

Paediatric Tracheostomy

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Abstract A practical approach to paediatric tracheostomy is presented in the light of current trends of management of chronic upper airway obstruction in the paediatric population. Our local experience is reviewed.

Key words Paediatric; Tracheostomy

Introduction

Paediatric tracheostomy has always been considered to be a procedure associated with significant morbidity and mortality. In as much as it should be avoided, if possible, by well established laser and airway widening procedures, it is possible, today, to eliminate tracheostomy associated mortality and minimise its morbidity.

Half a century back, tracheostomies were performed in the paediatric population for upper airway inflammatory conditions for short durations. Diphtheria and poliomyelitis used to be common indications. Premature infants and prolonged intubation were not an issue as neonatal intensive care did not exist. In the 1980s, much fewer tracheostomies

were performed.¹⁻³ The indications swayed to congenital or acquired airway abnormalities in the main.⁴⁻⁶ In the 1980s, more premature infants survived their pulmonary problems but acquired subglottic stenosis from prolonged intubation rose in incidence.¹ At the time, the incidence of laryngeal injury associated with prolonged intubation was reported to be 8%,⁷⁻¹⁰ although several authors reported a much lower incidence of acquired subglottic stenosis of 0.5-1.8%.¹¹⁻¹³ Paediatric tracheostomies at the time carried a high overall complication rate of 46.5%.¹⁴ Tracheostomy associated perioperative mortality was in the region of 8.7%.¹⁵ Tube obstruction and accidental decannulation were common. It is the tracheostomy associated mortality that made long term intubation the preference when long term ventilatory support was contemplated, at the expense of possible laryngeal injury. It is, nonetheless, true that polyvinyl chloride endotracheal tubes, better selection of tube size, improved techniques of fixation and assisted ventilation added significantly to diminished laryngeal injury in prolonged neonatal intubation.¹⁶ Most neonatal intensivists and nurses would be more comfortable looking after endotracheal tubes than a tracheostomy, the skin tract of which closes off at amazing speed should the tube falls out and fails to be replaced quickly. Endotracheal tube wins again if high pressure ventilation is required as it is easier to minimise leak with larger endotracheal tubes than with tracheostomy tubes which are usually too small to achieve a reasonable seal.

Today, the technique of a paediatric tracheostomy is well established with minor individual variations. The tube fixation techniques are secure thus minimising accidental

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decannulation. Neonatal intensive care doctors and nurses are well trained to manage tracheostomies. It is indeed, in the end, much easier and convenient for a trained nurse to replace a tracheostomy than to have an intensivist to re-intubate with an endotracheal tube. Home care protocols and the necessary accessories are well formulated. Home tracheostomy care by family members are now made safe.

The Indications

A tracheostomy in the paediatric population is best avoided if possible in the light of the available alternative treatment modalities. Failed extubation, for example, may be countered in cases of soft mucosal subglottic narrowing or early subglottic stenosis by an anterior cricoid split.¹⁷ An established subglottic stenosis can be treated by a single stage laryngotracheoplasty and the stenosed region widened with costal cartilage grafts. A subglottic haemangioma can be laser reduced or excised via an anterior laryngo-fissure. Congenital syndromes with narrowed upper airway can be considered for CPAP and distraction osteogenesis to widen the airway. A tracheostomy, albeit much safer today, does carry some risks and psychosocial implications at home and at school if decannulation is not achieved before.

The indications for a tracheostomy are as follows:-

- 1) Upper airway obstruction secondary to congenital craniofacial abnormalities or congenital or acquired laryngeal stenosis or other obstructive laryngeal pathology. It may also be performed as part of a planned Ex Utero Intrapartum Treatment in upper airway obstruction in a newborn.
- 2) Prolonged ventilation secondary to neuromuscular deficits.
- 3) Pulmonary toilet in neurological patients with aspiration.
- 4) A tracheotomy (no tubes) may be performed on the rare occasion for bronchoscopic access to a foreign body if the usual route is not available to the rigid ventilating bronchoscope.

For the first indication, the tracheostomy is fashioned as a temporary procedure until the child is ready for corrective procedures. For the congenital syndromes with craniofacial deficits, distraction osteogenesis may be undertaken at 2 years of age or formal maxillofacial procedures in the early teens. Subglottic stenosis may be corrected with laryngotracheoplasty usually at 2 years of age or when the

child has reached 10 kg in weight. A tracheostomy may also be performed as part of an 'EXIT' procedure. 'EXIT' stands for Ex Utero Intrapartum Treatment which is the treatment delivered to a newborn with his placenta still attached.

If long term ventilation is contemplated, in a patient with neuromuscular deficits for example, a tracheostomy has clear advantages. These will be discussed later.

In patients with neurological deficits who has swallowing difficulties and aspiration, a tracheostomy does help in pulmonary toilet during oral training.

Review of Cases

Eighteen tracheostomies were performed at the Prince of Wales Hospital and United Christian Hospital between January 1993 and May 2003. They are summarised in Table 1.

The Technique of Paediatric Tracheostomy

Optimal positioning can be achieved with the help of a shoulder pad and a chin strap (Figure 1) which brings the trachea closest to the neck skin. The skin is marked and a low vertical incision is made (Figure 2). The brachio-cephalic trunk can come up high in an infant and attention is called for. A low tracheostomy allows room for reconstructive procedures later on. A pad of subcutaneous fat is then excised (Figure 3). This shortens the tracheostomy tract and allows immediate exposure of the strap muscles. Dissecting bipolar diathermy forceps allow a bloodless dissection and the isthmus of the thyroid may be divided by the bipolar forceps. Spring retractors allows good exposure with the least instruments in the small and restricted field (Figure 4). The trachea is incised with a short vertical incision with stay sutures on both sides. The tube is inserted and the flanges are secured to the skin with sutures and round the neck with linen tapes using the Red Cross Memorial tying technique adopted from Red Cross Memorial Children's Hospital in Cape Town, South Africa. No accidental decannulation had occurred since its use in their hospital for many hundreds of cases over the years (personal communication from Red Cross Memorial Children's Hospital, Cape Town). The stay suture on each side of the tracheal incision is taped to the chest for emergency purposes. The sutures can be used to lift the

Table 1 Paediatric tracheostomies performed at the Prince of Wales Hospital and United Christian Hospital between January 1993 to May 2003

		Age at tracheostomy	Indications	Status
Subglottic Stenosis				
	F	23 days	Prematurity, prolonged intubation, extensive subglottic granulations and laryngomalacia.	Decannulated after 18 months.
	M	6 months	Grade III subglottic stenosis.	Awaiting laryngo-tracheoplasty.
	M	6 months	Prematurity, prolonged intubation, cardiac and pulmonary deficits. Grade I stenosis. Failed cricoid split.	Awaiting laryngo-tracheoplasty.
Bilateral Vocal Cord Palsy				
	M	3 months	Bilateral paramedian vocal cord palsy.	Now 10 years. Awaiting laser arytenoidectomy at 14 years.
	M	1 month	Bilateral paramedian vocal cord palsy.	Now 6 years. Awaiting laser arytenoidectomy at 14 years.
Laryngeal Granulations				
	F	22 days	Prematurity, prolonged intubation, granulations at glottic and subglottic levels.	Decannulated after 1 month.
Subglottic Haemangioma				
	M	10 days	Left subglottic haemangioma. Airway obstruction. Failed extubation.	Well with tracheostomy. (Recently performed)
Tongue Base Obstruction and Laryngomalacia				
	F	5 months	Tongue base obstruction and dynamic supralaryngeal obstruction. Failed to respond to laser aryepiglottoplasty alone.	Well with tracheotomy. (Recently performed)
Pharyngeal Stenosis				
	M	7 years	Immunodeficient. Pharyngeal stenosis sputum retention and pneumonia.	Lost to follow up.
Cystic Hygroma				
	F	5 months	Airway obstruction secondary to tongue base and pharyngeal cystic hygroma.	Pending OK432 injection and excision.
Posterior Laryngeal Cleft				
	M	13 months	Required nasal endotracheal tube. Pending laryngeal cleft repair.	Decannulated after posterior laryngeal cleft repair.
Prolonged Intubation				
	M	6 years	Neuromuscular deficits.	For long term ventilatory support.
	M	20 months	Neuromuscular deficits.	For long term ventilatory support.
	M	6 months	Neuromuscular deficits.	For long term ventilatory support.
	M	8 months	Neuromuscular deficits.	For long term ventilatory support.
Craniofacial Syndromes				
Treacher Collins	F	16 days	CO ₂ retention. Bilateral ankylosed TMJ.	Pending distraction osteogenesis and maxillofacial surgery.
Pierre Robin	M	2 months	Hypoplastic mandible.	Well with tracheostomy.
Crouzon's	F	3 years	OSAS	Pending maxillofacial surgery.

trachea for tube replacement if it should accidentally fall out.

The Red Cross Memorial technique of tying is simple to performed and the design is based on having a double loop round the neck, the tension of which is controlled by a single knot. At the completion of tying, the loop should not admit more than the little finger (Figure 5). The first tube change is then scheduled for 1 week.

The After Care in the First Week

A light weight ventilatory circuit should be used and steadying the flanges while connecting or disconnecting is important. A short neonatal tracheostomy tube can easily have its tip dislodged or half dislodged in the still unestablished tracheocutaneous tract. This tract is usually well formed at 72 hours. It is, nonetheless, not difficult to create a false tract in an infant.

Adequate humidification is mandatory to prevent crusting in small tubes and gentle suction, on a need to do basis, minimises trauma to the tracheal mucosa.

The linen tapes, once soiled with saliva and allowed to dry, become sharp blades which can cut into the neck skin. These wounds together with salivary soiling are the main causes of skin irritation in the neck. This can be minimised by a thin piece of duoderm round the neck or the change of tapes every two days. Tape changes are difficult and are done always in our institution by two members of staff, one steadying the tracheostomy tube firmly while the other replaces the tapes.

The wound is cleaned and dressed daily after the first 48 hours. It is not uncommon to have the lower rim of the tracheostomy flange eroding the manubrial skin over the chest. This can be prevented by a small piece of duoderm in between.

Care After the First Week

After the first tube change, the environment changes and humidification may become less plentiful. Crusting is then minimised or prevented by tube change daily or on alternate days. If performed after proper training, this is done with great ease and does not impart any trauma to the infant as



Figure 1 Chin straps and shoulder pad help bring trachea to the skin surface of the neck.



Figure 2 Skin markings for tracheostomy.



Figure 3 Excision of subcutaneous fat.



Figure 4 Spring retractors help expose the trachea in a small field.



Figure 5 The tying technique of having a double loop round the neck and a single knot.

the tube is simply replaced by sliding it through a preformed tunnel. This is excellent training for the nursing staff in the neonatal unit who shortly become experts in replacing tubes. This is also a time when the parents are trained. The parents are required to acquire basic resuscitation skills over a period of 6 weeks, in addition, to prepare for home care.

Infants with chubby chins may occasionally obstruct the tracheostomy opening. Protector caps are available with side ventilation holes to prevent complete obstruction if this should occur (Figure 6).

Home Care

This is the penultimate challenge of tracheostomy care and it is true that this may not always be possible for different reasons. If deemed appropriate, in well trained parents or caretakers, the home comers are well equipped with oxygen, suction, humidifiers, humovents, a collection of spare tubes and other accessories. The atmosphere at home gets even drier which may lead to crusting and frequent tracheitis. It is mandatory that a tube change is done daily. For the first weeks, the parents will bring their child to the neonatal unit and perform the tube change with the tracheostomy nurse around. Most adapt very quickly to the new lifestyle and proceed on their own at home.

Most children with residual laryngeal phonatory function would achieve a voice without help. One way speaking valves are available to aid phonation if need be.

24 hours access to a duty tracheostomy nurse is available for advice if need be. She in turn is supported by the duty otolaryngologist.



Figure 6 Protection cap with side holes to prevent obstruction by chubby chin.

Complications

In our series of cases, we have fortunately not had a tracheostomy related mortality. Recurrent tube dislodgement occurred in one of our eighteen cases who had glottic and subglottic granulations. This was a case, on review of notes, in whom the adult technique of tape tying using two loops and two knots was employed. It was more difficult in such a case to secure a firm loop round the neck and the shorter neonatal tube was easily dislodged. The airway was salvaged each time with endotracheal intubation. Mild local cellulitis occurred in 7 (39%) of our cases which settled on local and antibiotic treatment. Eight (44%) of our cases had manubrial skin erosion, minimised in our cases over the past 3 years with duoderm protection. Different degrees of suprastomal collapse and suprastomal granulations occurred in all patients who underwent endoscopy 6 months after the tracheostomy. In the decannulated cases only the suprastomal granulations required removal with a pair of Citelli punch forceps through the tracheostome at the pre-decannulation endoscopy. Suprastomal collapse can be treated if need be by laser trimming, suspension stitches to the strap muscles or reconstruction using a thyroid alar or auricular cartilage graft. In our decannulated cases, no treatment was required for the suprastomal collapse.

We have not had, using our vertical slit entry technique and Shiley's silicone paediatric tracheostomy tubes, a problem with late stenosis.

Recurrent tracheitis does occur in our syndromic cases in autumn and winter each year which is really a problem of humidification. It is more conspicuous a complication in them as they carry the tracheostomy long term.

Discussion

Our strife to achieve a safe tracheostomy in the needed paediatric population continues. The details are not meant to be exhaustive but the salient points are communicated. As mentioned earlier, whenever possible, a tracheostomy should still be avoided in the first instance. This is sometimes not achievable because of the medical condition of the patient and, other times, the corrective airway widening procedures may fail to be adequate. At the United Christian Hospital, the indications of the procedure have been extended to the management of patients with neuromuscular deficits. In this group of patients, a tracheostomy spares the child from the associated nasal,

palatal and laryngeal injury of long term intubation. There are no adhesive tapes on the face and the child looks more normal to his parents. Oromotor training is facilitated and pulmonary toilet is more effective. It also lays open the opportunities for home ventilation if practically feasible. Tracheostomy care is a skill much easier for parents and nursing staff to acquire.

The incidence of subglottic stenosis has decreased dramatically to probably less than 1% in our population because of the high standard of care in neonatal intensive care units in Hong Kong. Well established airway widening procedures obviate the absolute need for a tracheostomy. In bilateral paramedian vocal cord palsy, only 48-73%¹⁸⁻¹⁹ of patients need a tracheostomy, hence, only two of our cases were tracheostomised. A subglottic haemangioma can be treated with laser reduction²⁰ or excision.²¹⁻²² Laser in our small baby could have damaged normal subglottic tissue and can always be considered again in 6 months alongside formal excision for decannulation. On the other hand, the parents may decide to keep the tracheostomy until the haemangioma has achieved complete spontaneously involution, usually after 2 years of age. The options for the cystic hygroma are injection of sclerosing OK423 for the macrocysts and excision to minimise facial deformity. The tongue base lymphangioma causing the airway problem is, nonetheless, difficult to treat surgically without significant morbidity. The posterior laryngeal cleft repair was much facilitated by the tracheostomy as no trial of extubation and re-intubation were needed after the repair which could have been destructive. It also took a long time before normal swallowing was acquired after prolonged deprivation and the tracheostomy assisted in pulmonary care. For the craniofacial syndromes, the options could have been CPAP which is difficult to support long term without a dedicated team which does regular home visits. The advent of distraction osteogenesis has possibly revolutionised the treatment of the craniofacial syndromes who can now undergo corrective surgery at a much younger age, minimally invasively. A tracheostomy instantly relieves the airway obstruction in these cases and allows adjunctive maxillofacial procedures to be performed.

In our series of tracheostomies, we have not experienced a major complication except for the one case of repeated decannulation because of the inadequacy of the tying technique. It was fortunate that the laryngeal inlet was not completely obstructed or it would have been the one fatality. It is clear that attention to 3 factors are crucial in the attempt to eliminate tracheostomy associated mortality which are accidental decannulation, inability to replace a decannulated

tube immediately and confidently and obstruction of the lumen by crust. These are addressed in our protocols by a secure tying technique, fully fledged nursing and medical staff throughout the neonatal and paediatric intensive care units in tracheostomy management and frequent tube change plus adequate humidification. Suprastomal granulations are common if not invariable and are readily treatable the plucking with a pair of punch forceps via the tracheostome. Suprastomal collapse of varying degree is a common problem because of the soft neonatal cartilaginous framework. Few require treatment but if indicated, laser trimming is easiest with suspension suturing and reconstruction reserved for more severe cases.

Safe protocols, proper on-site hands on training for nursing and medical staff and indeed, parents, have made a difference in our experience in tracheostomy care which has always, understandably, elicited fear to astronomical proportion. It has also extended the horizons of its use in suitable cases. Its indications should, however, remain restricted to the needed few.

References

1. Arcand P, Granger J. Pediatric tracheostomies: changing trends. *J Otolaryngol* 1988;17:121-4.
2. Line WS Jr, Hawkins DB, Kahlstrom EJ, MacLaughlin EF, Ensley JL. Tracheotomy in infants and young children: the changing perspective 1970-1985. *Laryngoscope* 1986;96:510-5.
3. Carter P, Benjamin B. Ten-year review of pediatric tracheotomy. *Ann Otol Rhinol Laryngol* 1983;92(4 Pt 1):398-400.
4. Wetmore RF, Handler SD, Potsic WP. Pediatric tracheostomy. Experience during the past decade. *Ann Otol Rhinol Laryngol* 1982;91(6 Pt 1):628-32.
5. MacRae DL, Rae RE, Heeneman H. Pediatric tracheotomy. *J Otolaryngol* 1984;13:309-11.
6. Gerson CR, Tucker GF Jr. Infant tracheotomy. *Ann Otol Rhinol Laryngol* 1982;91(4 Pt 1):413-6.
7. Papsidero MJ, Pashley NR. Acquired stenosis of the upper airway in neonates. An increasing problem. *Ann Otol Rhinol Laryngol* 1980;89(6 Pt 1):512-4.
8. Jones R, Bodnar A, Roan Y, Johnson D. Subglottic stenosis in newborn intensive care unit graduates. *Am J Dis Child* 1981; 135:367-8.
9. Fan LL, Flynn JW, Pathak DR, Madden WA. Predictive value of stridor in detecting laryngeal injury in extubated neonates. *Crit Care Med* 1982;10:453-5.
10. Fan LL, Flynn JW, Pathak DR. Risk factors predicting laryngeal injury in intubated neonates. *Crit Care Med* 1983;11:431-3.
11. Ratner I, Whitfield J. Acquired subglottic stenosis in the very-low-birth-weight infant. *Am J Dis Child* 1983;137:40-3.
12. Conner GH, Bushey MJ, Maisels MJ. Prolonged orotracheal intubation in the newborn. *Ann Otol Rhinol Laryngol* 1980;89(5 Pt 1):459-61.
13. Hawkins DB. Hyaline membrane disease of the neonate

- prolonged intubation in management: effects on the larynx. *Laryngoscope* 1978;88(2 Pt 1):201-24.
14. Tucker JA, Silberman HD. Tracheotomy in pediatrics. *Ann Otol Rhinol Laryngol* 1972;81:818-24.
 15. Wetmore RF, Handler SD, Potsic WP. Pediatric tracheostomy. Experience during the past decade. *Ann Otol Rhinol Laryngol* 1982;91(6 Pt 1):628-32.
 16. Dankle SK, Schuller DE, McClead RE. Prolonged intubation of neonates. *Arch Otolaryngol Head Neck Surg* 1987;113:841-3.
 17. Cotton RT, Seid AB. Management of the extubation problem in the premature child. Anterior cricoid split as an alternative to tracheotomy. *Ann Otol Rhinol Laryngol* 1980;89(6 Pt 1):508-11.
 18. Holinger LD, Holinger PC, Holinger PH. Etiology of bilateral abductor vocal cord paralysis: a review of 389 cases. *Ann Otol Rhinol Laryngol* 1976;85(4 Pt 1):428-36.
 19. Cohen SR, Geller KA, Birns JW, Thompson JW. Laryngeal paralysis in children. A long-term retrospective study. *Ann Otol Rhinol Laryngol* 1976;85:428-36.
 20. Cotton RT and Prescott CAJ. Congenital anomalies of the larynx. In: Robin T. Cotton, Charles M. Myer, III, editors. *Practical Pediatric Otolaryngology*. Philadelphia, NY: Lippincott-Raven Publishers, 1998:509-11.
 21. Wiatrak BJ, Reilly JS, Seid AB, Pransky SM, Castillo JV. Open surgical excision of subglottic hemangioma in children. *Int J Pediatr Otorhinolaryngol* 1996;34(1-2):191-206.
 22. Phipps CD, Gibson WS, Wood WE. Infantile subglottic hemangioma: a review and presentation of two cases of surgical excision. *Int J Pediatr Otorhinolaryngol* 1997;41:71-9.