


Optimal Time of Tracheotomy in Infants: Still a Dilemma

Global Pediatric Health
January-December 2015: 1–5
© The Author(s) 2015
DOI: 10.1177/2333794X15569300
gph.sagepub.com


Sevim Unal, MD¹, Leyla Karadeniz Bilgin², Deniz Gonulal, MD¹,
and Fatih Alper Akcan, MD¹

Abstract

Objective. Infants with respiratory failure may require prolonged intubation. There is no consensus on the time of tracheotomy in neonates. **Methods.** We evaluated infants applied tracheotomy, time of procedure, and early complications in our neonatal intensive care unit (NICU) retrospectively from January 2012 to December 2013. **Results.** We identified 9 infants applied tracheotomy with gestational ages 34 to 41 weeks. Their diagnoses were hypotonic infant, subglottic stenosis, laryngeal cleft, neck mass, and chronic lung disease. Age on tracheotomy ranged from 4 to 10 weeks. Early complication ratio was 33.3% with minimal bleeding (1), air leak (1), and canal revision requirement (1). We discharged 7 infants, and 2 infants died in the NICU. **Conclusion.** Tracheotomy makes infant nursing easy for staff and families even at home. If carried out by a trained team, the procedure is safe and has low complication. When to apply tracheotomy should be individualized, and airway damage due to prolonged intubation versus risks of tracheotomy should be taken into consideration.

Keywords

complication, indication, newborn, respiratory failure, tracheotomy

Introduction

Neonatal respiratory failure (NRF) is one of the most common, serious clinical problems and a major cause of death in neonates admitted to a neonatal intensive care unit (NICU). The condition constitutes a medical emergency and often requires supplemental oxygen therapy. Underlying causes of NRF include upper and lower airway diseases, lung diseases, and poor respiratory effort secondary to especially central nervous system (CNS) dysfunction.¹ Assurance of an adequate airway is vital in a neonate with respiratory failure and most of them are commenced on mechanical ventilation and endotracheal intubation. The goal of endotracheal intubation is to obtain a secure airway and assure adequate oxygen delivery to tissues.^{1,2} Care of an endotracheal tube is extremely important, as correct placement, suctioning to maintain a patent airway, preventing accidental extubation or migration into mainstem bronchus, and constant monitoring in a critical care setting are imperative for endotracheal tubes.^{2,3}

Improvements in neonatal care have resulted in increased survival rates for infants born preterm and those with congenital anomalies. Concurrently, the incidence of tracheotomies in infants is supposed to be increased.⁴ Tracheotomy is most often indicated to

provide a stable airway for the infants with congenital or acquired airway obstruction and to provide long-term mechanical ventilation.^{5,6} To date, there are few data related to neonatal tracheotomy in the literature. In this study, we aimed to evaluate the infants who underwent tracheotomy in our NICU either for supplemental oxygen therapy or to obtain secure airway.

Methods

A retrospective clinical study was designed in our NICU to identify the infants who required tracheotomy between January 2012 and December 2013. We aimed to determine the clinical characteristics of infants who underwent tracheotomy, early complications, and outcomes related to the procedure. We evaluated hospital records of the infants performed tracheotomy in our

¹Ankara Children's Hematology Oncology Research Hospital, Ankara, Turkey

²Bakırköy Dr. Sadi Konuk Research Hospital, Istanbul, Turkey

Corresponding Author:

Sevim Unal, Ankara Children's Hematology Oncology Research Hospital, İrfan Bastug Cd, Kurtdereli Sk, Altındağ, Ankara 06510, Turkey.

Email: sevimun@yaho.com



NICU during 2 years retrospectively. Gender, postnatal age, birth weight, gestational age, Apgar score, physical and laboratory findings, postnatal age at time of tracheotomy, duration of mechanical ventilation via endotracheal tube, morbidities accompanying to the condition, early complications, mortality, and outcome of the neonates applied tracheostomy were determined. If performed, results of echocardiography and genetic analysis were evaluated.

In our NICU, the infants with respiratory failure and requiring prolonged mechanical ventilation were consulted to the otolaryngology department. These neonates were evaluated and a decision made in the council created by otorhinolaryngologists. Pediatric otolaryngology surgeon performed all tracheotomies in the operating room, under general anesthesia. All procedures were planned operations. A standard technique was used for the operation: a vertical skin incision, followed by dissection of soft tissues and vertical tracheal incision. A tracheal incision was employed on the third tracheal ring without cartilage excision. A nonabsorbable suture was used for the lateralization of the incised tracheal wings, which was then taped to the child's chest skin to prevent spontaneous decannulation. After inserting the tube into the trachea, the cuff was filled with air. At the end of the procedure, saturation, heart rate, and blood pressure of the infants were controlled. Besides, lung parenchymal sounds were checked by positive pressure ventilation, and chest wall was observed if there was symmetrical expansion. The location of tube was also checked by flexible fiber-optic endoscopy.

On follow-up in the NICU, if there were signs of respiratory failure or distress, we checked for possible mucus plugging or blockage. The mucus plugging was managed by softening with saline and aspirating the mucus plug under sterile conditions. Lung parenchymal sounds and chest wall movements were controlled, and chest radiography was undertaken to eliminate possible air leak. The cuff of the tube was also controlled for the presence of enough air. If there was a suspicion of infection, we checked hemogram, acute phase reactants, blood culture, peripheral blood smear, and culture of secretions. In case of strong suspicion of infection, that is, high acute phase reactants, leukocytosis or leukopenia, increased immature to total neutrophil ratio, we managed the patient by appropriate antibiotherapy according to possible pathogens of our NICU until we obtained culture results. If the patients' clinic was not improved, we performed indirect flexible bronchoscopy for possible disposition, canal obstruction, or abnormalities related to the respiratory tract. If necessary, there was a revision or removal of the tube and a new tube was inserted.

Results

Nine infants were applied tracheotomy in our NICU between January 2012 and December 2013 of the 1380 neonates hospitalized (667 in 2012, 713 in 2013). Their birth weights ranged between 1780 and 3800 g, and gestational ages ranged between 34 and 41 weeks. The main characteristics of these infants are shown in Table 1.

Tracheotomy was performed in 6 infants due to ventilator dependence. These infants were diagnosed hypotonic infant secondary to CNS dysfunction. We thought respiratory failure would continue in these infants and ventilator dependence was unavoidable. These patients underwent tracheotomy, following the observation of insufficient respiratory effort, apnea, and/or bradipnea. In our country, end-of-life decision is forbidden by law. Tracheotomy was performed to obtain patent airway in 3 infants. One infant who developed subglottic stenosis following endotracheal intubation, one with giant neck mass, and one with laryngeal cleft underwent tracheotomy to obtain patent and secure airway (Table 2).

Early tracheotomy complications were observed in 3 cases (33.3%) including minimal bleeding, canal obstruction, a need for canal revision and air leak. There were 6 infants without early complication due to tracheotomy. Two patients died in the NICU: one secondary to air-leak syndrome and other secondary to underlying disease (possible interstitial lung disease).

One of the infants diagnosed with arthrogryposis multiplex congenita was transported to the local hospital with the family's request. One of the patients transferred to the pediatric intensive care unit (PICU) on mechanical ventilation via tracheotomy at 2.5 months of age. We did not routinely transport our patients to the PICU when they turned 29 days of age. We followed infants until corrected 44 weeks of age. The cases were hospitalized longer if there was no bed in the PICU or they had not enough body weight to be able to be cared in the PICU.

We discharged 3 infants to home on room air by tracheotomy and 2 infants on home ventilator. The parents were trained on nursing their infant, taking care of the ventilator and tracheotomy, and the use of available health resources. We also coordinated home nursing visits and controls on outpatient clinics following discharge.

Discussion

Tracheotomy characterizes a substantial alternative in case of prolonged endotracheal intubation and mechanical ventilation. It provides a stable airway with decreased

Table 1. The Clinical Characteristics, Diagnoses, and Comorbidities Related to the Infants.

No.	BW (g)	GA (weeks)	MV duration via ETT	Diagnosis and Comorbidities
1	3700	41	40 days	Possible interstitial lung disease, BPD, PPHN
2	3700	40	4 weeks	Hypotonic infant, MCM syndrome, laryngeal cleft
3	3800	39.4	25 days	Subglottic stenosis following mechanical ventilation and intubation, perinatal asphyxia
4	3060	40	6 weeks	Hypotonia following acute life-threatening event
5	3050	38	7 weeks	Giant neck mass, lymphangioma
6	1780	35	2 months	Hypotonic infant, arthrogryposis multiplex congenita
7	2300	34	4 weeks	Hypotonic infant, Zellweger syndrome
8	3200	40.2	6 weeks	Hypotonic infant, perinatal asphyxia, HIE
9	2300	36	3 weeks	Hypotonic infant, antenatal asphyxia, intracranial hemorrhage, air-leak syndrome

Abbreviations: BPD, bronchopulmonary dysplasia; BW, birth weight; ETT, endotracheal tube; GA, gestational age; MV, mechanical ventilation; HIE, hypoxic ischemic encephalopathy; MCM syndrome, macrocephaly-capillary malformation syndrome; PPHN, persistent pulmonary hypertension of the newborn.

risk of pulmonary infection and is usually better tolerated than endotracheal intubation. In infants, tracheotomy generally is not preferred for possible damage to the immature airway in growing children.¹⁻⁴ There is no consensus on ideal timing of tracheotomy in infants. Besides, preoperative evaluation and timing of the procedure are very important, and generally intensive postoperative nursing is necessary. In the literature, tracheotomy generally described for premature infants with prolonged ventilation and airway abnormalities.^{4,7,8} We report 9 infants (in 6 due to ventilator dependence, in 3 due to obtain secure airway) who had tracheotomy at 4 to 10 weeks of age during the last 2 years of the study period in our NICU. The decision to have tracheotomy should be individualized according to the risks of prolonged endotracheal intubation versus risks of tracheotomy. Medical staff should consider moderately early tracheotomy placement especially for ventilator-dependent infants, due to if being more comfortable for the staff, patient, and family even at home.

The optimal time to tracheotomy is difficult to decide in children and neonates. In adults, a 10- to 14-day threshold has been frequently adequate. As visually observed larynx and vocal cord damage caused by the tube is maximal in 3 to 7 days, and tracheotomy has been recommended within 3 days of intubation in adults. If intubation continues, the damage may progress to scar formation and functional abnormalities may occur. In critically ill patients, a 3-week time limit of intubation based on the opinion of risk ratio (laryngeal risk vs surgical tracheotomy risk) is excessive if the tube remained longer than 1 month. Currently, there is insufficient objective data supporting this idea. Tracheotomy in infants and neonates is more important, as trachea in

neonates is immature and in the growth period during childhood. On the other hand, prolonged intubation does not appear to have important long-term consequences and serious airway damage in the infants, and there is a tendency to place tracheotomy later.^{2,3} In the studies related to neonatal tracheotomy, the procedure was generally performed with some period on mechanical ventilation in preterm and term infants. Sisk et al reported 18 very low birth weight (VLBW) infants with bronchopulmonary dysplasia (BPD) who underwent tracheotomy and 36 control infants without tracheotomy during 6 years.⁸ They found infants placed on tracheotomy had an average duration of intubation of 128.8 days with a median number of 11.5 intubation events, both significantly greater than those of controls. They suggested that when considering tracheotomy in VLBW infants, the total number of intubation events should be monitored as well as the total duration of intubation. Because of high incidence of laryngotracheal stenosis, they argued earlier endoscopy and possibly earlier tracheotomy in these infants. Kraft noticed the median age at the time of tracheotomy was 4 months for premature and 3 months for term infants among 201 tracheotomies in patients below 2 years old during 1 year.⁹ Infant's age on tracheotomy ranged between 4 and 10 weeks in our study. We emphasized individualized moderately early tracheotomy for the infants hard to extubate, likely to fail extubation, requiring chronic respiratory support and ventilator dependence in the NICU.

Long-term endotracheal intubation of infants can seriously damage the developing respiratory tract. The damages caused by endotracheal intubation include laryngeal edema, granulation tissue formation, ulceration, subglottic stenosis, vocal cord paralysis, tracheomalacia, necrotizing

Table 2. Weights, Ages, Indications, Complications, and Outcomes of Neonates Related to Tracheotomy.

No.	Weight on Tracheotomy	Age on Tracheotomy	Indication to Tracheotomy	Complication	Outcome
1	4090 g	1.5 months	Ventilator dependence, extubation failure	Minimal bleeding	Died in NICU at 3 months of age
2	4090 g	4th week	Requirement of a patent airway	Canal obstruction, revision need	Discharged on room air via tracheotomy
3	4300 g	4th week	Requirement of a patent airway	—	Discharged on room air via tracheotomy
4	4450 g	2nd month	Ventilator dependence	—	Transferred to PICU on ventilator
5	4100 g	8th week	Requirement of a patent airway	—	Discharged on room air by tracheotomy
6	1950 g	2nd month	Hypotonic infant, ventilator dependence	—	Transported to local hospital on home ventilator
7	2750 g	4th week	Hypotonic infant, ventilator dependence	—	Discharged on oxygen
8	3150 g	6th week	Hypotonic infant, ventilator dependence	—	Discharged on home ventilator
9	2840 g	4th week	Hypotonic infant, ventilator dependence	Canal obstruction, revision needed, air leak	Died in NICU at 2.5 months of age

Abbreviation: PICU, pediatric intensive care unit.

tracheobronchitis, tracheal perforation, tracheal stenosis, subglottic cysts, anterior web, and other less serious lesions of airway.¹⁰⁻¹³ We suggested that tracheotomy should be moderately early placed in the infants in whom ventilatory dependence is unavoidable to prevent these damages. In our NICU during 2 years, we determined one neonate underwent tracheotomy due to subglottic stenosis among the ventilated infants.

Disorders in infants requiring tracheotomy are well defined and generally include congenital respiratory tract anomalies, that is, giant neck mass, subglottic stenosis, Pierre Robin sequence, laryngeal web. Tracheotomy was preferred to obtain secure airway in these cases.¹⁻³ In recent years, following the increased survival rate as a result of improvement in neonatal care, tracheotomy is mostly indicated in ventilator-dependent infants. Premature infants with BPD may also require tracheotomy due to ventilator dependence.¹⁻⁸ Kraft notified that the most common indication for tracheotomy was requirement of long-term mechanical ventilation (32.2%) among 201 tracheotomies.⁹ We evaluated 9 infants who underwent tracheotomy and 6 infants with prolonged ventilation secondary to CNS dysfunction during 2 years. The second most common indication to tracheotomy was to obtain a secure airway due to respiratory tract anomalies.

The ratio of complications related to tracheotomy reported in the literature was between 18% and 64%. These complications are accidental decannulation, mucus plugging, infection, bleeding, and granulation tissue formation. Early complications are bleeding, wound problems, pneumothorax, and pneumomediastinum. Late

complications are tracheal stenosis and granulation tissue formation.^{3,4,14} Pereira et al studied 32 VLBW infants below 1000 g and 23 infants equal or higher than 1000 g who underwent tracheotomy during 5 years.¹⁵ They found a high complication rate in group 1 without mortality. The ratio of early complications due to tracheotomy was 33.3% (3 among 9 neonates) in our study. These complications were minimal bleeding, pulmonary infection and air leak, canal obstruction, and requirement of canal revision in the early period (Table 2). We thought that tracheotomy can be safely implemented without major complication in ventilator-dependent infants.

Successful transition of infants who underwent tracheotomy to home management is an important issue and several factors are associated with successful transition. A multidisciplinary approach is necessary for the successful transition of the infant to home. Learning care of an infant with tracheotomy can be challenging for both medical professionals and families. The family must develop the skills needed to competently and independently provide tracheotomy care. Developing a comprehensive discharge plan and detailed discharge checklists necessary to support family, familiarizing them with tracheotomy care, and linking them with resources available after discharge may be useful for a smooth transition.^{3,4} Schlessel et al reported 36 VLBW infants born at 24 to 32 weeks of gestation and birth weight of 635 to 1360 g who underwent tracheotomy for acquired subglottic stenosis or prolonged mechanical ventilation.¹⁶ They had been following infants prospectively and defined 31% early (within 1 weeks of postsurgery) and 64% late

complication ratio. They concluded that infants with a tracheotomy might require extended medical and home care. They proposed an effective home care program was necessary for parental training in tracheotomy care, the use of ancillary equipment, and even cardiopulmonary resuscitation. We managed the transition to home in 6 neonates. Among them, 2 infants were on home ventilator. The families were trained on ventilator and tracheotomy care, nursing their infant, and use of available health resources. We also coordinated home nursing visits and controls on outpatient clinics following discharge.

In the literature, mortality related to tracheotomy were mostly caused by underlying disease, and the most frequent causes of tracheotomy-related death are cannula obstruction and accidental decannulation. Mortality associated directly with tracheotomy ranged between 0.5% and 6%.^{3,6} Sisk et al reported a mortality ratio of 13.9% among 36 VLBW infants who had tracheotomy.⁸ Wootten et al notified 20.5% mortality among 127 pediatric tracheotomies performed in the first year of life at a tertiary care children's hospital between 1988 and 2004.¹⁷ But they stated that among preterm infants, non-tracheotomy-related mortality was high. Schlessel et al indicated 11% tracheotomy-related mortality among 36 VLBW infants applied tracheotomy, but mortality from all other causes was 25%.¹⁶ They concluded that death after hospital discharge had been associated with nonuse of prescribed cardiorespiratory monitors. Kremer et al¹⁴ determined no tracheotomy-related mortality in their experience consisting of 25 children less than 6 years of age operated between 1980 and 1996. They concluded this was possibly due to their operative technique. Our ratio of mortality was 22.2%; one infant died due to primary disease and other died secondary to tracheotomy-related complications.

In conclusion, for infants requiring prolonged mechanical ventilation, tracheotomy may be well tolerated and comfortable than endotracheal intubation. It prevents airway damage due to prolonged intubation and makes respiratory support easy for the families even at home. Although the decision to place a tracheotomy tube remains complex and depends on several factors, the procedure is safe and has low complication rate in infants, if carried out by a trained team. We proposed individualized moderately early tracheotomy placement for ventilator-dependent infants. Medical specialists should take into account both airway damage caused by prolonged intubation and the risks of tracheotomy.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

- Gnanaratnem J, Finer NN. Neonatal acute respiratory failure. *Curr Opin Pediatr*. 2000;12:227-232.
- Durbin CG Jr. Indications for and timing of tracheostomy. *Respir Care*. 2005;50:483-487.
- Groves DS, Durbin CG Jr. Tracheostomy in the critically ill: indications, timing and techniques. *Curr Opin Crit Care*. 2007;13:90-97.
- Papoff P, Cerasaro C, Caresta E, Barbàra CS, Midulla F, Moretti C. Current strategies for treating infants with severe bronchopulmonary dysplasia. *J Matern Fetal Neonatal Med*. 2012;25(suppl 3):15-20.
- Lawrason A, Kavanagh K. Pediatric tracheotomy: are the indications changing? *Int J Pediatr Otorhinolaryngol*. 2013;77:922-925. doi:10.1016/j.ijporl.2013.03.007.
- Kontzoglou G, Noussios G, Sakellariou T, Fachadidou A, Preponis C. Tracheotomy in neonates. *Acta Otorhinolaryngol Belg*. 1998;52:309-312.
- Pereira KD, MacGregor AR, McDuffie CM, Mitchell RB. Tracheostomy in preterm infants: current trends. *Arch Otolaryngol Head Neck Surg*. 2003;129:1268-1271.
- Sisk EA, Kim TB, Schumacher R, et al. Tracheotomy in very low birth weight neonates: indications and outcomes. *Laryngoscope*. 2006;116:928-933.
- Kraft S, Patel S, Sykes K, Nicklaus P, Gratny L, Wei JL. Practice patterns after tracheotomy in infants younger than 2 years. *Arch Otolaryngol Head Neck Surg*. 2011;137:670-674. doi:10.1001/archoto.2011.51.
- Benjamin B. Prolonged intubation injuries of the larynx: endoscopic diagnosis, classification, and treatment. *Ann Otol Rhinol Laryngol Suppl*. 1993;160:1-15.
- Santos PM, Afrassiabi A, Weymuller EA Jr. Risk factors associated with prolonged intubation and laryngeal injury. *Otolaryngol Head Neck Surg*. 1994;111:453-459.
- Flores-Nava G, Mateos-Sánchez L, Jurado-Hernández VH. Injury in air way of newborn with mechanical ventilation. *Rev Med Inst Mex Seguro Soc*. 2008;46(1):63-66.
- Yu HR, Niu CK, Su YT, Huang CB. Flexible bronchoscopic diagnosis of airway injuries after intubation in children. *J Formos Med Assoc*. 2000;99(8):618-622.
- Kremer B, Botos-Kremer AI, Eckel HE, Schlöndorff G. Indications, complications, and surgical techniques for pediatric tracheostomies-an update. *J Pediatr Surg*. 2002;37:1556-1562.
- Pereira KD, MacGregor AR, Mitchell RB. Complications of neonatal tracheostomy: a 5-year review. *Otolaryngol Head Neck Surg*. 2004;131:810-813.
- Schlessel JS, Harper RG, Rappa H, Kenigsberg K, Khanna S. Tracheostomy: acute and long-term mortality and morbidity in very low birth weight premature infants. *J Pediatr Surg*. 1993;28:873-876.
- Wootten CT, French LC, Thomas RG, Neblett WW 3rd, Werkhaven JA, Cofer SA. Tracheotomy in the first year of life: outcomes in term infants, the Vanderbilt experience. *Otolaryngol Head Neck Surg*. 2006;134:365-369.