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Original Article

Evaluation of Pediatric Patients Undergoing Surgical Tracheostomy

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ABSTRACT

Objective: Unlike adult practices, the tracheostomy procedure has higher morbidity and mortality in children. In this study, we aimed to retrospectively investigate our experience of anesthesia in cases who underwent tracheostomy with pediatric surgery.

Methods: Sixty-six children aged 0–18 years who underwent surgical tracheostomy between 2018-2020 were included. Data included patient demographics, intubation time, tracheostomy indications, anesthetic agents used, and intraoperative and postoperative complications.

Results: Of all patients, Thirty-nine (59.1%) were 1–12 months, 37 (56.1%) were female, and 43 (66.7%) had an underlying neuromuscular disease. Fifty-five patients (84.8%) were hospitalized in the pediatric intensive care unit. The intubation time was 44.16±32.45 days before tracheostomy and the duration of ICU stay was 34.60±26.76 days after tracheostomy. The overall mortality rate was 3.03% (n=2). One of the deaths occurred intraoperatively and the other during the early postoperative period. The most common complications were desaturation in the intraoperative period, bleeding in the early postoperative period, and stoma granulation in the late postoperative period. 63.6% of the patients were discharged.

Conclusion: We found that prolonged intubation related to neurological disease was the most common indication for tracheostomy in pediatric patients and prolonged tracheostomy opening time did not increase mortality or morbidity.

INTRODUCTION

With the development of neonatal and pediatric intensive care unit (PICU) facilities, the life expectancy of children with medical problems has increased. Temporary and permanent tracheostomies are needed to assist in the management of respiratory failure and secretionor to manage upper airway obstruction in critically ill patients who need long-term ventilation support in the PICU.[1] Despite their similarities, adult tracheotomy and pediatric tracheotomy still have certain differences. Tracheotomy should be performed by securing the airway with endotracheal intubation, bronchoscopy, and whenever possible ventilation or masking whenever possible. In pediatric patients, the anatomical characteristics of the trachea, like being more superiorly located, smaller in diameter, shorter, and less stabilized, and the upper position of the carina should not be forgotten.[2,3] Complications in pediatric tracheostomies stem from more severe and higher rates of anesthesia and surgery compared to adults due to anatomical and physiological differences. Despite all these risks, tracheostomy is a life-saving, safe airway control method.[1,4] Although tracheostomy indications, timing, and complications are well defined and determined in adults, they are still under discussion in the pediatric population.[1]

Skin and tracheal incision, subcutaneous tissue removal, maturation, and tracheal stay suturing techniques specific to the pediatric tracheotomy, vary from surgeon to surgeon.[5] The vertical or horizontal incision is often preferred on the skin, while the vertical incision is preferred in the tracheal incision. A survey study observed that most participants (87%) preferred the vertical tracheal incision in pediatric tracheotomy.[6] In this study, we aimed to evaluate our anesthesia experiences in pediatric surgical tracheostomies performed in our hospital between 2018 and 2020.

MATERIALS AND METHODS

After the approval of the local ethics committee (2011-KAEK-25 2020/08-07), our study was conducted following the principles of the Declaration of Helsinki. 66 patients aged 0–18 years, who underwent surgical tracheostomy in the pediatric surgery operating room between 2018 and 2020, were included. Surgical tracheostomies performed urgently in the intensive care unit and performed by the otolaryngology clinic were excluded from the study. The demographic characteristics of the patients, intubation time, tracheostomy indications, anesthetic agents used, and perioperative complications were analyzed retrospectively from the patient files.We have standard protocols for tracheostomy procedures in our operating room. We provide anesthesia to all patients in the same way. General anesthesia is applied to all patients with routine monitoring. After confirming the location of the endotracheal tube, patients brought to the operating room intubated are given 1 minimum alveolar concentration (MAC) for sevoflurane, and appropriate doses of fentanyl and rocuronium are added.

In patients brought not-intubated, lidocaine 1 mg/kg, propofol 2 mg/kg, fentanyl 2 mcg/kg, rocuronium 0.6 mg/kg is administered for the anesthesia induction, and the patients are intubated with an appropriate endotracheal tube. Anesthesia is provided with sevoflurane and 50% oxygen + 50% air. Although it is generally a short-term operation, no additional dose of muscle is required. If necessary, 1/3 of the initial dose is applied. Clean anesthesia circuits and fresh absorbents are used in patients at risk for malignant hyperthermia. Dantrolene is kept ready in the environment and no volatile agent is used. Rocuronium is calculated as a 0.6 mg/kg dose, but 10–20% of this dose is administered due to hypersensitivity in children with neuromuscular disease.

The surgeon performs the tracheostomy procedure in the same way for all patients, using a certain surgical technique. In the supine position and head extension, the layers are passed over the jugular notch with a transverse incision and the trachea is suspended. The trachea is opened vertically using a scalpel and the tracheostomy cannula is inserted. After the cuff is inflated to the appropriate volume and the patient appears to be easily ventilated, the wound edges are fixed using prolene and the procedure is finalized. The patient is transferred to the intensive care unit with a monitored balloon mask and O_2 under the supervision of a doctor. Anterior-posterior chest radiography is performed in the intensive care unit, and the cannula level and conditions like pneumothorax, and pneumomediastinum are evaluated.

Complications occurring within 7 days postoperatively were considered early complications, and those encountered after 7 days were considered as late complications. The length of stay and the final status of the patients were also recorded.

Statistical analysis

Data analysis was carried out using the Statistical Package for the Social Sciences, version 23 (SPSS Inc., Chicago, IL., USA). Descriptive statistics are given as frequency, qualitative data as a percentage, and quantitative data as mean and standard deviation.The results were evaluated at a 95% confidence interval. The Chi-square test was used in the analysis of categorical data. The level of statistical significance was taken as $p<0.05$ for all analyses.

RESULTS

Out of 68 patients who underwent surgical tracheotomies at our hospital, 2 underwent emergency tracheostomy due to ventilation and intubation difficulties, and they were excluded from the study. One of the tracheostomy procedures of these patients was performed by the pediatric surgeon in the operating room, and the other by the otolaryngologists in the PICU. Statistical analysis was performed with the remaining 66 patients. The demographic data of the patients are shown in Table 1. 59.1% of the patients were 1–12 months old and 56.1% were female. 66.7% of the underlying diseases consisted of neuromuscular diseases (cerebral palsy, spinal muscular atrophy, hypoxic- ischemic encephalopathy, muscular dystrophy, congenital myopathy, encephalitis, and tuberculosis meningitis). The tracheostomy indication was upper airway obstruction in 1 (1.5%) and prolonged intubation in 65 (98.5%) of the patients. 36.4% of all patients had cerebral palsy. Fifty-six patients (84.8%) were hospitalized in the PICU and 10 (15.2%) in the neonatal intensive care unit (NICU). Fifty-seven patients (86.4%) were intubated when they were taken to the operating room.

Complications related to tracheostomy are shown in Table 2. We observed desaturation, reintubation and death as perioperative complications. While bleeding, decannu-

Table 1. Demographic data

	n	%
Age		
0–1 months	1	1.5
1–12 months	39	59.1
1–4 years	10	15.2
≥5 years	16	24.2
Gender		
Female	37	56.1
Male	29	43.9
Diagnosis		
Neuromuscular diseases	44	66.7
Metabolic diseases	19	28.8
Trauma	2	3
Respiratory diseases	1	1.5
ASA		
III	4	6.1
IV	62	93.9

ASA: American Society of Anesthesiologists physical status.

lation, pneumothorax and death were observed as early postoperative complications, stomal granulation was considered as the late postoperative complication (Table 2). One of the patients who died intraoperatively was a syndromic baby with a 10-day cleft lip, cleft palate, tracheal anatomic defect, and micrognathia. A decrease in saturation was observed in the patient during the tracheostomy procedure. Despite the interruption of the procedure, deep desaturation, bradycardia, and then cardiac arrest developed. There was no response to resuscitation. The patient, who had been hospitalized in the NICU for 3 months with the diagnosis of resistant epilepsy and meningoencephalitis, had a cardiac arrest 2 daysafter tracheostomy due to decreased oxygen saturation and carbon dioxide retention due to the obstruction in the cannula.

The time elapsed between the intubation date and the opening of the tracheostomy was accepted as the tracheostomy time. The mean intubation time before tracheostomy was 44.16±32.45 days, and the mean postoperative stay in the ICU was 34.60±26.76 days. Tracheostomy opening time was ≤14 days in 10 patients (15.2%), >14 days in 56 patients (84.8%). The complications of the patients according to the tracheostomy opening time are shown in Table 2. While there was no difference between the two groups in terms of complications, mortality rates, and duration of stay after tracheostomy, there was a difference in age (Table 3).

Table 2. Complications related to tracheostomy

	n	%
Perioperative complications		
Desaturation	3	4.5
Reintubation	1	1.5
Death	1	1.5
Postoperative complications		
Early period		
Bleeding	2	3.03
Decannulation	1	1.5
Pneumothorax	1	1.5
Death	1	1.5
Late period		
Stomal granulation	3	4.5

In thirty patients (45.5%), laparoscopic Nissen fundoplication and gastrostomy operations were performed along with tracheostomy. Forty-two patients (63.6%) were discharged from the hospital and 7 patients (10.8%) were referred to another hospital. During follow-up, 17 patients (25.8%) died in the ICU. No patients were decannulated so far.

DISCUSSION

Tracheostomy indications, complications, and the epidemiological profile of patients have changed in recent years. These changes are attributed to the development of new intensive care techniques, improvements in treatment, and increased survival rates in premature newborns and babies born with anomalies.[7,8]

According to the results of various studies, it has been reported that most children undergoing tracheostomy are under the age of 1 year.[9,10] In another study, it was found that most of the children (55.8%) undergoing tracheostomy were over one year old.[11] In our study, 60.6% of the patients were under the age of 1 year. 15.2% of our patients were hospitalized in the NICU. Also, 56.1% of our patients were female. Similar studies have also reported that the female sex is more common.[12] In one study, 63% of 123 children were reported to be male patients.[10] In the past, the most common tracheostomy indication was airway obstruction due to infectious diseases.[13] However, the most common tracheostomy indications today are often premature and long-term ventilator dependence resulting from the consequences of bronchopulmonary dysplasia and upper respiratory tract obstruction due to craniofacial or structural abnormalities of the upper respiratory tract, or hypotonia resulting from neurological or neuromuscular disorders.[14] Douglas et al.[9] reported that the most common tracheostomy indications were the need for long-term ventilation (20%), followed by the craniofacial abnormality (18%), and subglottic stenosis (14%)

Table 3. Complications of tracheostomy according to opening time

	≤14 days (n=10)	>14 days (n=56)	p
Age			
0–1 months	1 (10)	0 (0)	0.043*
1–12 months	4 (40)	35 (62.5)	
1–4 years	3 (30)	7 (12.5)	
≥5 years	2 (20)	14 (25)	
Patients with perioperative complications	3 (30)	5 (8.9)	0.06
Patients with postoperative complications	1 (10)	4 (7.1)	0.753
Length of stay after tracheostomy (days)	19.90±22.42	37.27±26.79	0.058
Mortality	4 (40)	13 (23.2)	0.264

*P<0.05.

in their sample of 111 patients. In another study with 63 patients, the tracheostomy indications were reported as upper airway obstruction (14.3%) and prolonged intubation (85.7%) caused by various neuromuscular diseases.[15] In our study, similar to the literature, 66.7% of the underlying diseases consisted of neuromuscular diseases, while our most common indication was prolonged intubation with a rate of 98.5%.

The timing of opening a tracheostomy varies between 4.3–30.4 days among ICUs.[16] tracheostomy is recommended 10–14 days after intubation in adult patients, there is no guideline for the optimal timing of tracheostomy for pediatric patients. It has been shown that a longer ventilation time before tracheostomy is associated with increased morbidity and hospital stay.[17,18] Research has reported a significant decrease in the incidence of infection in the early tracheostomy group compared to the late tracheostomy group, along with shorter mechanical ventilation and length of stay in the ICU.[19] However, it has been observed that more studies are needed to determine the patient categories in which it may be useful. In a meta-analysis, it was stated that early tracheostomy in pediatric patients significantly decreased mortality and mechanical ventilation and shortened the hospital stay.[20] In our study, there was no difference between the early and late tracheostomy groups in terms of complications, mortality rates, or length of stay after tracheostomy.

Dursun et al.[21] reported the average pre-tracheostomy ventilation time as approximately 30 days. In another study in which 80 patients were scanned retrospectively, 75 patients (93.75%) were followed up under invasive mechanical ventilation, with a mean duration of mechanical ventilation of 22.47±13.91 days.[22] In our patients, the mean intubation time before tracheostomy was found to be 44.16±32.45 days. We think that our longer intubation time compared to other studies may be due to the patients' infection status, unstable vital signs, and extubation attempts due to intolerance. Moreover, anesthesia and the procedure itself cause anxiety and fear in the patients' relatives, leading longer consent times and thus longer intubation durations. This also results in increased cost and labor loss.

Studies have shown that 20% of children who underwent tracheostomy developed complications.[23,24] Early Postoperative complications include bleeding, infection, pneumothorax, tube obstruction, and decannulation, while late complications include granulation tissue development, tube occlusion, decannulation, bleeding, tracheomalacia, and more rarely, tracheo-innominate artery fistula.[25,26] Tolunay et al.[12] observed perioperative complications due to tracheostomy procedure in 14 patients (26.4%). The most common minor perioperative complication (13.2%) was the right insertion of the tube, which was easily treated by retraction of the tracheostomy cannula. This was followed by bleeding at the tracheostomy insertion site.[12] In a study on 123 children in Brazil, researchers found that 10 children (8.1%) developed perioperative pneumothorax, subcutaneous emphysema, and pneumomediastinum.[10] They stated that a child with otopalatodigital syndrome died as a result of failure to provide ventilation due to lung problems during the procedure. They observed early postoperative bleeding, decannulation, wound infection, and displacement of the cannula in 7 patients and stomal granulomas, occlusion of the cannula with a secretion plug, late decannulation, papillomatosis prolongation to the trachea, and tracheal stenosis in 38 patients (31%).[10] In our study, the most common complications were desaturation in the perioperative period, bleeding and pneumothorax in the early postoperative period, and stoma granulation in the late postoperative period.

Tracheostomy application in pediatric patients has higher mortality and morbidity compared to adults. These risks and complications are higher in young children. The mortality rate due to pediatric tracheostomy ranges from 0.5% to 5%.[27] The most common causes of tracheotomy-related deaths in children are tube-related obstruction followed by displacement, and accidental decannulation. In our study, the rate of mortality due to tracheostomy was found to be 3.03% in the perioperative and early postoperative periods, similar to the literature. We think that the causes of death in our patients may be related to a tracheal anatomical defect in one and occlusion or malposition of the cannula in the other.

With the development of PICU and post-discharge home care services, patients live longer and tracheostomy care gains importance. Barlas et al.[22] reported that 11.25% of their patients in long-term follow-up died due to underlying diseases and 88.75% were discharged. Anette et al.[28] reported that 78% of patients who underwent tracheostomy were dependent on long-term tracheostomy. In our study, 63.6% of the patients were discharged, while 17 patients (25.8%) died during their follow-up in the ICU. While there were significant differences between living and non-living patients in terms of their age and hospitalization in the intensive care unit, there was no difference in terms of underlying disease or length of stay.

The main limitations of our study are its retrospective nature and the lack of long-term survival evaluation. Another limitation is our lack of protocol for the opening time of the tracheostomy.

CONCLUSION

Tracheostomy is frequently performed in the NICU and PICU in patients who require long-term intubation. A significant majority of pediatric patients undergoing tracheostomy are pediatric patient group with hereditary diseases and congenital anomalies. We observed that prolonged intubation due to neurological diseases was the most common reason for performing a tracheostomy in the pediatric patient group. Finally, we found no difference between early and late tracheostomy opening times in terms of mortality under operating room conditions.

Ethics Committee Approval

This study approved by the Bursa Yuksek Ihtisas Training and Research Hospital Clinical Research Ethics Committee (Date: 05.08.2020, Decision No: 2011-KAEK-25 2020/08-07).

Informed Consent

Retrospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: N.K., Ü.K., D.K.; Design: N.K., D.K.; Supervision: N.K., M.K., S.E.O.; Fundings: N.K., S.E.O.; Materials: N.K., M.K.; Data: N.K., M.K.; Analysis: N.K., Ü.K.; Literature search: N.K., S.E.O.; Writing: N.K., Ü.K.; Critical revision: M.K., D.K., N.K.

Conflict of Interest

None declared.

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Cerrahi Trakeostomi Uygulanan Çocuk Hastaların Değerlendirilmesi

Amaç: Trakeostomi işlemi, çocuklarda yetişkinlerdekinin aksine morbidite ve mortalitesi daha yüksek bir uygulamadır. Çalışmamızdaki amacımız, pediatrik cerrahi trakeostomi olgularında anestezi deneyimlerimizi geriye dönük olarak değerlendirmektir.

Gereç ve Yöntem: 2018–2020 yılları arasında cerrahi trakeostomi uygulanan 0–18 yaş arası 66 çocuk hasta çalışmaya dahil edildi. Hastaların demografik özellikleri, entübe kaldıkları süre, trakeostomi endikasyonları, kullanılan anestezik ajanlar, intraoperatif ve postoperatif gelişen komplikasyonlar değerlendirildi.

Bulgular: Tüm hastalar arasından 39'u (%59.1) 1–12 ay aralığında, 37'si (%56.1) kızdı ve hastaların 43'ünün (%66.7) altta yatan nöromusküler bir hastalığı vardı. Hastaların 55'i (%84.8) çocuk yoğun bakımda yatmakta idi. Hastaların trakeostomi öncesi entübe kaldıkları süre 44.16±32.45 gün ve trakeostomi sonrası yoğun bakımda yatış süresi 34.60±26.76 gün idi. Genel ölüm oranı %3.03'dü (n=2). Hastalardan biri intraoperatif diğeri de postoperatif dönemde öldü. En sık görülen komplikasyonlar, intraoperatif dönemde desatürasyon, erken postoperatif dönemde kanama ve geç postoperatif dönemde stoma granülasyonu'ydu. Hastaların %63.6'sı hastaneden taburcu oldu.

Sonuç: Pediyatrik hastalarda nörolojik hastalıklara bağlı uzamış entübasyonun trakeostominin en sık görülen endikasyonu olduğunu ve trakeostomi açma süresindeki uzamanın mortalite ve morbiditeyi arttırmadığını bulduk.

Anahtar Sözcükler: Anestezi; komplikasyon; pediyatri; trakeostomi.