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Original Article

Pediatric tracheotomy: insights from a single-center study

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Abstract

Introduction: Over the years, pediatric tracheotomy has evolved significantly, and ongoing debates regarding its indications, timing, surgical techniques, and decannulation protocols persist. In most cases, management decisions are based on the medical team's clinical experience and existing literature, as there are no universally accepted guidelines.

Aim: This study aims to present our experience with pediatric tracheostomies and compare our results with those reported in the international literature.

Patients and methods: Over the past few years, 18 pediatric tracheotomies were performed at the ENT Clinic at St George University Hospital in Plovdiv due to various chronic conditions. All procedures were planned due to disease progression.

Results: The surgical interventions were completed without complications in all cases. Eight patients underwent permanent tracheostomy, while ten underwent temporary tracheostomy. Three children were successfully decannulated.

Conclusion: Pediatric tracheotomy is a relatively rare surgical procedure with an estimated incidence rate of 6.6 per 100,000, according to the literature. Despite extensive research on the topic, several aspects of planned pediatric tracheotomy remain under discussion and require further clarification.

Keywords

diseases leading to tracheotomy, pediatric tracheotomy, planned tracheotomy in children, outcome

Introduction

According to the literature, pediatric tracheotomy has undergone significant development in recent decades, particularly with regard to its applications. The focus has shifted from using it to resolve acute asphyxiation to using it for children with chronic and progressive diseases who depend on tracheostomy and related medical technologies for long-term survival.[1] Today, the primary indication for tracheotomy in children is prolonged mechanical ventilation.[2-4]

Compared to adults, tracheotomy in children, especially those under one year of age, is associated with a significantly higher mortality rate due to several key anatomical and physiological factors.[1,5] In children, the hyoid bone often extends beyond the thyroid cartilage. Additionally, an infant's laryngeal cartilage is softer and more flexible than

that of adults, making it prone to collapse under pressure. The mucosa of the supraglottis and subglottis in infants is also more susceptible to edema in cases of inflammation or injury, as well as ischemia.[6] Despite these challenges, an experienced physician can perform the procedure without significant difficulty, particularly when it is planned rather than conducted as an emergency intervention.

The main complications associated with pediatric tracheotomies are similar to those in adults and include bleeding, pneumothorax, mediastinitis, and tracheoesophageal fistula.[3,7] Age-related complications have also been observed, such as the inability to speak, which may lead to developmental delays depending on the child's age.[4] Additionally, accidental decannulation, which can result in asphyxia, is significantly more common in children than in adults.[8]

The rising number of tracheotomies in children with chronic diseases underscores the mounting reality that many of these patients will be discharged from medical institutions with a tracheostomy tube, necessitating long-term care at home. This raises critical questions about who will be responsible for the child's daily tracheostomy management and how caregivers (staff from social institutions, parents, etc.) will be trained.

The financial burden of raising a child with a tracheostomy is another significant concern, as the costs associated with specialized equipment, medical care, and potential home modifications can be substantial. An often-overlooked aspect of pediatric tracheotomy is its psychological impact on the child's family. Parents and close relatives who take on the primary caregiving role frequently experience emotional and psychological distress, particularly in the initial weeks and months after the procedure. There is an urgent need for structured support systems—both medical and psychological—for these "indirect victims" of pediatric tracheotomy, and this issue deserves greater attention in healthcare planning and policy.

Aim

This study aims to present our experience with pediatric tracheostomies and compare our results with those reported in the international literature.

Patients and methods

Over the past few years, the ENT Clinic of St George University Hospital in Plovdiv has performed 18 planned tracheotomies on pediatric patients with various underlying chronic diseases. In all cases, the procedure was necessary due to disease progression requiring prolonged mechanical ventilation and/or tracheobronchial hygiene.

Each case was thoroughly discussed in advance with the medical team responsible for managing the underlying disease, the postoperative care team, and the child's parents. Written informed consent was obtained from the parents before proceeding with the surgical intervention.

In one case, despite progressing laryngeal dyspnea and explanations from the surgical team, the mother refused consent for the tracheotomy. After discussions with the hospital's lawyers, parental rights were transferred to the medical team. The surgical procedure was then carried out successfully without complications. Subsequently, the mother relinquished custody of the child, who was placed in a care institution.

A standard tracheotomy procedure was performed in all 18 cases. The cannula size was chosen based on the child's age using the following formula: For children older than one year, the inner diameter of the cannula (in millimeters) is determined by dividing the child's age by four and adding four millimeters. For convenience, the table provided by Cote F[9] can be used to determine the appropriate cannula size for pediatric patients **(Table 1)**.

Table 1. Cannula size in infants and children (Cote F[9])

Age of the patient	Inner diameter mm
Prematurely born	
<1000 g	2.5
1000–2500 g	3.0
Newborn aged 0–6 mos.	3.0-3.5
Infants aged 6 mos.–1 year	3.5-4.0
Infants aged 1–2 years	4.0-5.0
Children more than 2 years old	[age (years) + 16]/4

Results

The purpose of this article was to present our experience with pediatric tracheotomies and to compare our data with that in the global literature. The children who had undergone tracheotomies were divided into subgroups according to different criteria.

Distribution by age at the time of tracheostomy

The children were divided into three age groups according to their age at the time of the tracheotomy **(Fig. 1)**.

a. Under 1 year old: 6 children
b. 1–6 years old: three children
c. Older: 9 children

Distribution by sex

The sex distribution of tracheotomized children was as follows **(Fig. 2)**:

a. Boys: 8
b. Girls: 10

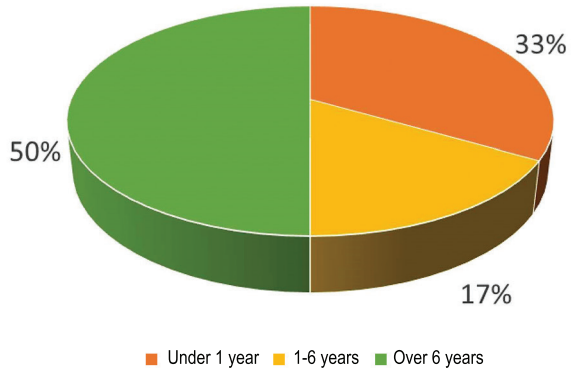

Figure 1. Distribution of children at the time of the surgical intervention.

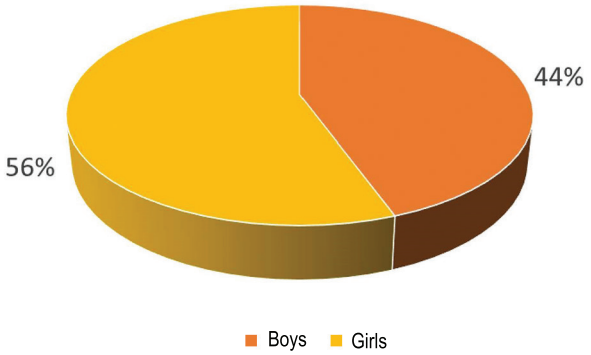

Figure 2. Distribution of tracheotomized children by sex.

Distribution by type of disease

The division based on the type of disease (genetic or non-genetic) was as follows **(Fig. 3)**:

a. Tracheotomized children with a proven genetic disease: 6

b. Tracheotomized children without a genetic disease: 12

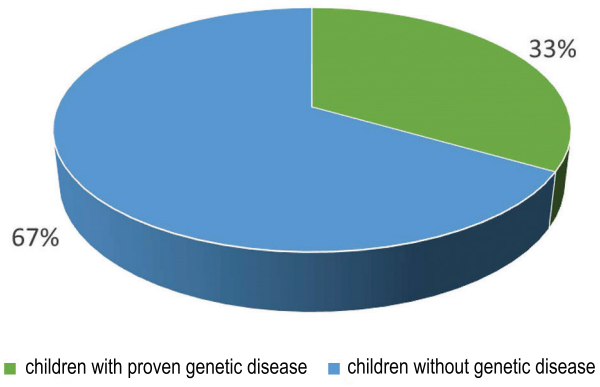

Figure 3. Distribution of children according to the presence/absence of a genetic disease.

Distribution of children by underlying condition

The distribution of tracheostomized children in our study based on their underlying condition (whether it is congenital or acquired) was **(Fig. 4)**:

a. Congenital diseases: 9 children

b. With acquired diseases: 9 children

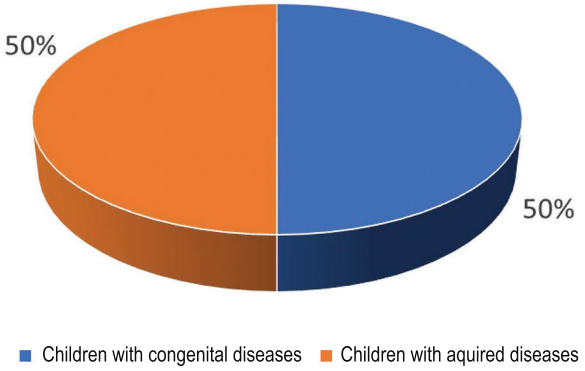

Figure 4. Distribution of congenital vs. acquired diseases among tracheotomized children

Affected system

Based on what the affected system was in the patient, the children were categorized into several main groups, as shown in **Table 2** and **Fig. 5**.

Table 2. Distribution of tracheotomized children according to the affected system

Affected system	Number
Nervous system	10
Respiratory system	4
Hematological diseases	2
Traumatic injuries	1
Polymalformative conditions	1

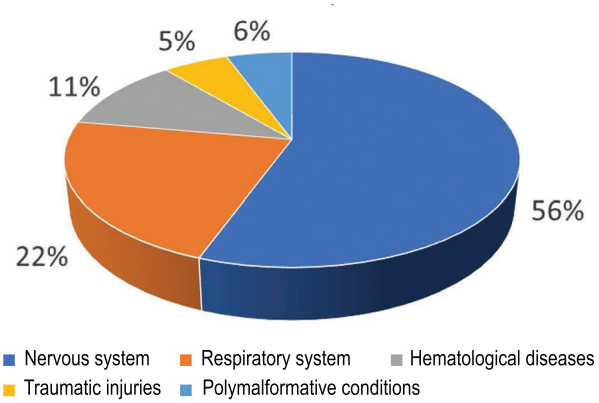

Figure 5. Distribution of tracheotomized children according to the affected system.

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Distribution by type of tracheostomy

The children in the study were divided into two groups based on what type of tracheostomy they received (**Fig. 6**):

a. Children with a permanent tracheostomy: 8 patients. Four of these patients initially had a temporary tracheostomy, but reoperation was necessary during the postoperative period to transition to a permanent tracheostomy. Two of these cases required the change after failed cannula replacement and emergency intubation. The other two cases involved converting an initially temporary tracheostomy to a permanent one after deciding to discontinue decannulation attempts. This ensured easier and safer home care for the child.

b. Children with a temporary tracheostomy: 10 patients.

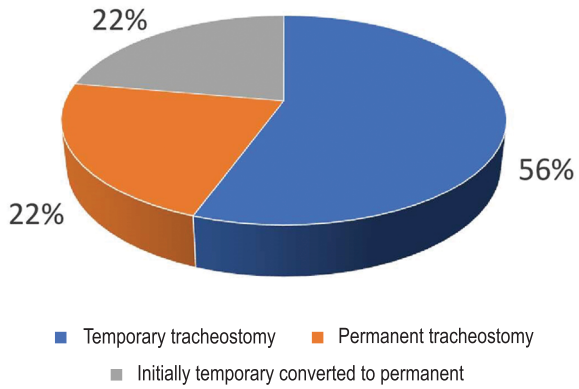

Figure 6. Distribution of tracheotomized children based on tracheostomy type.

Decannulation

Decannulation can be defined as the reversal of a tracheotomy. In general, it is the primary goal of treatment for tracheotomized children, except in cases where the underlying condition is not expected to improve, necessitating a permanent tracheostomy.

Among the eighteen tracheotomized children in our clinic, five underwent decannulation attempts (**Fig. 7**). The process was successfully completed in three cases, while in two cases, retracheotomy and recannulation were required.

Survival of tracheotomized children

After undergoing tracheotomies, the children were monitored by pediatricians from the Pediatric Clinic at St. George University Hospital. Most of the children received long-term care at the clinic and were periodically admitted for monitoring and treatment of their underlying disease. During the observed period, the survival statistics were as follows (**Fig. 8**):

a. Diseased children: five of the deceased children were tracheotomized, two due to late complications related to tracheostomy (decannulation with unsuccessful recannulation or intubation) and three due to the underlying disease or its complications.

b. Alive: Thirteen tracheotomized children.

Complications of tracheotomy – intraoperative, early, and late

The distribution of tracheotomy-related complications was as follows:

a. Intraoperative complications: None were observed.

b. Early postoperative complications: Occurred in five cases, all involving accidental decannulation.

c. Late postoperative complications: Ten cases of accidental decannulation; three cases of peristomal granulation tissue requiring surgical intervention; and several hospitalizations due to pneumonia, other inflammatory diseases, or progression of the underlying condition. However, data on these cases are incomplete.

Discussion

Pediatric tracheotomy is a relatively rare surgical procedure with an estimated frequency of 6.6 per 100,000 according

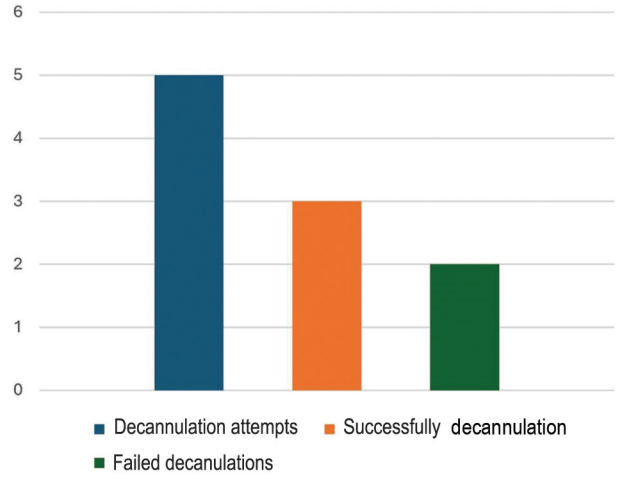

Figure 7. Classification of children based on decannulation status

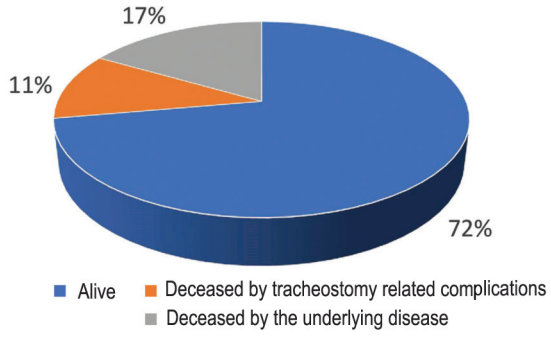

Figure 8. Deceased to living tracheotomized children ratio

to the literature.[4] Over the past few decades, significant advancements in pediatric care have led to changes in the necessity and indications for tracheotomy.[10] On the one hand, improvements in child healthcare, better management of acute inflammatory diseases, and enhanced endotracheal intubation techniques have reduced the need for urgent tracheotomy. Until the 1880s, emergency pediatric tracheotomies were extremely common.[11-13] On the other hand, progress in medicine, particularly in neonatal and critical care, has introduced a new, heterogeneous group of young patients who require tracheotomies, primarily in a planned manner.[1,14] This is most often due to prolonged mechanical ventilation.[15] Our study did not include a single case of pediatric tracheotomy performed due to acute respiratory distress. During the observed period, there was no need for emergency tracheotomy, which further confirms that the indications for the procedure in our study align with those reported in the literature.

The critical importance of the decision to perform or withhold tracheotomy in children on mechanical ventilation, especially in pediatric intensive care units, is highlighted by the following global statistics: Over 7% of children who undergo tracheostomy do not survive their hospital stay, with mortality rates increasing to 9-15% within 10 years of the procedure. It is noteworthy that less than 3% of this mortality is directly attributed to tracheostomy-related complications. The majority of deaths are due to complications arising from the child's chronic underlying diseases. The data from our study reflected similar trends. The overall mortality rate observed was 27.77%, with 11.11% of deaths related to late complications associated with the tracheostomy (decannulation) and 16.66% resulting from the progression of the underlying disease.

Between 15% and 19% of the children developed complications related to the tracheostomy within the first two years, and recent clinical studies suggest that this figure can rise to as high as 38.8%. In our study, no intraoperative complications were observed (0%). Early postoperative complications were seen in 27.77% of cases, all of which involved accidental decannulation. Late complications associated with the tracheostomy occurred in 11% of cases, primarily involving the development of peristomal granulations. These findings are consistent with global experience.

An essential aspect of tracheotomy in both children and adults is the decannulation attempt.[16] Literature data show a wide range in the success rate of decannulation, varying from 29% to 98%.[2,4,17-19] In our study, the decannulation success rate was 11.11%, which we attribute to the previously mentioned trend of reducing tracheotomies in children with acute diseases, in favor of those with chronic, progressive conditions.

Despite the extensive number of articles on the topic, several aspects related to the performance of planned pediatric tracheotomy remain subjects of ongoing discussion and require further clarification.[15]

There are no internationally established or universally accepted guidelines regarding key aspects of pediatric tracheotomy. For example, there are no established guidelines for the optimal timing of the procedure during prolonged intubation. According to various authors, the optimal timing ranges from 21 to 65 days[20,21], with an average of 39 days and a maximum of 90 days. Similarly, there are no internationally accepted decannulation protocols, etc.[7] Consequently, management of each patient is highly individualized and largely determined by the surgeon and medical team caring for the tracheotomized child.

Conclusion

A literature review supported by our experience indicates that pediatric tracheotomy has evolved significantly. Today, it is primarily performed as a planned procedure due to the need for long-term mechanical ventilation and/or tracheobronchial toilet.

However, due to the dependence of decannulation success on the underlying condition that necessitated the tracheotomy during childhood and the increasing prevalence of tracheotomies in children with chronic diseases rather than acute asphyxiation, the percentage of patients who are successfully decannulated remains low.

Despite the relatively low mortality rate and declining complication rates associated with pediatric tracheotomy, this procedure should be avoided when alternative treatment options are available.

It is essential to establish international guidelines outlining the management of pediatric tracheotomies. These guidelines should cover all steps of the procedure, including assessing the need for intervention, performing the tracheotomy, providing postoperative care, and managing the child in the long term.

To improve care and quality of life for tracheotomized children, specialized centers and interdisciplinary teams dedicated to their management must be established.

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