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Research Article

Tracheostomy experiences in chronic respiratory failure after congenital heart surgery

Konjenital kalp cerrahisi sonrasi gelişen kronik solunum yetmezliğinde trakeostomi deneyimlerimiz

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Abstract

Aim: A small number of children with repaired congenital heart defects may require a tracheostomy for ongoing ventilatory support. Congenital airway anomalies, laryngomalacia, postoperative airway complications and genetic syndromes associated with airway and facial anomalies, such as DiGeorge Syndrome (22q11 deletion), can be counted among the reasons why patients are unable to be weaned from the ventilator. In this study, we aimed to define the outcomes of patients who required a tracheostomy due to chronic respiratory failure after congenital heart surgery, and the existing risk factors for in-hospital and post-discharge mortality.

Material and Methods: The files of 1382 patients who underwent surgery due to congenital heart disease in the Pediatric Cardiovascular Surgery Clinic in Ankara Bilkent City Hospital, between February 2019 and February 2023, were retrospectively scanned. Patients' age, gender, body weight, cardiac diagnosis, surgical intervention, length of stay in the intensive care unit, number of extubation attempts, total length of stay on the ventilator, need for ventilator at discharge, rates of weaning from tracheostomy and time of weaning from tracheostomy and mortality rates, were obtained from patient files and hospital database.

Results: Tracheostomy was performed in 15 of 1382 patients who underwent surgery during the four year study period. Mean (SD) duration of ventilation prior to tracheostomy was 35 days (IQR= 19 – 47). The median follow up time in patients was 224 days (IQR=116-538). Three patients were decannulated and six had died. Causes of death in six patients included sepsis (2), cardiac instability (1), neurological complications (2) and pulmonary haemorraghia (1).

The median time to discharge after tracheostomy in patients was 51 days (IQR= 33.50 – 147). Eight patients (53.3%) were discharged on home ventilation. One patient (6.6%) were decannulated during the hospital stay before discharge. Causes of deaths were often multifactorial for children who died during their initial hospital stay. Mortality was seen in six patients, a rate of 40%.

Conclusion: The need for tracheostomy after cardiac surgery plays an important role in early and late mortality in children. Ventilator-dependent chronic respiratory failure is the most common cause of childhood tracheostomies. We believe that determining the optimal timing for tracheostomy in the pediatric population will be effective in reducing prolonged ventilation and tracheostomy-related morbidities.

Keywords: congenital heart diseases; tracheostomy; chronic respiratory failure; cardiac surgery

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ÖZ

Amaç: Konjenital kalp cerrahisi geçiren çoğu hasta cerrahi sonrasında ekstübasyonu tolere etmektedir, fakat bazı hastalarda entübasyon süresi uzamakta, ventilatörden ayrılma zorlaşmaktadır. Hastaların ventilatörden ayrılamama sebepleri arasında konjenital hava yolu anomalileri, laringomalazi, postoperatif havayolu komplikasyonları, DiGeorge Sendromu (22q11 delesyonu) gibi havayolu ve yüz anomalileri ile ilişkili genetik sendromlar sayılabilir. Bu çalışmanın ile konjenital kalp cerrahisi sonrası kronik solunum yetmezliği sebebiyle trekeostomi ihtiyacı duyulan hastaların sonuçlarını, hastane içi ve taburculuk sonrası mortalitede mevcut risk faktörlerini tanımlamayı amaçladık.

Gereç ve Yöntemler: Ankara Bilkent Şehir Hastanesi Çocuk Kalp ve Damar Cerrahisi Kliniğinde Şubat 2019-Şubat 2023 tarihleri arasında KKH nedeniyle ameliyat edilen 1382 hastanın dosyaları retrospektif olarak tarandı. Hastaların yaşı, cinsiyeti, vücut ağırlığı, kardiyak tanı, cerrahi girişim, yoğun bakımda kalış süresi, ekstübasyon girişimi sayısı, ventilatörde toplam kalış süresi, taburculukta ventilatör ihtiyacı, trakeostomiden ayrılma oranları ve süresi trakeostomiden ayrılma ve mortalite oranları, hasta dosyalarından ve hastane veri tabanından elde edildi.

Sonuç: Dört yıllık çalışma döneminde ameliyat edilen 1382 hastanın 15'ine trakeostomi uygulandı. Trakeostomi öncesi ortalama (SD) ventilasyon süresi 35 gündü (IQR= 19 – 47). Hastalarda ortanca takip süresi 224 gündü (IQR=116-538). Üç hasta dekanüle edildi ve altı hasta öldü. Altı hastada ölüm nedenleri arasında sepsis (2), kardiyak instabilite (1), nörolojik komplikasyonlar (2) ve pulmoner hemoraji (1) vardı.

Hastalarda trakeostomi sonrası medyan taburcu olma süresi 51 gündü (IQR= 33.50 – 147).

Sekiz hasta (%53.3) ev tipi ventilatör ile taburcu edildi. Bir hasta (% 6.6) hastane yatışı sırasında taburculuk öncesi trakeostomiden ayrıldı. Hastanede ilk kalışları sırasında ölen çocuklar için ölüm nedenleri genellikle çok faktörlüydü. Altı hastada (%40) mortalite görüldü.

Tartışma: Çocuklarda kalp cerrahisi sonrası trakeostomi ihtiyacı erken ve geç mortalitede önemli rol oynamaktadır. Ventilatöre bağlı kronik solunum yetmezliği, çocukluk çağı trakeostomilerinin en yaygın nedenidir. Pediatrik popülasyonda trakeostomi için en uygun zamanlamanın belirlenmesinin uzamış ventilasyonu ve trakeostomiye bağlı morbiditeleri azaltmada etkili olacağına inanıyoruz.

Anahtar Kelimeler: konjenital kalp hastalıkları; trakeostomi; kronik solunum yetmezliği; kardiyak cerrahi

Introduction

Most patients undergoing congenital heart surgery tolerate extubation after surgery, but in some patients the intubation time is prolonged and weaning from the ventilator becomes difficult.[1] Approximately 10% of patients are still intubated at the end of the first week after congenital heart surgery.[2] Although most of these patients are extubated during their follow-up, a small group of patients undergo tracheostomy and are discharged with a home ventilator. Congenital airway anomalies, laryngomalacia, postoperative airway complications and genetic syndromes associated with airway and facial anomalies, such as DiGeorge Syndrome (22q11 deletion), can be counted among the reasons why patients are unable to be weaned from the ventilator.[3] Airway problems after cardiac surgery in infants prolong mechanical ventilator times and intensive care unit stays. In addition, the risk of surgical complications is higher in patients who require repetitive repair for reasons such as single ventricle surgery, and for whom respiratory complications are more common. Among these are diaphragm paralysis and vocal cord paralysis due to recurrent laryngeal nerve damage seen during complex aortic arch repairs.[1] In the adult population, tracheostomy is opened earlier in prolonged intubation, but there are no criteria and routine practices for these in the pediatric population.[4] Pediatric patients thus constitute the high-risk patient group for tracheostomy and children face more complications due to smaller airways.[5]

While the presence of congenital heart disease (CHD) and/or congenital heart surgery in children is a risk factor on its own, tracheostomy after cardiac surgery carries a five-fold higher risk of death compared to other tracheostomy cases.[6] In this study, we aimed to define the outcomes of patients who required a tracheostomy due to chronic respiratory failure after congenital heart surgery, and the existing risk factors for in-hospital and post-discharge mortality.

Material and Methods

In our study, the files of 1382 patients who underwent surgery due to CHD in the Pediatric Cardiovascular Surgery Clinic in Ankara Bilkent City Hospital, between February 2019 and February 2023, were retrospectively scanned. Patients who were younger than eighteen years of age at the time of the surgery

and who underwent a tracheostomy due to prolonged intubation in the intensive care unit, were included in the study. Patients who were older than eighteen years of age at the time of the operation, who underwent an emergency tracheostomy and who underwent tracheostomy for any reason before the surgery, were excluded in the study.

Patients' age, gender, body weight, cardiac diagnosis, surgical intervention, length of stay in the intensive care unit, number of extubation attempts, total length of stay on the ventilator, need for ventilator at discharge, rates of weaning from tracheostomy and time of weaning from the tracheostomy as well as mortality rates, were obtained from patient files and hospital database. When evaluating the diagnosis of the patient, if patient had more than one cardiac anomaly, the hemodynamically prominent disease was accepted as the primary disease.

Genetic diseases such as Down and DiGeorge Syndrome were recorded. Comorbidities of the patients (prematurity, prolonged intubation in the neonatal period, previous surgical operations such as tracheoesophageal fistula repair, congenital diaphragmatic hernia repair), were also evaluated.

Patients undergoing cardiac surgery in our center are followed up by pediatric cardiovascular surgeons in the pediatric cardiovascular surgery intensive care unit, and opinions are obtained from pediatric cardiologists, pediatric intensive care specialists and neonatologists when necessary.

Extubation is attempted in all patients in the early postoperative period. In the phase of weaning from the ventilator, blood gas sampling and saturation values suitable for the patient's cardiac pathology and surgery are taken as a basis.

At least five extubation attempts are made before tracheostomy in patients with extubation failure. Bronchoscopy, neurological imaging, echocardiogram, cardiac catheterization and fluoroscopy imaging of diaphragm movements are performed within indications in extubation failure.

Tracheostomy indications

With prolonged intubation and repeated extubation failure was determined as follows:

- Tracheobronchomalacia
- Tracheal or subglottic stenosis
- Bilateral vocal cord paralysis
- Upper respiratory tract problems, such as cleft palate
- Diaphragm paralysis
- Suboptimal hemodynamic status (moderate/severe systemic ventricular failure, severe AV valve failure, severe hypoxia, hemodynamically significant residual disease)

Tracheostomy opening is performed in our hospital by otolaryngology, anesthesia or paediatric cardiovascular surgery, depending on availability.

Statistical analysis used descriptive statistics (SPSS.25. SPSS Inc., Chicago, IL, USA) including mean, standard deviation (SD), median and range, number and percent, as appropriate.

Results

Tracheostomy was performed in 15 of 1382 patients who underwent surgery during the four-year study period. The demographic characteristics of the patients are summarized in Table-1.

Table-1: Demographic characteristics of patients (AVSD: Atrioventricular Septal Defect, VSD: Ventricular Septal Defect, ASD: Atrial Septal Defect)

	n=15 n%
Male Gender	10 (66.6%)
Primary cardiac disease	
Unbalanced AVSD	3 (20%)
Tetralogy of Fallot	2 (13.3%)
Tetralogy of Fallot + Ebstein Anomaly	1 (6.6%)
VSD + Pulmonary Atresia	3 (20%)
Aortic Insufficiency + Ascending Aorta An Aneurysm	1 (6.7%)
Aortic Stenosis	1 (6.7%)
Pulmonary Banding + VSD	1 (6.7%)
Residual ASD + Ellis Van Crevald Syndrome	1 (6.7%)
Transposition of Great Arteries	1 (6.7%)
Double Inlet Left Ventricle	1 (6.7%)

Seven of the patients had previously undergone cardiac surgery. Blalock Taussig(BT) shunt was performed in four of these patients, pulmonary artery banding was performed in one patient, aortic stenosis was repaired in one patient, and atrial septal defect repair was performed in one patient.

Two of the three patients who underwent BT shunt in the neonatal period had tracheomalacia due to prolonged intubation in the neonatal period. Our patient with subglottic stenosis underwent a BT shunt operation at the age of four months due to Ebstein Anomaly + Fallot Tetralogy and was intubated for a long time.

Extracorporeal membrane oxygenator (ECMO) was inserted in 5 of 15 patients who underwent tracheostomy in the postoperative period, and all of them were successfully weaned from ECMO.

Diaphragm plication due to left diaphragmatic paralysis was performed in three patients. Tracheostomy was performed in patients who could not be extubated despite a diaphragmatic plication. Primary patology of these patients were, tetralogy of Fallot, unbalanced complete atrioventricular septal defect and tricuspid atresia.

Cardiovascular instability and neurological events were the most common indications for tracheostomy accounting for 53.4% of patients. Although cardiac instability is a broad definition, we evaluated the increased need for inotropes, resistant hypotension, documented ventricular dysfunction, and hemodynamically significant residual defects in this context. The reasons for opening a tracheostomy are summarized in Table-2.

Table-2: Reasons for tracheostomy

	n=15 n%
Tracheomalasia	2 (13.3%)
Cardiac Instability	4 (26.7%)
Subglottic stenosis	3 (20%)
Neurological Events	4 (26.7%)
Laryngomalacia	1 (6.7%)
Pulmonary Hemorrhage	1 (6.7%)

Mean (SD) duration of ventilation prior to tracheostomy was 35 days (IQR= 19 – 47). Pressure supported-synchronized intermittent mandatory ventilation was the commonest mode of ventilation in all patients.

The median time elapsed until mortality develops after tracheostomy in patients was eight days (IQR= 3.75 – 21.75).

The median (range) age at the time of the tracheostomy was fifteen months (IQR= 11–30). The median weight of the patients, in grams, at the time of operation was 9500 (IQR= 6000 – 12000).

The median CPB time (minutes) of the patients was 123 (IQR= 80 – 178) and The median cross-clamp time (minutes) of the patients was 65 (IQR= 45 – 120).

The median follow up time in patients was 224 days (IQR=116-538). 3 patients were decannulated and 6 had died. Causes of death in 6 patients included sepsis (2), cardiac instability (1), neurological complications (2), pulmonary haemorraghia (1).

The median time to discharge after tracheostomy in patients was 51 days (IQR= 33.50 – 147).

Eight (53.3%) patients were discharged home on home ventilation.

Causes of death are listed in Table-3. Causes of deaths were often multifactorial for children who died during their initial hospital stay. Mortality was seen in six patients and the mortality rate was 40%.

Table-3: Causes of deaths.

	n=6
Hearth failure	1
Neurological events	2
Possible/confirmed sepsis	2
Pulmonary haemorraghia	1

At the time of follow up three patients had been decannulated. One of these patients was decannulated after fifteen months and the other one was decannulated twelve months after the tracheostomy, whereas the last patient was decannulated three months after the tracheostomy. Of the six surviving patients that were discharged from the hospital on a ventilator, only four still required positive pressure ventilation.

Discussion

The indications and outcomes of tracheostomies in children with CHD have been described in previous studies.[7] Cardiac insufficiency, tracheobronchomalacia, diaphragmatic palsy and new central nervous system events, are the commonest reasons described in prolonged ventilation. Children with more complex CHD lesions, single ventricle physiology or greater risk adjustment for congenital heart surgery scores, had higher mortality and less weaning off ventilation.[8] A tracheostomy is required in a small percentage of patients undergoing surgery for CHD.[7] This rate was found to be 1.09% in our study and is similar to the literature.[9]

With studies conducted in a single center such as ours, both the experience of the center and the number of patients is critical in determining the conditions that require a tracheostomy after congenital heart surgery and the factors affecting this process. There are no guidelines regarding timing of tracheostomy after congenital heart surgery. The general approach, if a patient cannot be extubated, should first be to identify the potential causes of this condition. For example, it would be appropriate to detect and repair the paralyzed diaphragm with a fluoroscopy, to detect subglottic stenosis, vocal cord paralysis or tracheomalacia by bronchoscopy and to perform treatment for it, and then to try extubation again. Although there are three extubation attempts before tracheostomy on average in the literature, we decided to attempt the tracheostomy after a minimum of five extubation attempts in our clinics. The exception to this situation is patients whose neurological status was poor on cranial imaging.

The median duration from cardiac surgery to tracheostomy of 35 days (IQR= 19 – 47) is slightly longer than the 30 days duration published previously.[9] These durations are significantly longer than the standard practice of tracheostomy occurring within 1 to 3 weeks in adult patients. This is supported by data demonstrating longer ICU stay, higher ICU mortality and higher rate of failure to wean from mechanical ventilation, in adults undergoing tracheostomy after greater than 21 days on intubation.[4] Although early tracheostomy in adults has better outcomes, such information is not available for the pediatric population.

Single ventricle patients constitute the group with the worst tracheostomy results in the pediatric population.[1] In our study, six of fifteen patients underwent single ventricular surgery. Four of these patients died after tracheostomy. All three patients on whom we performed tracheostomy weaning were patients who underwent double ventricular repair. If high-risk patients with single ventricle require tracheostomy and long-term mechanical ventilation, parents should be informed about the poor prognosis for this patient population. Our clinical and literature experience shows that tracheostomy weaning is more difficult in patients with single ventricular physiology.[7] Our mortality rate of approximately 40% was similar to the literature but our follow-up duration was shorter.[1,2] Among the reasons for the relatively high mortality in our study, we found that since we are a newly established clinic, the number of our patients was low and our follow-up period was short. In addition, tracheostomy weaning could be performed in a small proportion of our patients (20%). This seems to indicate that some airway problems, respiratory and cardiac failure may improve over time with growth and cardiac recovery.

One of the most important limitations of our retrospective study is the lack of sufficient resources in the literature regarding the indications and timing of tracheostomy in children. In addition, since our study was a single-center study, the results may vary in different centers and may not be valid for all centers.

Conclusion

The need for tracheostomy after cardiac surgery has an important role in early and late mortality in children. Ventilator-dependent chronic respiratory failure is the most common cause of childhood tracheostomies. The timing of tracheostomy in prolonged ventilation in patients undergoing surgery for congenital heart disease is uncertain. Similar studies in the pediatric population with congenital heart disease will improve clinical outcomes. We believe that determining the optimal timing for a tracheostomy in the pediatric population will be effective in reducing prolonged ventilation and tracheostomy-related morbidities.

Ethical Approval: Ankara Bilkent City Hospital Clinical Researches Ethics Committee, (No: E2-23-3576, Date: 01/03/2023) has authorized all techniques used in this work. The authors declare that they adhered to the ethical norms of the 1975 Helsinki Declaration, as revised in 2008.

Conflict Of Interest

The authors declare no conflict of interest.

Disclosure

None.

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Authors' Contributions

BST: Acquisition, analysis.

AA: Drafting of the work, revising, final approval.

MY: Drafting of the work, analysis.

ANE: Analysis

CLB: Final approval

References

1. Cotts T, Hirsch J, Thorne M, Gajarski R. Tracheostomy after pediatric cardiac surgery: frequency, indications, and outcomes. J Thorac Cardiovasc Surg. 2011 Feb;141(2):413-8.
2. Polito A, Patorno E, Costello JM, Salvin JW, Emani SM, Rajagopal S, et al. Perioperative factors associated with prolonged mechanical ventilation after complex congenital heart surgery. Pediatr Crit Care Med. 2011 May;12(3):e122-6.
3. Székely A, Sápi E, Király L, Szatmári A, Dinya E. Intraoperative and postoperative risk factors for prolonged mechanical ventilation after pediatric cardiac surgery. Paediatr Anaesth. 2006 Nov;16(11):1166-75.
4. Hsu CL, Chen KY, Chang CH, Jerng JS, Yu CJ, Yang PC. Timing of tracheostomy as a determinant of weaning success in critically ill patients: a retrospective study. Crit Care. 2005 Feb;9(1):R46-52.
5. Mahida JB, Asti L, Boss EF, Shah RK, Deans KJ, Minneci PC, et al. Tracheostomy Placement in Children Younger Than 2 Years: 30-Day Outcomes Using the National Surgical Quality Improvement Program Pediatric. JAMA Otolaryngol Head Neck Surg. 2016 Mar;142(3):241-6.
6. Rosner E, Mastropietro CW. Prior cardiac surgery is independently associated with decreased survival following infant tracheostomy. Respir Care. 2015 Jan;60(1):47-55.
7. Challapudi G, Natarajan G, Aggarwal S. Single-center experience of outcomes of tracheostomy in children with congenital heart disease. Congenit Heart Dis. 2013 Nov-Dec;8(6):556-60.
8. Edwards JD, Kun SS, Keens TG, Khemani RG, Moromisato DY. Children with corrected or palliated congenital heart disease on home mechanical ventilation. Pediatr Pulmonol. 2010 Jul;45(7):645-9.
9. Hoskote A, Cohen G, Goldman A, Shekerdemian L. Tracheostomy in infants and children after cardiothoracic surgery: indications, associated risk factors, and timing. J Thorac Cardiovasc Surg. 2005 Oct;130(4):1086-93.