Türk Pediatri Arşivi
Turkish Archives of Pediatrics

Original Article

The outcomes of children with tracheostomy in a tertiary care pediatric intensive care unit in Turkey

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Cite this article as: Kamit Can F, Anıl AB, Anıl M, et al. The outcomes of children with tracheostomy in a tertiary care pediatric İntensive care unit in Turkey. Turk Pediatri Ars 2018; 53(3): 177-84.

Abstract

Aim: We aimed to describe which clinical characteristics were associated with the outcome of tracheostomy in our tertiary care pediatric intensive care unit.

Material and Methods: This was a retrospective review of medical records of pediatric patients who underwent tracheostomy in our Pediatric Intensive Care unit from 2008 to 2014 in Turkey.

Results: Sixty-three patients were included the study. The median age of patients was 11 (range, 1-195) months. Twenty-five (39.7%) patients were female. The tracheostomy rate was 8.5% over a six-year period. Forty-nine (77.7%) patients were able to be discharged and sent home. The decannulation rate was 12.6% (n=8). The indications for tracheostomy were upper airway obstruction (n=9) and prolonged mechanical ventilation (n=54). The median intubation period before tracheostomy was 32 (range, 1-122) days and the median duration of pediatric intensive care unit stay after tracheostomy was 37 days. A total of 21 (52.5%) patients were weaned off mechanical ventilation. The rate of successful weaning from mechanical ventilation was higher in patients with upper airway obstruction than in those in the prolonged mechanical ventilation group (p=0.021). The complication rate was 25.3% in the pediatric intensive care unit and 11.1% at home.

Conclusions: Tracheostomy seems safe and improves pediatric patients' outcomes. The most important factor that affects the prognosis of children who underwent tracheostomy is the indication for tracheostomy. The outcomes are always better if the tracheostomy has been performed because of upper airway obstruction. Performing tracheostomy helps weaning from and off ventilator support and finally the discharge of patients with prolonged mechanical ventilation from the pediatric intensive care unit setting.

Keywords: Children, pediatric intensive care unit, prolonged mechanical ventilation, tracheostomy

Introduction

Tracheostomy has become an increasingly important option for earlier transition of children from the pediatric intensive care unit (PICU), which allows them to go home and stay in their natural environments. The most common indication for tracheostomy is prolonged mechanical ventilation (PMV) with significant comorbidities. Another common indication for tracheostomy in current practice is upper airway obstructions because of laryngotracheal anomalies (1-4). Many advantages of tracheostomy have been reported: patient comfort, less need for sedation, lower work of breathing, better long-term laryngeal function, faster weaning from mechanical ventilation (MV), lower risk of ventilator-associated pneumonia, shorter PICU stay, and improved oral hygiene (2-4).

In the literature, timing, indications, techniques, and the context of home care for tracheostomy are varied (2-4). The outcomes of tracheostomy are usually dependent on age, comorbidities, patient anatomy, experience of the unit, the timing of tracheostomy, and techniques used (1-3). There are limited studies evaluating the outcomes of children with tracheostomy in Turkey. In this study, we aimed to describe which

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Received: 04.12.2017 **Accepted:** 14.03.2018

DOI: 10.5152/TurkPediatriArs.2018.6586

clinical characteristics were associated with the outcome of tracheostomy in our patient population from Turkey.

Material and Methods

This was a retrospective review of medical records of pediatric patients (age 1 month-18 years) who underwent tracheostomy in a tertiary mixed medical/surgical PICU from 2008 to 2014. Patients were excluded if they were not followed-up at two-month intervals for at least one year after PICU discharge.

Tracheostomy indications and the timing of tracheostomy were determined by the treating pediatric intensive care physician and otorhinolaryngologist. Tracheostomies were performed only after the parents were informed and consented to the intervention. All tracheostomies were performed electively under general anesthesia using the same surgical procedure by the same group of otorhinolaryngologists.

The parents and other caregivers of patients who were going home with the tracheostomy tube (with or without home ventilation) were educated in the PICU regarding stoma care, suctioning, changing the tracheostomy tube, the equipment required for emergency situations, and routine care. Patients were discharged when the caregivers and the treating pediatric intensive care physician were confident that the education needed for the management of emergency and the routine care was adequate and the equipment was provided. Patients were followed-up at two-month intervals and a contact number was given to families for questions and emergency situations. All decannulation procedures were performed in the PICU.

The medical records of all patients included were reviewed. The age, sex, primary diagnosis at PICU admission, Pediatric Risk of Mortality 2 (PRISM 2) score at admission (calculations were made using web-based calculators; http://www.sfar.org/article/316/scoring-systems-for-icu-and-surgical-patients), underlying chronic diseases, indications for tracheostomy, complications in PICU and at home, mortality rate (in PICU and after discharge), length of stay in the PICU before and after tracheostomy, and duration of tracheostomy were all recorded.

The indications for tracheostomy were classified into two categories initially: upper airway obstruction and PMV. The PMV group was divided into four subgroups: neuromuscular, muscular, neurologic, and pulmonary diseases. PMV was defined as invasive MV longer than two weeks. Neuromuscular diseases included central and peripheral neuromuscular diagnoses such as cerebral palsy and spinal muscular atrophy. Muscular diseases included muscular dystrophies and acute inflammatory neuropathies such as Guillain-Barre disease. Neurologic diseases included encephalopathies with Glasgow Coma Scale <8 such as traumatic brain injury. Pulmonary diseases included chronic lung diseases such as bronchopulmonary dysplasia. The study was approved by the institute's ethics committee: 170/24.07.2014.

Statistical Analysis

All statistical analyses were performed using Statistical Packages for the Social Sciences (SPSS) for MAC, version 20.0 (IBM Corp.; Armonk, NY, USA). Categorical variables were expressed as numbers (n) with percentages (%) and compared using the Chi-square test or Fisher's exact test, as appropriate. Continuous variables are expressed as median (interquartile range: IQR). The Mann-Whitney U test was used for group comparisons of continuous variables. A p-value<0.05 was considered statistically significant.

Results

A total of 1502 patients were admitted to our PICU and 762 patients were intubated and mechanically ventilated over a six-year period (2008-2014). Sixty-five (8.5% of 762 patients) tracheostomies were performed. Two patients were excluded because of missing records after discharge from the PICU. Sixty-three patients were included in the study, and 23 patients (36.5%) died. No cases of death were directly related to the tracheostomy. The decannulation was performed in eight patients (12.6%). The overall outcomes of patients who underwent tracheostomy are given in Figure 1.

The indications for tracheostomy in the 63 patients were classified into two categories: 1. Upper airway obstruction (n=9, 14.3 %) and the diagnoses were: congenital laryngotracheal malformation (n=4), acquired subglottic stenosis (n=3), Hunter syndrome

with upper airway obstruction (n=1), and inhalation injury with upper airway obstruction (n=1). 2. PMV (n=54, 85.7%) related to neuromuscular (n=16), muscular (n=9), neurologic (n=25), and pulmonary (n=4) diseases. The most common indication for tracheostomy under one year of age was neuromuscular diseases (42.4%); above one year of age, it was neurologic (63.3%).

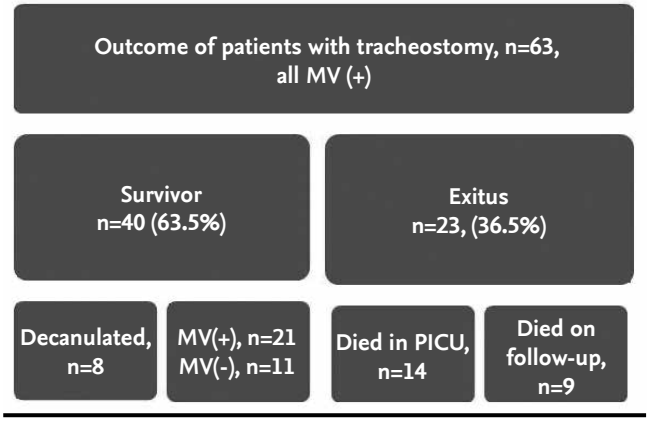

Figure 1. **Overall outcome of patients who underwent tracheostomy**
MV: Mechanical ventilation, PICU: Pediatric Intensive Care Unit

The median age of patients was 11 (range, 1-195) months. Twenty-five patients (39.7%) were female. Fifty-one (81%) patients had a chronic disease. Thirty-three (52.4%) patients underwent tracheostomies within the first year of life. The survival rate was significantly lower in the PMV group than in the upper airway obstruction group (p=0.020). Nevertheless, there was no significant differences in survival rates between the subgroups of the PMV categories (p=0.588) (Table 1).

The median intubation period before tracheostomy was 32 (range, 1-122) days and the median length of PICU stay after tracheostomy was 37 (range, 7-291) days. The number of PICU days before tracheostomy was lower in survivors than in non-survivors (29 vs. 43 days), but this difference was not statistically significant (p=0.057). The number of PICU days af-

Table 1. Demographic, clinical characteristics, and differences between patients who survived and those who died

Parameter (median/interquartile range or n, %)	Total n=63	Survivor n=40	Exitus n=23	p
Age (months),	11 (5-34)	7.5 (5-47.7)	16 (6-33)	0.653
Age <1 year	33 (52.4)	23 (57.5)	10 (43.5)	0.283
Sex				
Male	38 (60.3)	22 (55)	16 (69.6)	0.255
Female	25 (39.7)	18 (45)	7 (30.4)	
Primary Diagnose				
Respiratory	44 (69.8)	29 (72.5)	15 (65.2)	0.769
Cardiovascular	5 (7.9)	2 (5)	3 (13)	
Neurologic	3 (4.8)	2 (5)	1 (4.3)	
Trauma	7 (11.1)	5 (12.5)	2 (8.7)	
Infectious	4 (6.3)	2 (5)	2 (8.7)	
PRISM 2	13.2 (9.1-22)	15.3 (8.7-28)	13.4 (4-40)	0.364
Chronic disease (+)	51 (81)	30 (75)	21 (91.3)	0.183
Tracheostomy indication				
Upper airway obstruction	9 (14.2)	9 (22.5)	0	
PMV for neuromuscular disease	16 (25.3)	9 (22.5)	7 (30.4)	
PMV for neurologic disease	25 (39.6)	13 (32.5)	12 (52.2)	
PMV for muscular disease	9 (14.2)	7 (17.5)	2 (8.7)	
PMV for pulmonary disease	4 (6.3)	2 (5)	2 (8.7)	0.020[a]
PICU days before tracheostomy	32 (17-50)	29 (14.7-47.7)	43 (19-60)	0.057
PICU days after tracheostomy	37 (22-54)	28 (20-47)	42 (28-106)	0.043

PRISM 2: pediatric risk of mortality 2; PMV: prolonged mechanical ventilation; PICU: Pediatric Intensive Care Unit

[a]: The rate of upper airway obstruction is significantly different from other indications of tracheostomy

ter tracheostomy was significantly lower in survivors than in non-survivors (28 vs. 42 days; p=0.043) (Table 1).

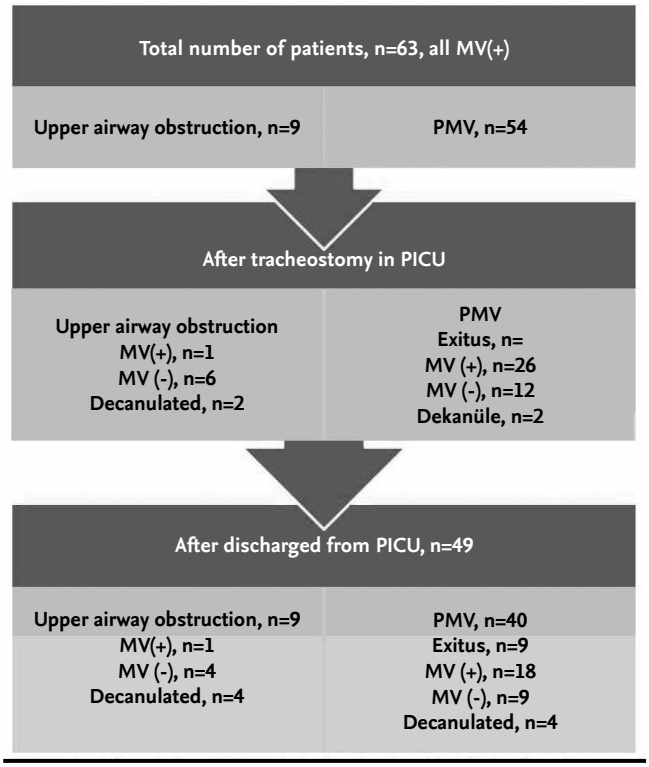

Figure 2. Outcome of patients who underwent tracheostomy according to the indication, in PICU and after discharged from PICU
MV: Mechanical ventilation; PICU: Pediatric Intensive Care Unit, PMV: prolonged mechanical ventilation

When we analyzed the PICU days before and after tracheostomy according to the indications for tracheostomy; for both periods, the median intubation period before tracheostomy (10 vs. 40 days; p<0.001) and the median period of post-tracheostomy PICU stay was significantly shorter in the upper airway obstruction group than in the PMV group (18 vs. 39 days; p=0.002).

We found no significant difference in total mortality or in the PICU and after being discharged between patients aged under and over one year (n=10 patients, 43.5% vs. n=3, 56.5%; p=0.283). In patients aged under one year, 30 out of 33 had a chronic disease: neuromuscular (n=15, 50%), genetic (n=6, 20%), neurologic (n=3, 10%), respiratory (n=2, 6.7%), metabolic (n=2, 6.7%), and muscular (n=2, 6.7%), but the mortality rate was not different in patients with chronic disease (p=0.183). The PRISM 2 score [median 11.4 (7.6-22) vs 13.6 (10-30); p=0.133], decannulation rate (n=3, 37.5% vs. n=5, 62.5%; p=0.252), complications of tracheostomy in the PICU (n=8, 50% vs. n=8, 50%; p>0.999) and complications of tracheostomy after being discharged (n=1, 25% vs. n=3, 75%; p=0.309), PICU days before tracheostomy (median 50 (33-68) vs. 50 (31-74); p=0.863) and PICU days after tracheostomy [(median 70 (42-165) vs. 43 (30-95); p=0.130)]

Table 2. The differences between patients who were weaned from mechanical ventilation and those who failed to be weaned among the survivors

Parameter (median/interquartile range or n, %)	Weaned from MV, n=21	Failed to wean from MV, n=19	p
Patients aged under 1 year	9 (42.9)	14 (73.7)	0.049
Sex			
Male	12 (57.1)	10 (52.6)	
Female	9 (42.9)	9 (47.4)	0.775
Chronical disease (+)	11 (36.7)	19 (63.3)	0.001
PICU days before tracheostomy	26 (13.5-47.5)	33 (14-52)	0.290
PICU days after tracheostomy	28 (18-45)	35 (23-49)	0.206
Tracheostomy indication			
Upper Airway Obstruction	8 (38.1)	1 (5.3)	
PMV	13 (61.9)	18 (94.7)	0.021
PMV subgroups	n=13	n=18	
Neuromuscular disease	1 (7.6)	8 (44.4)	
Neurologic disease[a]	9 (69.2)	4 (22.2)	
Muscular disease	2 (15.3)	5 (27.7)	
Pulmonary disease	1 (7.6)	1 (5.5)	0.045

MV: mechanical ventilation; PICU: Pediatric Intensive Care Unit; PMV: prolonged mechanical ventilation

[a]: statistically significant because of neurologic disease group

Table 3. The features of patients who were successfully decannulated

Diagnose	Age , sex	PICU days before tracheostomy	Primary diagnose	Presence of chronic disease	Time of decannulation (days)
1. Acquired subglottic stenosis	5 months, Male	1	Sepsis	No	12
2. Acquired subglottic stenosis	2 years, Female	1	Pneumonia	Neurometabolic	8
3. Congenital laryngotracheal malformation	5 months, Male	20	Pneumonia	Genetic, neurologic	365
4. Congenital laryngotracheal malformation	6 months, Male	30	Bronchiolitis	Genetic, neurologic	184
5. PMV for pulmonary disease	6.5 years, Male	49	Pneumonia	Respiratory (BPD)	21
6. PMV for neurologic disease	2.5 years, Female	52	Trauma	No	120
7. PMV for neurologic disease	4 years, Female	56	Trauma	No	730
8. PMV for muscular disease	4 years, Male	30	Guillain-Barre Disease	No	96

BPD: bronchopulmonary dysplasia; PICU: Pediatric Intensive Care Unit; PMV: prolonged mechanical ventilation

were not different between patients aged under and over one year.

The outcomes of patients who underwent tracheostomy are given in Figure 2. All patients were intubated and mechanically ventilated before tracheostomy and all patients who underwent tracheostomy because of upper airway obstruction survived, whereas 14 patients died in the PICU and nine patients died after PICU discharge in the PMV group. The median duration between the PICU discharge and the time of death was 180 (range, 60-720) days. Among the survivors (n=40), after tracheostomy, a total of 21 (52.5%) patients were weaned off MV completely, and 19 (47.5%) patients required home ventilation. Patients aged under one year (p=0.049) and patients with chronic disease (p=0.001) failed to wean from MV significantly more frequently when compared with the patients aged older than one year and those with no chronic disease. The rate of the patients who were successfully weaned off MV was significantly higher in the upper airway obstruction group than in the PMV group (p=0.021). When we compared the subgroups of PMV, the patients with neurologic disease were significantly more successful according to weaning outcomes (p=0.045) (Table 2).

Decannulation was achieved in the PICU (n=4) and after PICU discharge (n=4). Decannulation rates were significantly lower in the PMV group than in the upper airway obstruction group (p=0.011). All patients who were decannulated survived (n=8). The features of patients who were successfully decannulated are given in Table 3.

The complication rate was 25.3% in the PICU and 11.1% at home. Tracheostomy-related complications in the PICU were pneumothorax (n=6), respiratory arrest after accidental decannulation (n=3), fatal tube obstruction (n=3), bleeding (n=2), accidental decannulation with false passage (n=1), and subcutaneous emphysema (n=1). The most common tracheostomy-related complication after being discharged was stoma granulation (n=5). No patients died during the operation or because of complications.

Discussion

Tracheostomy was performed on 8.5% of the patients who were intubated and mechanically ventilated over a six-year period in our PICU. In this retrospective evaluation, we found that almost 80% of patients who underwent tracheostomy could be discharged from the PICU and sent home, 30% were completely weaned off MV, and more than 10% of patients who underwent tracheostomy were decannulated. The survival and the decannulation rates were notably higher among patients who underwent tracheostomy due to upper airway obstruction. All deaths were related to underlying disease, not to complications of tracheostomy.

The tracheostomy rates of units vary from 2% to 7%, and the rate of patients with comorbidities is not

clear in the literature (5-7). Though the diagnostic and treatment approaches have changed over the years in the PICU, there is a substantially increased number of young patients with chronic diseases who require prolonged ventilator assistance for survival and PICU discharge. As a result, PMV has now become the main indication for tracheostomy (5, 8-12). Children with severe underlying diseases may undergo tracheostomy as part of palliative treatment in order for the patient to spend more time with their family in the comfort of their own home (13). In our study, the most common indication for tracheostomy was PMV (85.7%) due to neurologic, neuromuscular, muscular or respiratory problems, which is similar to the literature. The tracheostomy rate was higher (8.5%) than the literature, and this is likely due to the high rate of patients with severe comorbidities (81%).

The timing of elective tracheostomy and factors associated with longer operations vary in units in several countries (12, 14, 15). Graf et al. (14) in the United States of America reported a shorter duration of intubation before tracheostomy with a median of 13 (range, 0-148) days, but it was two times longer for the PMV group (median: 26 days). The median duration of PICU stay was 32 (range, 1-122) in our study, which was similar to other studies reported from Turkey (6, 16). The median intubation duration before tracheostomy was also longer in the PMV group than in the upper airway obstruction group (40 vs. 10 days). According to our experience, some families needed more time in order to feel comfortable signing the consent form. These families experienced a great amount of stress regarding care for their tracheostomy-dependent child for reasons such as the high cost, no home nursing, and no suitable place for the equipment.

There is an increased prevalence of children undergoing tracheostomy, but deaths directly attributable to tracheostomy complications are very rare (3, 11, 17). According to our data, the complication rate was 25.3% in the PICU and 11.1% at home; no patients died of tracheostomy-related complications, which shows that performing tracheostomy is a relatively safe intervention in the PICU.

The mortality rates of pediatric patients with tracheostomy are reported from 5.5% to as high as 52% (5, 7, 11, 12, 16, 18, 19). Comorbidities, especially neurologic and neuromuscular diseases in younger age patients (under one year) are reported to result in higher mortality. Deaths are thought to be related to the underlying disease, not tracheostomy-related death (1, 11, 19). In a previous study, lower mortality rates were reported in children with upper airway anomalies than in those with no upper airway anomalies (1). In our study, the mortality rate was 36.5% and there was no tracheostomy-related death. Neither chronic disease nor younger age were found to be associated with mortality, just the indication for tracheostomy was related to mortality. The survival rate was significantly lower in the PMV group than in the upper airway obstruction group. All patients who underwent tracheostomy because of upper airway obstruction survived.

Decannulation rates are reported as 17% to 78%. These large variations in rates are related to the varying indications for tracheostomy and the underlying medical conditions of the patients (6, 12, 15, 16, 19, 20). Eight (12.6%) patients were successfully decannulated in our study. The patients who underwent tracheostomy for upper airway obstruction had significantly higher decannulation rates (44%); only four of the 54 patients in the PMV group (7.4%) were decannulated. Our decannulation rate was below that in the literature. This difference is most likely related to the greater number of patients with chronic neurologic conditions (72.7%) and the higher rate of patients who underwent tracheostomy for PMV (85.7%).

Zia et al. (15) reported that about 80% of patients were weaned from MV and 80% were successfully taken off ventilator support. Recently, the benefits of early tracheostomy were demonstrated in patients with isolated head injury with GCS <8, brainstem deficits, and cerebral contusion by decreasing total days of MV and PICU stay (2, 21-23). In our study, among the survivors, more than 50% of the patients were weaned and discontinued MV after tracheostomy. Patients had a better chance of being taken off a ventilator if they were aged older than one year, had no chronic disease, or if they underwent tracheostomy because of an upper airway obstruction. Moreover, patients with neurologic diseases in the PMV group had a significantly higher rate of being taken off a ventilator than in the other subgroups, which was likely due to the higher

number of trauma patients in this subgroup. According to our tracheostomy experience in isolated severe head trauma patients, after performing tracheostomy, it is easy to wean such patients from MV and send them home solely with the tracheostomy. Trauma patients with significant neurologic and cognitive deficits showed great improvements in their follow-up. Five patients were taken off their ventilators and two were successfully decannulated. In the last examination, both could easily walk and talk. These observations changed our practice such that now we prefer to perform tracheostomy earlier in this selected patient group. Patients with significant neurologic deficits, especially trauma patients who were cared for in their natural environments, demonstrated improvements medically and developmentally.

Our study has several limitations. First, it is a retrospective study from a single center. Secondly, the number of patients is insufficient to make a remark about the outcomes of patients in different subgroups.

In conclusion, tracheostomy seems safe and improves pediatric patients' outcomes. The most important factor that affects the prognosis of children who undergo tracheostomy is the indication for tracheostomy. The outcomes are always better if the tracheostomy is performed because of an upper airway obstruction. Performing tracheostomy helps patients with weaning from ventilators and eventually enables them to be discharged from the PICU. It also enables a higher turnover rate of beds in the PICU. We believe in encouraging parents to consider tracheostomy and educating them on how to properly take care of their child at home after the patient's clinical situation is stabilized.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of İzmir Kâtip Çelebi University School of Medicine (170/24.07.2014).

Informed Consent: Informed consent was not obtained from patients due to the retrospective nature of the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - K.C., A.B.A., M.A., M.G., H.Ç., T.K., N.Z.; Design - F.K.C., A.B.A., M.A., M.G., H.Ç., T.K., N.Z.; Supervision - F.K.C., A.B.A., M.A., M.G., H.Ç., T.K., N.Z.; Data Collection and/or Processing - M.G., N.Z., H.Ç.; Analysis and/or Interpretation - F.K.C., A.B.A., M.A.; Literature Review - F.K.C., A.B.A.; Writing - F.K.C., A.B.A.; Critical Review - M.A., A.B.A., T.K.

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

Financial Disclosure: The authors declared that this study has received no financial support.

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