in neonatal and pediatric intensive care units for various reasons and especially in patients followed up under intubation [7,8]. This increase has led to a change in tracheotomy indications for long-term intubation and its associated sequelae. Today, abnormal airways, neurological disorders and craniofacial anomalies are the leading indications for tracheotomy [9-11].

In this study, we aimed to present our tracheotomy experiences in pediatric patients in our hospital between 2014 and 2021. We reviewed the data in light of the literature by analyzing pediatric

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tracheotomy patients retrospectively in terms of indications, follow-up and complications.

Materials and Methods

This retrospective study was conducted with the approval of the Clinical Studies Ethics Committee with the decision numbered 2021/2223. Forty-six pediatric patients who underwent tracheotomy between 2014 and 2021 in our clinic located in a tertiary care center were included in the study, and the files of the patients were reviewed retrospectively. Patients aged 0-16 years were included. Data such as demographic characteristics, primary diagnosis, tracheostomy indications, complications, intubation time of the patients before tracheotomy, tracheotomy cannula diameters, decannulation and mortality status of the patients were collected and recorded in an excel database. The indications were examined under five headings according to the diagnoses that led to the tracheotomy of the patients included in the study. These were prolonged intubation, upper airway obstruction, craniofacial anomalies, neuromuscular disorders, and postoperative-traumatic sequelae. The complications were perioperative bleeding, wound infection, cannula occlusion, accidental cannula removal, subcutaneous emphysema, pneumothorax, and development of granulation tissue. All pediatric tracheotomies were opened with the same surgical technique, in the operating room, under general anesthesia, with a vertical incision, and tracheotomy cannulas were placed at the appropriate size by placing guide sutures in the trachea.

Results

In our study, the medical records of 46 pediatric tracheotomy patients who underwent their operations between 2014 and 2021 were reviewed. Twenty-three (50%) of these patients were girls, and 23 (50%) were boys. The mean age of the patients was 53.8±62.9 months. The youngest patient was a 1-day-old newborn, while the oldest patient was 15 years old. The patients were examined under 5 headings according to their tracheostomy indications. Accordingly, tracheotomy was performed in 14 patients for prolonged intubation, 12 patients for craniofacial anomalies, 7 patients for upper airway obstruction, 7 patients for postoperative-traumatic sequelae and 6 patients for neuromuscular disorders (Table 1).

Preoperative or postoperative complications were seen in 10 of the patients. Emphysema developed in two patients, and pneumothorax was observed in one of these two patients after emphysema. A complication of pneumothorax was observed in another patient. Two patients had accidental decannulation and developed respiratory distress. Postoperative bleeding from the tracheostomy site occurred in three patients. Granulation was observed in the trachea in two patients (Table 2).

Emergency tracheotomy was performed in 6 patients, and elective tracheotomy was performed in the remaining 40 patients. Upper airway obstruction was the cause in 4 of the patients who underwent emergency tracheotomy. These obstructions were acute epiglottitis in one patient, congenital larynx malformation in one patient, subglottic stricture due to caustic substance in one patient and tracheal atresia in the other patient. Intubation attempts were unsuccessful in one of the other patients, and emergency tracheotomy was applied due to intubation trauma and airway edema. Another patient who underwent an emergency tracheotomy was a syndromic child. The patient had craniofacial anomalies such as micrognathia and cleft palate, and an airway was provided by tracheotomy without intubating the patient due to respiratory distress. None of these 6 patients who underwent emergency tracheotomy remained intubated. The mean intubation duration of the patients who underwent elective tracheotomy was calculated as 25.7±17.1 days. Of these patients, the shortest duration of intubation was 6 days, and the longest duration was 90 days.

The smallest diameter of the tracheostomy cannula inserted in the patients was 2.5 mm, the largest was 7 mm, and the mean was 4.5 mm. In the follow-ups, it was observed that only 6 of the patients were decannulated, 11 of them died, and the remaining 29 continued their lives with tracheostomy. Among the six decannulated patients, the shortest time to decannulation was 7 days, and one patient was decannulated after a long period of 3.5 years and tolerated decannulation well.

Table 1. Distribution of Tracheotomy Indications

Tracheotomy Indications	**n**	**%**
Prolonged Intubation	14	30.4
Craniofacial Anomaly	12	26.1
Upper Airway Obstruction	7	15.2
Postoperative-traumatic Sequelae	7	15.2
Neuromuscular Disorders	6	13.1
Total	46	100

Table 2. Distribution of Complications

	n	**%**
Postoperative bleeding	3	30
Emphysema/ Pneumothorax	3	30
Accidental Decannulation	2	20
Granulation	2	20
Total	10	100

Discussion

In recent years, the success of surgical interventions for congenital cardiac and pulmonary pathologies and the increase in life expectancy due to supportive treatments provided to pediatric patients with neurological problems have significantly increased the number of patients followed in the intensive care unit in the pediatric population. These developments have increased the number of pediatric tracheotomy operations as well as supportive treatments to increase the life expectancy of these patients and made pediatric tracheotomy an even more important operation [12].

The increase in the life expectancy of premature babies or patients with congenital anomalies due to treatment and technological developments in neonatal and pediatric intensive care units has dramatically changed the indications for pediatric tracheotomy in the last 20-30 years. While obstructions due to acute upper respiratory tract infections had been the first line of pediatric tracheotomy indications until the 1980s, today, the indications have changed towards prolonged intubation in children who are dependent on a ventilator for a long time due to conditions explained in previous studies [7,8,13]. In our study, it was observed that 30.4% of the pediatric tracheotomies opened in our hospital in the last 7 years were opened due to prolonged intubation for various reasons. The most common condition causing prolonged intubation was respiratory distress in children with cerebral palsy and pneumonia, which frequently developed in these children. For these patients, tracheostomy not only eliminates the risks of prolonged intubation but also has advantages such as less dead space and the easier aspiration of the lower airways compared to intubation [14]. In our study, the second most frequent indication for pediatric tracheostomy was respiratory distress due to craniofacial anomalies. The rate of these patients was found to be 26.1%. Although it was examined in two separate groups, if patients with craniofacial anomalies were intubated due to respiratory distress and remained intubated for a certain period of time, and if these patients were considered in the prolonged intubation group, the reason for opening tracheostomy in 56.5% of the patients was prolonged intubation. In their study conducted in 39 pediatric patients who underwent tracheostomy, Kaygusuz et al. stated that the most common indication was prolonged intubation at a rate of 43.6%. Similarly, this rate was 53% in Wetmore et al.'s series and 61% in Carron's series, which was close to the rate in our study [9,11].

Prolonged intubation, which is the most common indication, is actually used to express the need for a prolonged ventilator. In intubated patients, this situation brings with it ventilator-associated pneumonia and endotracheal tube-related complications. Tracheotomy and its timing are very important in these patients. It was reported that the risk of ventilator-associated pneumonia and other complications are significantly reduced with tracheostomy, and the oral intake of patients is started early [15-17]. Additionally, the duration of being connected to a mechanical ventilator after tracheostomy is significantly reduced in comparison to patients who are intubated before tracheostomy, that is, their length of stay in the intensive care unit is shortened [17,18]. In the study conducted by Lin et al. with 142 pediatric patients who underwent tracheostomy, the mean duration of mechanical ventilation before tracheostomy was found to be 61.8 days, while the duration of mechanical ventilation after tracheostomy decreased significantly with a mean duration of 29.5 days. In our study, the duration of intubation of the patients before tracheostomy was calculated, and it was found to be a mean duration of 25.7 days. The reason for this long duration was the fact that the patients' families allowed tracheostomy late, which has been a common reason in other studies [12,15]. In our study, six patients underwent tracheostomy for emergency reasons without being intubated. The shortest duration of intubation was 1 day, and the longest duration was 90 days.

Apart from prolonged intubation and craniofacial anomalies, the causes of pediatric tracheotomy in our study were upper airway obstruction, postoperative/traumatic sequelae, and neuromuscular diseases. Considering the causes of upper airway obstruction, emergency tracheotomy had to be performed in one patient due to acute epiglottitis and in another patient due to subglottic stricture caused by caustic substance. In another patient who was examined under upper airway obstruction, respiratory distress was observed from birth, and an attempt was made to intubate the patient immediately after birth, but it was not possible, and emergency tracheostomy intervention was initiated. This intervention, however, was not successful, and it was observed that there was tracheal atresia. Although this patient was included in the study with an open tracheostomy, it could actually be considered an unsuccessful emergency tracheostomy attempt.

The most interesting tracheostomies opened due to postoperative/traumatic sequelae were to secure the airway in an 8-year-old patient due to tracheal perforation caused by a donkey bite. Another patient in this group was intubated due to drowning, and a tracheostomy operation was performed on the patient in the following periods. Again, tracheostomy had to be performed in three patients after an in-vehicle traffic accident.

We had six patients who underwent pediatric tracheostomy due to neuromuscular diseases. Four of these patients had Spinal Muscular Atrophy (SMA) type 1 disease. One patient had advanced Myasthenia Gravis, and one patient had Duchenne Muscular Dystrophy.

Although the age of tracheostomy in pediatric patients differs in many studies, it is mostly stated below 1 year old. In the study of Ogilvie et al., the mean age was found to be 44.4 months (between 0 and 18 years), and it was observed that nearly half of the patients were under the age of 1 [19]. In another study, 63% of the patients were found to be under the age of 1, with a mean age of 38.9 (between 16 days and 14 years). In the study conducted by Özmen et al. on 282 patients, the mean age of tracheostomy was found to be 53 months, and the youngest patient was 5 days old, while the oldest patient was 16 days old [8]. In our study, the mean age at which pediatric tracheotomy was opened was 53.8 months. The youngest patients in our study were two one-day-old newborns, and both had to undergo an emergency tracheostomy due to upper airway obstruction.

Another issue examined in our study was the diameters of the tracheostomy cannulas that were used. The mean diameter of the tracheostomy cannulas used in the patients was found to be 4.5 mm. It was observed that the smallest cannula had a diameter of

2.5 mm, and the largest one was 7 mm in diameter. Accordingly, it seems reasonable to have cannulas in this range of diameters available in centers where pediatric tracheotomy is frequently performed.

The complication rate of pediatric tracheotomy is 2-3 times higher than the rate in adults. Despite its high morbidity, complication and death rates, it is a life-saving procedure in most pediatric patients. It has also been emphasized that the risks in pediatric tracheotomy have decreased due to developing conditions and are not as high as before [5,15,20,21]. In our study, various complications were observed in 8 (17.4%) of the 46 patients. Considering the complications seen in the patients, emphysema and pneumothorax came to the fore. Emphysema and pneumothorax, which are early complications of tracheostomies, developed in 3 of the 8 patients, but serious morbidity was prevented by interventions. Emphysema and pneumothorax, which are early complications of tracheostomies, developed in 3 of 8 patients, but serious morbidity was prevented with the interventions. In these patients, avoidance of positive pressure ventilation and follow-up were sufficient. Two patients had accidental decannulation and were treated at the bedside. Tracheostomy cannulas of these patients were fixed in such a way that they would not be displaced by patient movement. Granulation tissue formation around the stoma, which is one of the late complications of tracheostomy, occurred in two patients. Granulation tissue formation around the stoma, one of the late complications of tracheostomy, occurred in two patients. Stoma revision procedure was performed in these patients. One patient had bleeding from a postoperative stoma and was successfully managed. In this patient, no surgical intervention was needed to stop the bleeding, and the placement of soluble hemorrhage pads around the stoma was sufficient. In the literature, the tracheostomy-related mortality rate is reported as 0-3.6% [22]. In our study, two patients died during tracheostomy, but it could not be associated with tracheostomy. The mortality rate in children followed by tracheostomy was reported as 41% in various studies. Deaths are due to underlying diseases rather than tracheostomy. This is because these children have severe anomalies that cannot sustain their lives [23,24]. In the patients we followed, the mortality rate was 28.2%. As stated, two of these patients died intraoperatively, while the cause of death of the remaining patients was the course of their current disease.

Our study had several limitations. One of these was the inability to draw definite boundaries in the indications because the patients had more than one anomaly or disease that required tracheostomy. For this reason, we had to gather the indications for the disease or anomaly, which was seen as the main cause, under the main headings. Another limitation was that although the tracheostomy procedure was performed by us, the preoperative and postoperative follow-ups of the patients were carried out by pediatricians, which prevented a full consensus. Furthermore, as many children undergoing tracheostomies experience mortality and morbidity not only from tracheostomy but rather from their underlying disease, it was difficult to relate, interpret and compare medical records.

Conclusion

Although pediatric tracheotomy is rare, it is a life-saving surgical procedure in the presence of appropriate indications. Mortality and morbidity rates are higher in pediatric patients than adult patients, but especially in patients with tracheostomy due to prolonged intubation, the intensive care unit provides shorter hospitalization times, a more sustainable daily life, home follow-up, and lower care costs. In the last 30 years, reasons for opening tracheostomy have changed dramatically, from obstruction due to upper respiratory tract infections to diseases requiring long-term mechanical ventilator support, with changing indications. A multidisciplinary approach is important in the decision and follow-up of pediatric tracheotomy. Pediatric tracheotomies can be successfully performed with manageable complications, contrary to expectations, with the appropriate surgical technique and adequate postoperative care.

Conflict of interests
The authors declare that they have no competing interests.

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Ethical approval
This retrospective study was conducted with the decision and permission of the Clinical Studies Ethics Committee numbered 2021/2223..

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