International Journal of Research in Medical Sciences
Sharma K et al. Int J Res Med Sci. 2024 Sep;12(9):3315-3320
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20242609

Original Research Article

Pediatric tracheostomy, its indications, outcome and need for family education: a study in a tertiary hospital

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Received: 29 June 2024
Revised: 16 August 2024
Accepted: 17 August 2024

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ABSTRACT

Background: Paediatric age group remains a challenging patient group for any kind of surgical intervention. Tracheostomy in this age group remains a challenge and its indications have evolved and shifted over the years.
Methods: A prospective study of 1 year period where patients below 18 years of age undergoing tracheostomy were studied and analyzed. Literature for existing protocols/guidelines were studied and implemented. Data was grouped according to age, gender, indications, contraindications, decannulation trends, complications and mortality outcome.
Results: 17 elective paediatric tracheostomies were done out of which 5 patients were female and 12 were male. In the <1 year age group there were 2 patients (12%), 4 (24%) in the 1-5 years group, 5 (29%) in 6-10 years and 6 (35%) in the 11-18 years age bracket. Commonest indication was prolonged intubation (41.18%) followed by upper airway obstruction (29.41%). Complications that we faced which was the most common was blockage of tube (46.67%), followed by decannulation difficulty (20%).
Conclusions: It is still a major challenge to standardize protocols for tracheostomy in paediatric age group as well as initiation of the care giver at home to follow adequate measures to manage children needing prolonged tracheostomy tube care.

Keywords: Airway obstruction, Decannulation, Family education, Paediatric tracheostomy, Prolonged intubation, Standard protocol

INTRODUCTION

Tracheostomy is a surgical procedure that creates an opening in the anterior wall of the trachea and converts it into a stoma on the skin.[1] Lorenz Heister first used the term "tracheostomy" in 1718 to describe the opening, maturation, and insertion of an indwelling tube through the neck into the trachea. The indications for pediatric tracheostomy have evolved throughout time. The most common reason for a tracheostomy was upper airway blockage due to viral infectious diseases.[2] Currently, the most prevalent reason for a pediatric tracheostomy is extended ventilation caused by neuromuscular or respiratory issues.[3]

In most centers, the main indications for tracheostomy in a child are either anticipated long-term cardiorespiratory compromise caused by chronic ventilatory (or, rarely, cardiac) insufficiency or, the presence of a fixed upper airway obstruction that is unlikely to resolve for an extended period of time.[4-7] Respiratory papillomatosis, caustic alkali ingestion, and craniofacial abnormalities have all contributed to an increase in the number of paediatric tracheostomies during the last decade.

The procedure itself is a challenge as it must be done in a well-equipped centre at the hands of an experienced surgeon. Anatomical variations in children such as highly located dome of pleura (it extends to root of neck in

children), high riding innominate artery pose a challenge. The periprocedural considerations, post operative care at the medical institution, counselling the parents to provide a standard tracheostomy tube care at home are very important. Also, proper decannulation plan must be considered in children on whom it is possible to do so as there is a lack of consensus as to when a decannulation must be done. Tracheostomy related mortalities as well as mortality due to factors relating to underlying comorbidity have been studied as well by various researchers in the past as they serve as independent factor related to deaths in these children. An important aspect of post tracheostomy status is training of parents and domestic care givers about tracheostomy tube care; such as being aware when the tube is blocked; how to efficiently change a tracheostomy tube, usage of suction catheters along with portable suction machine, humidifiers, knowing how to give CPR if necessary. Followed by this if decannulation is planned, after proper downsizing of tube and endoscopic evaluation; capped tube monitoring during sleep and daytime must be intimated to the caregivers. This study aims to study those trends and practices associated with pediatric tracheostomy along with the outcome at our institute.

METHODS

The current study was a prospective study design at Gauhati Medical college and Hospital, Assam over a period of one year (September 2022 to August 2023) at Dept. of Otorhinolaryngology. The study was conducted after ethical approval from the Institutional ethics committee of our college. Selection criteria are patients <18 years needing tracheostomy for various indications; morbid or moribund patients excluded. Sampling technique employed was non-random purposive sampling and for statistical analysis calculation mean, median, inter quartile range and Microsoft excel software were used.

Pre procedural planning

Surgical considerations in paediatric tracheostomy

It is primarily an open surgical procedure and therefore has higher risk of perioperative complications compared to adults. Surgical access is limited with short neck with the added challenge that trachea is small, pliable with a tendency to collapse. Also, airway mucosa is more prone to oedema and the lumen being smaller than adults can pose complications later. There is a risk of pleural dome extension into neck. The majority of paediatric tracheostomies are done on an elective or semi-elective basis and emergency tracheostomies for acute airway obstruction or for difficult airway and craniofacial abnormalities may need assistance from anesthesia team and ventilatory support. The original tracheostomy tubes were constructed of sterling silver and stainless steel. They had a lower tissue reactivity but did not conform well to the airway, producing discomfort and bleeding from the tracheal mucosa. Since the mid-1960s, these tubes have been replaced by tracheostomy tubes composed of silicone and PVC (polyvinyl chloride), which provide more flexibility and comfort. The tiny caliber of the paediatric airway coupled with copious mucous secretions causes a considerable resistance to airflow within. To allow for the maximal diameter inside, the majority of paediatric tubes lack an inner tube or cannula. To avoid damaging the tracheal mucosa, use an uncuffed tube. Cuffed tubes are used for positive pressure breathing and to protect the lower airway from aspirations and secretions. Wetmore recommends the following pediatric tracheostomy tube sizes based on the patient's age and weight.[8] Premature neonates or babies who weigh less than 1000 g - 2.5 mm, babies who weigh 1000-2500 g – 3 mm, neonates aged 0-6 months – 3-3.5 mm, infants aged 6 months to 1 year - 3.5-4 mm, infants aged 1-2 years – 4-4.5 mm, children older than 2 years – [age (years) + 16]/4.

The complications of paediatric tracheostomy

Children with tracheostomies are at a higher risk of major morbidity and mortality, which is primarily due to persistent underlying conditions rather than the tracheostomy itself. The incidence of tracheostomy-related problems in children has been recorded between 10% and 58%, with the severity ranging from minor to life-threatening.[9-11]

Table 1: Complications in paediatric tracheostomy.

Time	Complications
General	Tube obstruction Accidental decannulation General complications of surgery and anaesthesia Death
Early post operative (up to 1 week)	Bleeding: post-operative, wound edge Pneumothorax Subcutaneous emphysema Infection Apnoea
Long term	Granulation Vascular erosion, bleeding Suprastomal collapse Skin complications Aphonia, speech delay Psychological factors Adverse effects on family Tracheo-oesphageal fistula

According to NTSP guidelines, their recommendations focus on: i) Prioritising oxygenation, ii) expert help early, iii) Bedside signs with all the relevant information about the airway and TT, iv) Bedside tracheostomy boxes containing essential equipment for each patient, v) Regular training of staff and carers in the routine and emergency management of children with tracheostomies. The initial examination involves performing airway opening manoeuvers, administering high-flow oxygen to

the face and tracheostomy, and calling for assistance and equipment. To assess tracheostomy patency, we have to use a suction catheter. If the tracheostomy cannot be passed, it may get blocked or misplaced, requiring removal. Replace the TT up to three times (same-size, half-size smaller, and half-size smaller over a suction catheter) to ensure proper fit. If unsuccessful, prioritize oxygenation using simple techniques through the upper airway or tracheostoma. If primary oxygenation fails, other options should be considered.

Danger signs pertaining to paediatric tracheostomy

There are tracheostomy specific red flags in the initial period which is important for the surgeon or health care personnel to note which may be- a displaced tracheostomy tube, tube with blood or blood-stained secretions around the tube which means a recently performed or changed tracheostomy. If bleeding is more than usual and in doubt, a proper assessment should be done. Also, a patient complaining of increased discomfort or pain should be taken as a sign to give the patient a second look. General red flags to note are - any physiological changes which can be due to an airway problem. Specifically, changes in respiratory rate, heart rate, blood pressure, level of consciousness. Anxiety, restlessness, agitation and confusion may also be due to an airway problem and therefore must not be ignored. Parents should be taught to look out for some of the danger signs and report immediately.

Surgical technique

After selection of appropriate tubes and patient preparation, the patient is transferred onto the operating room table and under general anesthesia, tracheostomy is performed in the standard conventional method by making a slit incision over the trachea after proper dissection and securing the sides of the pliable trachea with maturation and stay sutures; then the tube is inserted into the stoma and adequate and equal air entry is checked by the intensivists.

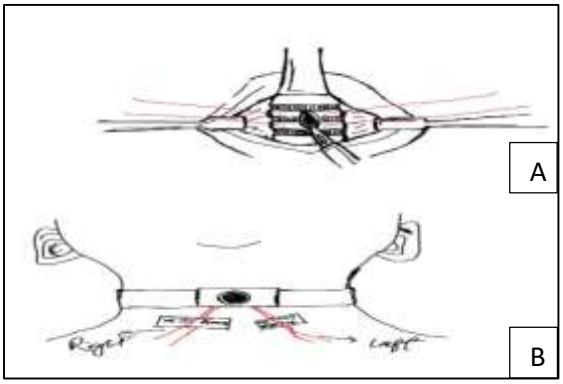

Figure 1 (A and B): Procedure of tracheostomy in the paediatric age group. Stay sutures given adjacent to the new incision in trachea.

Figure 2: A child with an uncuffed PVC tracheostomy tube for recurrent vocal cord papillomatosis who underwent microlaryngeal surgeries multiple times.

Figure 3: A 6-year-old child with acute retropharyngeal abscess who presented with respiratory distress.

Figure 4: Tracheostomy performed in a case of retropharyngeal abscess causing upper airway obstruction.

Decannulation

Decannulation can be considered when the original condition requiring tracheostomy has improved; the child must be able to maintain an adequate airway without the tracheostomy tube. Decannulation may be difficult due to some factors such as - a) Injury to the first tracheal ring or cricoid arch leading to perichondritis of cricoid cartilage, b) a hole in tracheal wall that is too small or too large, c) Granulation around the orifice, d) Tracheomalacia, e) Extratracheal pressure from goitre or tumour. Decannulation in children must be planned in a staged manner where at first downsizing of the tube is done followed by reversible capping (taping, button or by obturator) and observation period of 24 hours. This will be followed by decannulation and stoma closure and further observation in the ward and after discharge. We followed the Great Ormond Street protocol for decannulation. However, in more serious cases it is better to consider decannulation in a controlled ICU environment or some children might need the tube for a prolonged period which may go up to months or years.

RESULTS

Overall, a total of 163 tracheostomies were done over a year (September 2022 to August 2023), out of which 146 were adults and 17 were of paediatric age group. Patients above 18 years of age- 95 were males and 51 females. Among the adults 97 cases were done in the ICU, 49 cases were done as emergency procedure in the OT. In the paediatric age group, 17 tracheostomies were done during the same period out of which 5 patients were female and 12 were male. In the <1 year age group there were 2 patients, 4 in the 1-5 years group, 5 in 6-10 years and 6 in the 11-18 years age bracket. Median age at tracheostomy in this study was 8 years (Interquartile range 1-18) (Figure 5).

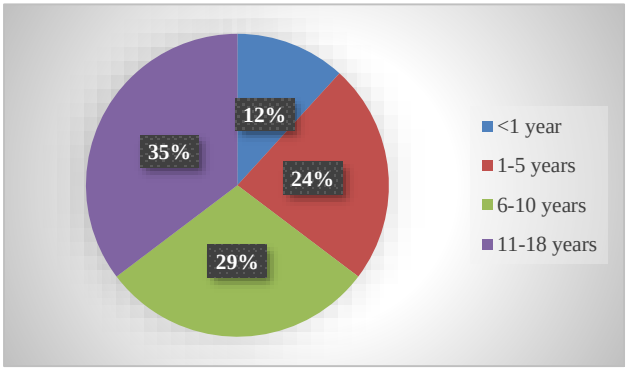

Figure 5: Age distribution in the present study.

In this study the most common indication was prolonged intubation in ICU setting, followed by upper airway obstruction due to causes such as laryngeal papillomatosis, laryngeal cyst, upper airway injury post RTA. Pre-procedural causes were to secure the airway intra or preoperatively in cases of large nasopharyngeal tumour excision where prompt carotid artery or jugular vein access was required. Rest was due to tracheal stenosis and neuromuscular disease.

Table 2: The various indications for tracheostomy in the current study were as follows.

Indications	Numbers (N) %
Prolonged intubation	7 (41.18)
Upper airway obstruction	5 (29.41)
Pre procedural	3 (17.65)
Tracheal stenosis	1 (5.88)
Neuromuscular disease (GBS)	1 (5.88)

Table 3: The complications in the post tracheostomy period were.

Complications	Numbers (N) %
Blockage	7 (46.67)
Apnea/CO_2 washout	1 (6.67)
Subcutaneous emphysema	2 (13.33)
Decannulation difficulty	3 (20)
Peristomal granulation	1 (6.67)
Accidental decannulation	1 (6.67)

Table 4: The decannulation trend in the following study.

Time frame	Numbers of patients
Within 72 hours	0
3-7 days	7
7-14 days	2
Prolonged (with tube)	2

Table 5: Mortality outcomes in the following study.

Directly related to tracheostomy	Unrelated to tracheostomy
Accidental decannulation- 1nos	Respiratory failure in a patient with Guillain Barre syndrome- 1
Post procedural Co2 washout and cardiac arrest- 1nos	Post operative case of posterior craniotomy- 1nos
	Retropharyngeal abscess leading to rupture and aspiration- 1nos
	Childhood AV block leading to cardiac arrest- 1nos

DISCUSSION

The number of paediatric tracheostomies has decreased overall but pediatric tracheostomies at tertiary healthcare referral centers have increased.[12] The most common group in the present study was 11-18 years. A study by Perez-Ruiz et al commented that an incidence in the

higher age a group may be due to the tertiary center being a multi-center referral hospital obtaining referrals from other departments. Additionally, our institute in the capital city remains to be the referral center for other tertiary hospitals from other districts as well. However, a significant proportion of <5 years children required tracheostomy in the present study. Median age at tracheostomy in this study was 8 years (Interquartile range 1-18) similar to a study by Watters K et al where median age was 8 years (Interquartile range 1-16 years).[17] Out of 17 patients, 11 were males (79%) and 3 females (21%). Male predominance in pediatric tracheostomy cohorts has been linked to a greater risk of congenital abnormalities and acquired airway illness in boys.[13] The commonest indication in the present study was found to be prolonged ventilation, followed by upper airway obstruction. Between 1968 and 2005, the most common reason for tracheostomy was obstruction in the upper airway, according to a 37-year study of pediatric patients. Furthermore, there was an increase of tracheostomies for prolonged ventilation in the study's later stages.[14] Two studies conducted from 1996 to 2001 in France and 1999 to 2003 in Singapore discovered an increase in the number of tracheostomies performed on children for prolonged intubation.[15,16] Early complication was tube blockage similar to a study by Wetmore et al.[12] In the present study for the following complications, blockage was managed by timely suctioning of secretions and loosening the secretions by normal saline or sodium bicarbonate solution. Tracheostomy stoma occlusion with secretions is more serious in children compared to adults as the diameter of the tube is smaller. A 2.5 mm tube is the starting size and smaller the tube, worser the blockade. Two cases of subcutaneous emphysema however needed intervention only in the form of expectant management and short course of steroids. Decannulation difficulty that was faced was mainly tracheostomy tube dependence; 2 cases presented with acute “air hunger” when we tried to do a capped decannulation. Most cases tolerated staged decannulation after prior assessment with skiagrams and endoscopy. Before closure of stoma, 1 case encountered peristomal granulation which was cauterized under sedation. Patients that have been successfully decannulated were 59% (10) and are on regular follow up at ENT OPD. Mortality percentage was at 30%, 2 of which were directly tracheostomy related deaths and the rest were unrelated to tracheostomy and due to primary disease or other co-morbidities. Children with tracheostomy tubes have complex underlying medical problems. To take care of these, multidisciplinary management policy is necessary. In the present study a case of 5-year-old girl child with recurrent vocal cord respiratory papillomatosis is in a tracheostomy tube in regular follow up as she needs debulking and removal of papillomatosis on frequent basis. Trial by vaccination with Gardasil has failed in her case probably because it has a lower role post infection by the HPV virus. Another patient who is 3-year-old girl with supraglottic laryngeal spindle cell tumor with recurrence with a tracheostomy tube in situ is on follow up and has been explained about the possibility of long-term usage of tracheostomy tube and its outcomes.

Need for family education, multidisciplinary approach

Children with tracheostomies require multidisciplinary care from otorhinolaryngologists, pulmonologists, cardiologists, neurologists, primary care physicians, nurses, respiratory therapists, and equipment specialists. Patient specific planning involving primary caregivers is of utmost importance. Gaps identification is necessary; such as lack of nursing homes nearby patient residence, with adequately trained staff and equipment. In a developing country, social factors need to be considered-language barrier, economic status, social stigma associated with prolonged tube. Implementing tracheostomy care teams in the tertiary care institute can significantly improve care and prevent adverse events associated with the procedure as evidenced by various studies.[18-21] In this study, with the resources available some practical points to care givers were adopted-Humidification with wet gauze veil over the tracheostomy tube, care during suctioning by inserting only up to total length of tracheostomy tube till the tip only to avoid tracheal injury, not beyond. Sterile saline solution or sodium bicarbonate solution was the preferred mode to loosen secretions. Danger signs identification training to on duty doctors, nurses and family were intimated. Stoma care and dressing was done by the primary caregivers and also training parents to monitor stoma capping during staged decannulation (24 hr period). An important aspect was counselling of parents to deal with psychological impact of the child’s condition. In the present study there were no patients requiring prolonged ventilation at home. Cases needing a prolonged indwelling tube were taught and counselled regarding home care. Minimum requirements were arranged such as appropriate sized tubes(uncuffed), sterile saline, syringes, gauze, gloves, pulse oximeter, portable suction machine, portable oxygen cylinder, mount catheter for nebulization or humidification, suction catheters.

Limitations of this study: The study could have used a questionnaire or assessment of the understanding of the primary care givers of the children regarding tracheostomy and its implications. A study with comparative cohorts in multiple institutions, specifically tertiary centres of state are warranted.

CONCLUSION

While there are many literatures and studies of standard protocols in adults, there are no standard protocols available for children universally. SOPs for good paediatric tracheostomy practices available currently adopted by multiple hospitals are provided by “The Global Tracheostomy Collaborative”, the UK National Tracheostomy safety project, International paediatric otolaryngology group. Training of health providers,

parents and caregivers, school staff must be standardized accordingly. Post discharge of patients with tracheostomy tubes, follow up needs to be emphasized. Training programmes for the family members as well as local health care givers may be arranged by the tertiary health care centre. In anticipated prolonged intubation, the optimal time to do a tracheostomy must be discussed with paediatric intensivists for better outcome. Paediatric laryngotracheal stenosis- a challenge for anaesthetists and otolaryngologists alike as there is a very short time to perform tracheostomy as well as difficulty in intubating patients and lack of jet ventilation facilities in developing countries. Superimposed high-frequency jet ventilation (SHFJV) for tracheal stenosis in eastern India may be considered as suggested in a study by Eva-Matthaeus et al.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Sharma K, Basumatary PS. Pediatric tracheostomy, its indications, outcome and need for family education: a study in a tertiary hospital. Int J Res Med Sci 2024;12:3315-20.