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Pediatric Tracheostomy: A Five-year Retrospective Review at a Tertiary Care Center

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Abstract

Objective: Tracheostomy in the pediatric population is a technical and demanding procedure due to the smaller, more pliable trachea and the limited exposure of the operating field. It has been documented to have higher morbidity and mortality, especially among low birth weight and pre-term infants. A review of the existing literature shows that indications, epidemiology, and complications are changing dynamically, and no definite guidelines have been established.

Methods: A five-year retrospective observational study on pediatric tracheostomy was carried out at a pediatric tertiary care center. All children aged between 1 day and 18 years who had undergone tracheostomy were included. Case records of all children were analyzed meticulously for age, sex, indications, procedure, and complications of tracheostomy.

Results: During the study period, 148 children underwent tracheostomy at our pediatric tertiary care center. The most common indication for tracheostomy was neurological causes, noted in 77 patients (52.02%). The most common early postoperative complication was tube obstruction in 13 patients (8.78%), and the most common delayed postoperative complication was suprastomal collapse in 52 patients (35.13%). In total, 104 patients (70.27%) underwent successful decannulation.

Conclusion: Pediatric tracheostomy is a very demanding and challenging procedure owing to the alterations in the neck anatomy, variations in the airway, and several associated complications. There is a growing need to know the change in indications, complications, and overall outcome of pediatric tracheostomies for better care and efficient management of children requiring tracheostomies.

Keywords: Tracheostomy, child, infant, postoperative complications, decannulation

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Introduction

Tracheostomy is one of the oldest documented surgical procedures in history (1). It is a lifesaving procedure in which the trachea is exteriorized, creating a surgical opening between the external environment and the trachea, bypassing the upper airway (2). The present-day tracheostomy can be attributed to Armand Trousseau, who initially used the procedure to manage patients with diphtheria associated airway distress. The procedure was later modified and standardized by Chevalier Jackson in the early 20th century (3). Although tracheostomy is deemed a life-saving procedure, it is also associated with significant complications, morbidity, and mortality.

Pediatric tracheostomy is a more demanding and challenging procedure in comparison to the one performed in adults. This can be attributed to the smaller airway, more pliable trachea, and limited extension of the operating field in children. The procedure in children has shown an overall higher morbidity and mortality, particularly among syndromic, pre-term, and low birth weight infants (4,5).

Tracheostomies in the pediatric population have been historically employed for emergency indications such as laryngotracheobronchitis, diphtheria, and upper airway obstruction (6). In recent years, however, better intensive care protocols and anesthetic management have led to a significant shift in the indications, complications, and overall management of pediatric tracheostomy.

Hence, the present retrospective study was carried out to analyze the indications, complications, and outcomes of pediatric tracheostomy at our pediatric tertiary care center.

Methods

A retrospective observational study was done on pediatric tracheostomies between July 2020 and July 2025 at a tertiary care center in Southern India. The study included all children, aged 1 day to 18 years, who underwent tracheostomy for various indications. Case records of all children were analyzed meticulously for age, sex, indications, procedure, and complications of tracheostomy. Patients with incomplete records, patients who had undergone tracheostomy outside our center, and those requiring revision tracheostomy were excluded from the study.

A total of 148 children aged 1 day to 18 years who had undergone tracheostomy at our center were included in the study over a period of five years. The tracheostomy procedure was performed by a single pediatric otorhinolaryngology unit in the operating theater to maintain uniformity and strict asepsis. Patients were followed up regularly for up to 6 months post-surgery.

Statistical Analysis

Data was collected and tabulated in an Excel sheet. A total of 148 patients who underwent tracheostomy over a period of five years at our center were included in the study. Mean, range, and standard deviation were used for quantitative data such as age, sex, indications for the surgery, and complications, while counts and percentages were used for data in the categorical form. Statistical analysis was done using SPSS software (version 20.0).

Ethics Approval

The ethical clearance was taken from the Institutional Review Committee Indira Gandhi Institute of Child Health, where the study was done (reference number: IRB/12/25/May/2024, date: 25.05.2024).

Results

During the study period, a total of 148 children underwent tracheostomy at our pediatric tertiary care center. All tracheostomies were conducted in the operating theater to maintain absolute sterility and by a single pediatric otorhinolaryngology team to maintain surgical uniformity. Of the 148 patients, 80 (54%) were male and 68 (46%) were female. The most common age group was less than one year of age (35.13%), followed by the children in the pre-school age group (19.59%) (Figure 1).

The most common indication for tracheostomy was neurological causes, seen in 77 patients (52.02%) (Figure 2). This was followed by upper airway obstruction seen in 41 patients (27.70%). The most common neurological cause requiring tracheostomy was Guillain-Barré syndrome, seen in 28 patients (18.91%) (Table 1).

The complications were categorized as intraoperative, early postoperative (up to seven days of tracheostomy), and delayed postoperative (beyond seven days of tracheostomy). There were no intraoperative complications documented

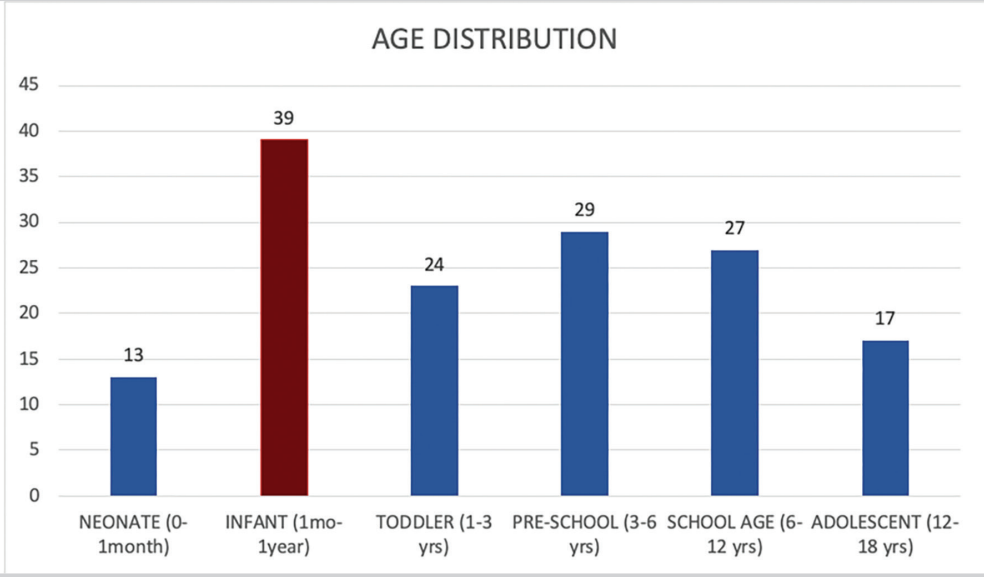

Figure 1. Age distribution of tracheostomized patients

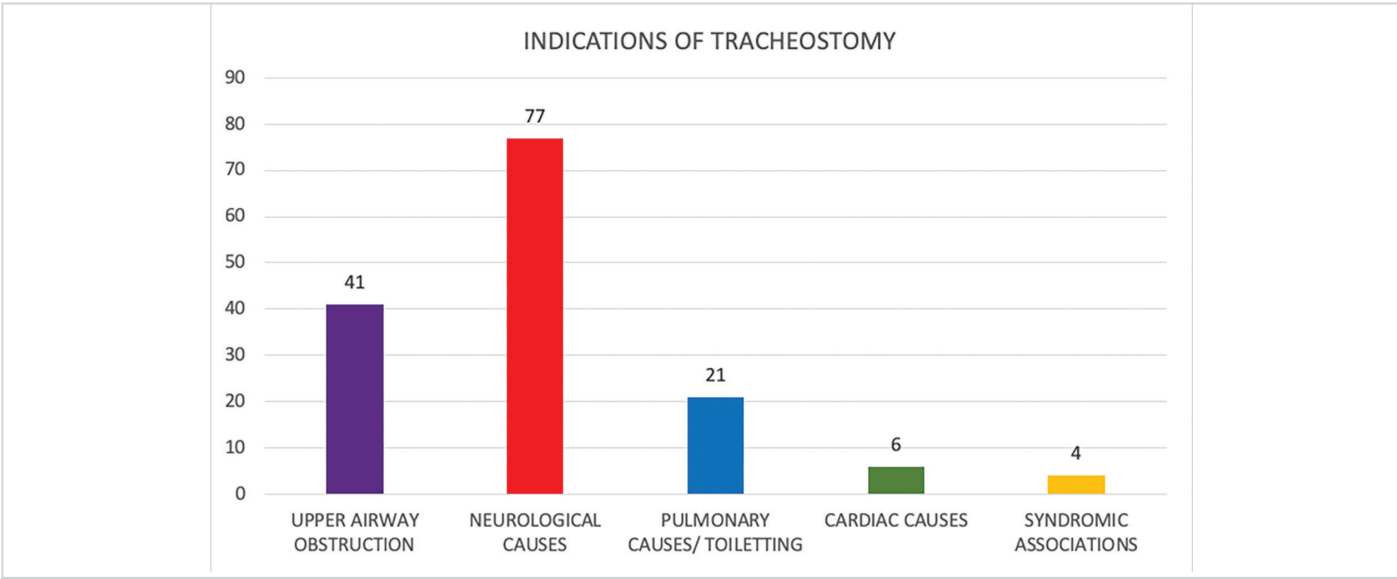

Figure 2. Indications of pediatric tracheostomy

in our study. The most common early postoperative complication was tube block, which was noted in 13 patients (8.78%). The second most common early complication was accidental decannulation in 10 patients (6.75%) (Figure 3). The most common delayed postoperative complication was suprastomal collapse in 52 patients (35.13%), followed by tip granulations noted in 24 patients (16.21%) (Figure 4).

During the study period and the follow-up period of six months, 104 patients (70.27%) underwent successful tracheostomy decannulation. Of these, 16 patients (15.38%) developed further complications of tracheocutaneous fistula, which was surgically corrected.

Five patients (3.38%) among our study population died which was attributable to the primary condition of the patient. None of these were due to the tracheostomy procedure or its associated complications.

Discussion

Tracheostomy is a life-saving procedure that involves creating an opening in the neck to maintain the airway in critically ill patients. When tracheostomy is performed in pediatric patients, especially on low birth weight and preterm infants, the procedure has been associated with higher morbidity and mortality in comparison to adults (5).

Tracheostomy was more frequently done in males in our study population (80 patients, 54.05%) in comparison to females (68 patients, 45.95%). This is in accordance with a study by Yukkaldıran and Doblan (7), in which 51.4% of their tracheostomies were performed on male patients. The most common age group in our study population was less than one year of age (52 cases, 35.13%). This is in accordance

Table 1. Indications of tracheostomy

Serial number	Indications	Number of cases	Percentage
1.	**Upper airway obstruction**	41	27.70
A.	Diphtheria	3	2.02
B.	Laryngomalacia	15	10.13
C.	Subglottic stenosis	9	6.08
D.	Tracheomalacia	4	2.70
E.	Vocal cord palsy	3	2.02
F.	Laryngeal cleft	1	0.68
G.	Recurrent respiratory papillomatosis	1	0.68
H.	Post tracheo-esophageal fistula repair	3	2.02
I.	Acid consumption	2	1.35
2.	**Neurological causes**	77	52.02
A.	Guillain-Barré syndrome	28	18.91
B.	Acute encephalitis	13	8.78
C.	Traumatic brain injury	4	2.70
D.	Myopathies	7	4.73
E.	Spinal injury	1	0.68
F.	Central hypoventilation syndrome	2	1.35
G.	Seizure disorder	6	4.05
H.	Leigh's disease	2	1.35
I.	Acute flaccid paralysis	2	1.35
J.	Meningitis	10	6.78
3.	**Pulmonary causes/toileting**	21	14.18
A.	Pneumonia	13	8.78
B.	Acute respiratory distress syndrome	8	5.40
4.	**Cardiac causes**	6	4.05
5.	**Syndromic associations**	4	2.70
A.	Pierre Robin sequence	2	1.35
B.	Edward's syndrome	1	0.68
C.	Down's syndrome	1	0.68

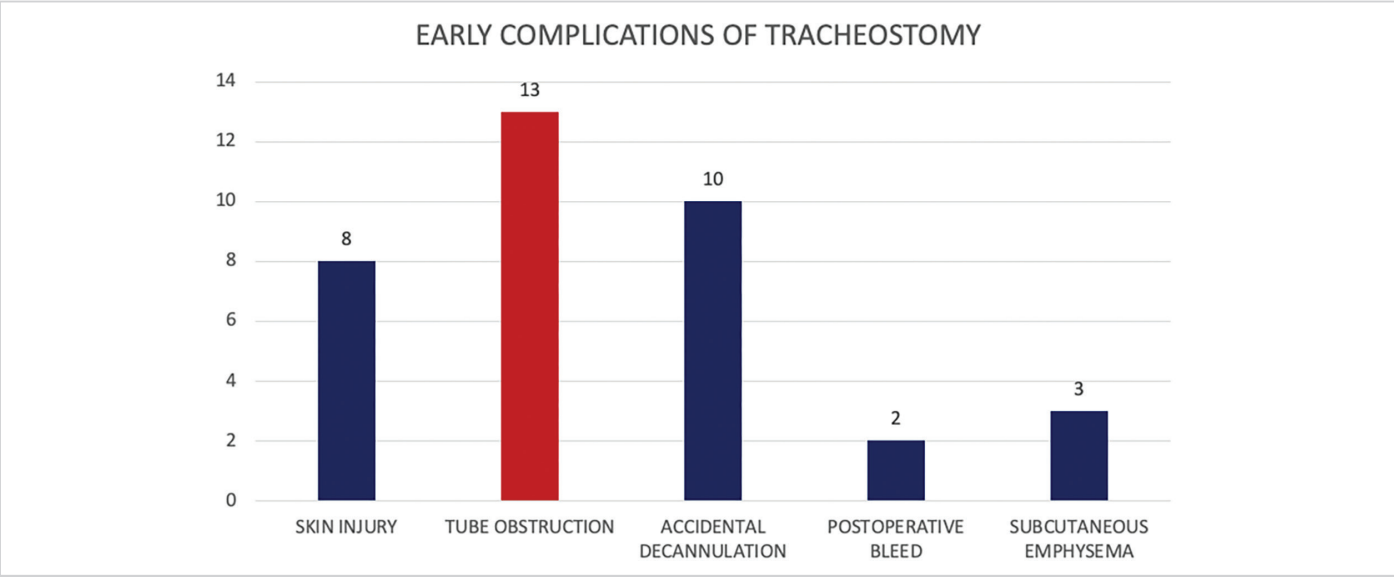

Figure 3. Early complications (up to seven days of procedure)

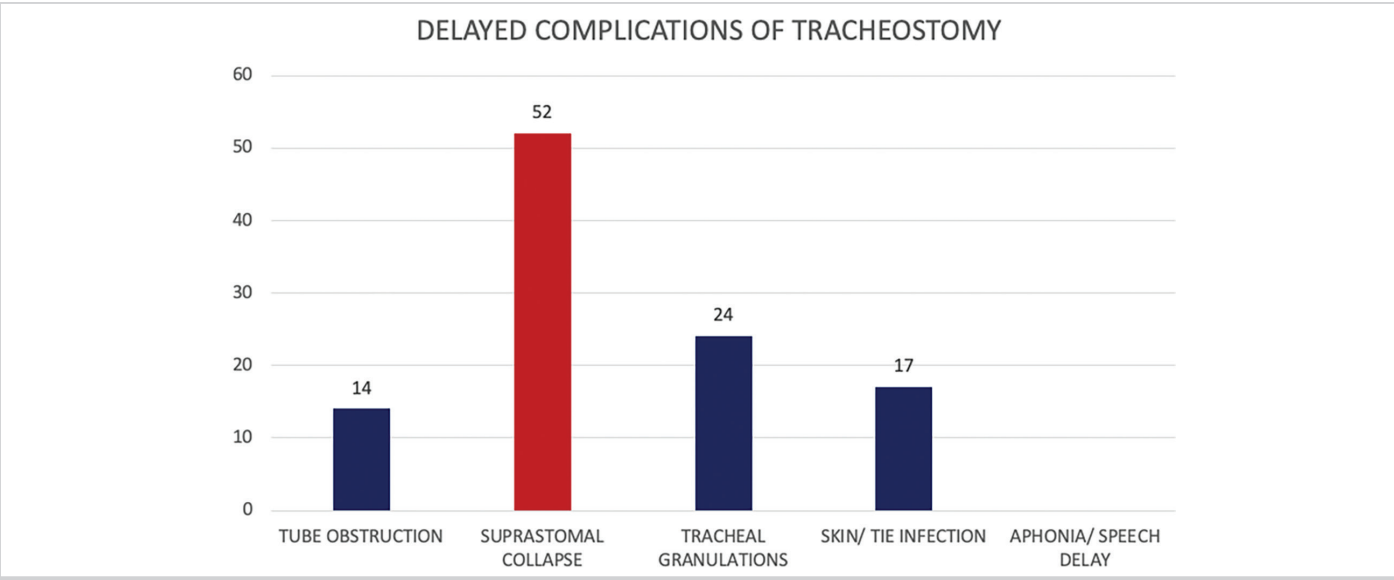

Figure 4. Delayed complications (beyond seven days of procedure)

with a study by Schweiger et al. (8), where the majority of tracheostomies were performed in patients less than one year of age.

Recent advances and developments have emerged in endotracheal intubation, intensive care units, and vaccinations, leading to a significant decline in acute infectious diseases requiring tracheostomy (9). Only three patients (2.02%) in our study underwent tracheostomy for acute airway obstruction (laryngeal diphtheria). A study by Waki et al. (10) noted that there has been a significant decline in tracheostomies done for acute upper airway obstructions.

The most common indication for tracheostomy in our study population was neurological disorders, seen in 77 patients (52.02%). Among the neurological causes, Guillain-Barré syndrome was the most common etiology, seen in 28 patients (18.91%), followed by encephalitis in 13 patients (8.78%). This was in accordance with a study by Tolunay et al. (11), in which 60.4% of their study population had undergone tracheostomy for neurological causes. In the study of Akcan et al. (12), 59.86% of their population had undergone tracheostomy for neurological causes.

Pediatric tracheostomy is associated with a higher incidence of complications in comparison to the tracheostomy done in adults (13). These complications can be broadly classified as intraoperative and postoperative. Postoperative complications can be further subclassified into early (within

seven days of procedure) and late (beyond seven days of procedure) postoperative complications (14). In our study, there were no intraoperative complications.

Early postoperative complications can include, among others, bleeding at the stoma site, accidental decannulation, tube obstruction, and peri-tracheostoma skin infections. The most common early postoperative complication noted in our study population was tube obstruction within seven days of tracheostomy, seen in 13 patients (8.78%). This was marginally higher compared to the study by Van Buren et al. (15), in which early tube obstruction was noted in only 4.7% of their study population. This complication could be attributed to the presence of blood clots within the tube, improper and irregular suctioning, and alterations in the quantity and quality of the tracheal secretions, which could lead to a tracheostomy tube block (16).

Accidental decannulation is a dreaded complication associated with tracheostomy tubes and is a significant cause of tracheostomy-related morbidity and mortality (17). It is considered a serious early postoperative complication, with an incidence ranging from 0.9% to 20% in the literature (18). In our study, it was the second most common early complication, occurring in 10 patients (6.75%), and was more frequently observed in patients with uncuffed tubes. This finding is consistent with a Scottish series by Douglas et al. (19), in which tube displacement occurred in 5.2% of 111 pediatric patients who underwent tracheostomy. Accidental decannulation can be minimized by placing stay sutures from the anterior tracheal wall to the chest, thereby reducing tube displacement and effectively anchoring the tracheostomy tube (16).

The complications that occurred after seven days of performing tracheostomy were termed as late complications. These can include suprastomal collapse, tracheal granulations, local skin infections, accidental decannulation, and tracheo-vascular fistula. Suprastomal collapse occurs due to damage to the mucosa and the tracheal cartilage. In particular, it occurs due to weakening of the anterior tracheal wall superior to the tracheostoma (16). In a study by Antón-Pacheco et al. (20), suprastomal collapse was noted in 20% of their study population. The presence of significant suprastomal collapse can impede the decannulation of the tracheostomy tube. Fifty two patients (35.13%) in our study had suprastomal collapse, which was higher than in other studies. This could be attributed to the technique of tracheostomy being used, as the authors did not fix the tracheal wall to the tracheostoma skin at the time of surgery to prevent development of tracheocutaneous fistula, as was being followed in other studies (16).

The second most common late complication noted in our study was lower tracheal granulations, seen in 24 patients (16.21%). Across literature, the rate of tracheal granulations was noted as being 12.3% to 66% (21). The presence of these granulations is usually non-obstructive and asymptomatic and does not warrant any surgical treatment. Only the granulations that would impede decannulation should be excised. These can be managed endoscopically, or in case they are large and firm, should be removed via an open excision (16).

Of the 148 patients in our study population, 104 patients (70.27%) were successfully decannulated. These were mostly patients who had been tracheostomized in view of neurological or pulmonary causes. In a study by Schweiger et al. (8) in Southern Brazil on 123 children who had undergone tracheostomy, only 35 (28%) were successfully decannulated. They attributed a lower rate of decannulation in their study to patients having more comorbidities. In another study by Bandyopadhyay et al. (22), 147 of 189 (77.8%) patients were successfully decannulated. They concluded that decannulation without adequately addressing comorbidities could result in adverse outcomes.

Tracheocutaneous fistula is a complication of tracheostomy decannulation. Failure of the tracheostoma to close spontaneously after decannulation results in a tracheocutaneous fistula. In our study, it was noted in 16 patients (15.38%) post decannulation. Failure to spontaneously close the tracheostomy for up to six months was considered a tracheocutaneous fistula. Our study was in accordance with a study done by Tasca and Clarke (23) in Liverpool, where 11.9% of their study population had a tracheocutaneous fistula requiring surgical closure. It was noted in this study that children who had the tracheostomy tube for more than two years were more prone to developing a tracheocutaneous fistula.

Study Limitations

The study design is retrospective in nature, which could have potentially introduced a selection bias. The study is limited to being carried out at a single institution which could lead to difficulty in generalizing the findings to a wider population.

Conclusion

Tracheostomy in children is a very demanding and challenging procedure owing to the alterations in the neck anatomy, variations in the airway, and several associated complications. The procedure remains a common practice in tertiary care hospitals due to varied conditions and indications. Regardless of the indication and the protocol used, there are several complications described in literature which the operating surgeon and caregivers should keep in mind. There is a growing need to know and understand the indications, complications, and overall outcome of pediatric tracheostomy for better care and efficient management of children requiring this procedure.

Ethics

Ethics Committee Approval: The ethical clearance was taken from the Institutional Review Committee Indira Gandhi Institute of Child Health, where the study was done (reference number: IRB/12/25/May/2024, date: 25.05.2024).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.F., P.K.P., Concept: A.F., P.K.P., Design: A.F., P.K.P., Data Collection and/or Processing: A.F., S.R., Analysis or Interpretation: A.F., P.K.P., Literature Search: A.F., S.R., Writing: A.F.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Main Points

- Pediatric tracheostomy is a more challenging procedure due to the smaller, more pliable trachea, and the limited extension of the available operating field.
- In recent years, there has been significant change in the indications and complications of tracheostomy in the pediatric population.
- 52.02% of patients in our study population underwent tracheostomy due to an underlying neurological cause. • The most common early complication related to tracheostomy was tube block seen in 8.78% of the patients.
- The most common delayed complication noted in our study was suprastomal collapse seen in 35.13% of the patients.

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