



COMPLICATIONS OF TRACHEOSTOMY IN CHILDREN : A SYSTEMATIC REVIEW

¹ Jeremy Stephen Hermanto, ² Andrew Theodoros Timothy, ³ Mellvin Telasman

¹ Mitra Keluarga Kelapa Gading General Hospital, Indonesia

^{1,2,3} Faculty of Medicine, University of Pelita Harapan, Indonesia

Corresponding Email : jeremystephen98@gmail.com

Article History :

Received date : 2025/09/09

Revised date : 2025/10/17

Accepted date : 2025/12/26

Published date : 2026/01/04



Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (BY NC) license (<https://creativecommons.org/licenses/by-nc/4.0/>).

E-ISSN :

ISSN 3048-1368



P-ISSN

ISSN 3048-1376



ABSTRACT

Tracheostomy is the term that is used to describe an opening that has been created in the trachea, whereas tracheotomy is the phrase that is solely used to refer to the act of producing an incision in the trachea. Tracheostomy is a term that was first coined in the 1960s to describe an opening that had been created in the trachea. When there is a sudden or prolonged obstruction of the upper airway, a tracheostomy can be performed to help bypass the obstruction. Although tracheostomy is sometimes performed as a last-ditch effort in the treatment of severe obstructive sleep apnea, the procedure is rarely used as an initial method of treatment. A tracheostomy is performed in place of an endotracheal tube in patients who need artificial ventilation for an extended period of time. Those who have inadequate control of their secretions and suffer from chronic aspiration may benefit from having a tracheostomy performed because it gives them access to deep pulmonary suctioning. Those who are born with or develop subglottic stenosis as a result of medical treatment may be able to circumvent this obstruction with the use of a tracheostomy. The

potential for complications after surgery can be divided into two groups: intraoperative and postoperative, with the latter group being further subdivided into early and late postoperative difficulties. The findings of this research point to a diverse set of potential scenarios regarding the prevalence and distribution of these issues. This article demonstrates that granulation were the most common problems that we encountered in the research that were conducted above as recently as 2017. In tracheostomized patients, death is a possible unwelcome event. Most of the time, it is unrelated to the procedure and occurs as a result of the progression of the underlying disease.

Keyword: Complication; Children; Granulation; Intensive Care; Tracheostomy

INTRODUCTION

In the year 1718, Lorenz Heister was the first person to use the phrase "tracheostomy" to describe the process of opening the trachea, allowing it to mature, and inserting an indwelling tube into the trachea through the neck.¹ Since then, many surgical and medical disciplines have improved surgical airway management. Otolaryngologists and pediatric surgeons are skilled at performing tracheostomies on children, and various hospital teams support long-term stoma care, including family education, supplies, and chronic mechanical ventilation.²⁻⁴

Tracheostomy is the term that is used to describe an opening that has been created in the trachea, whereas tracheotomy is the phrase that is solely used to refer to the act of producing an incision in the trachea.⁵ Upper airway blockage caused by infectious infections or tumors was the sole known indicator of this condition for a very long time. Indications for tracheotomies became more common beginning in the 20th century and continuing ahead. Almost two thirds of all tracheostomies performed today are on children younger than one year old.⁶

A tracheostomy is beneficial for bypassing sudden or persistent blockage of the upper airway. Tracheostomy can be the final resort in the management of severe obstructive sleep apnea, however it is rarely utilized as a first-line strategy. For patients requiring long-term artificial ventilation, a tracheostomy substitutes the endotracheal tube. A tracheostomy provides access to deep pulmonary suctioning for individuals with inadequate secretion control and chronic aspiration. A tracheostomy can enable individuals with congenital or iatrogenic subglottic stenosis bypass this obstacle.⁷

These tracheostomies typically remain in place for longer periods of time compared to those performed on adults. Laryngotracheal stenoses, prolonged use of mechanical breathing, and the requirement for ongoing pulmonary hygiene management are the primary indications in children.⁴ Numerous different methods have been outlined here. The primary distinctions often concern the direction in which the incision is made in the skin, the shape of the incision made in the trachea, and whether or not the trachea is sutured into the skin, which is also referred to as "stoma maturation".⁸

The potential for complications after surgery can be divided into two groups: intraoperative and postoperative, with the latter group being further subdivided into early and late postoperative difficulties. The findings of this research point to a diverse set of potential scenarios regarding the prevalence and distribution of these issues.^{4,9} The purpose of this research is to provide information about challenges that are unique to tracheostomies performed on children.

METHODS

The Recommended Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 initiative met the data collecting, processing, and reporting standards. A variety of factors affected the decision to adopt new restrictions. This review of the literature investigates the issues associated with tracheostomy in children. According to the study's main findings, all written materials about tracheostomy difficulties in children must be written in English. This systematic review looked at scholarly articles published after 2017 that met the inclusion criteria for the study. Editorials, entries without a DOI, reviews of previously published books, and duplicate journal articles that are excessively long will be excluded from the collection.

The search for studies to be included in the systematic review was carried out from April, 3rd 2023 using the PubMed and SagePub databases by inputting the words: “complications”, “tracheostomy” and “children”. Where (*"complicances"[All Fields] OR "complicate"[All Fields] OR "complicated"[All Fields] OR "complicates"[All Fields] OR "complicating"[All Fields] OR "complication"[All Fields] OR "complication s"[All Fields] OR "complications"[MeSH Subheading] OR "complications"[All Fields]*) AND (*"tracheostomy"[MeSH Terms] OR "tracheostomy"[All Fields] OR "tracheostomies"[All Fields]*) AND (*"child"[MeSH Terms] OR "child"[All Fields] OR "children"[All Fields] OR "child s"[All Fields] OR "children s"[All Fields] OR "childrens"[All Fields] OR "childs"[All Fields]*) is used as search keywords.

Abstracts and names of studies had an impact on their acceptability. Due to this, they must rely on historical documents. There is a need for unpublished English publications because the results of investigations are typically consistent. Only studies that met the inclusion criteria were

investigated for inclusion in the systematic review. This restricts the search results to only those that meet the specified criteria. The evaluation procedure is divided into the sections listed below. The study examined numerous factors, including authors, publication dates, geographical locations, activities, and motives. After EndNote documented a search's results, the database removed duplicate articles.

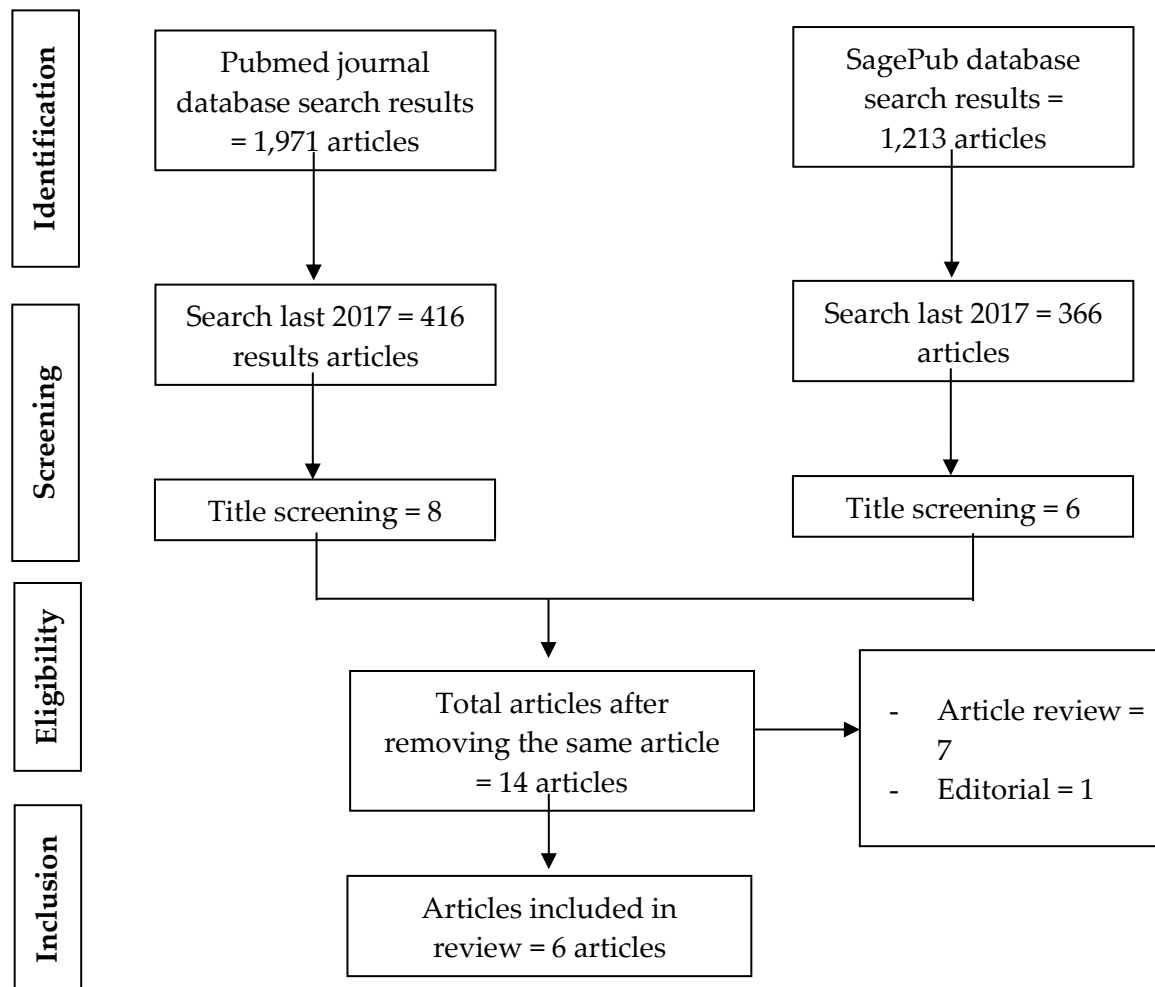


Figure 1. Article search flowchart

Two persons reviewed article titles and abstracts. Each writer evaluated the article's abstract and title when choosing which to address. Every manuscript that passes review will be thoroughly analyzed. After our investigation, we will review any relevant scholarly articles we overlooked. This rule specifies document evaluation criteria. For efficiency, identifying objects to be inspected should be streamlined. Why was a certain study picked out of all the others to be included in the synthesis of the literature that was available?

RESULTS

Syed, et al (2018)¹⁰ showed early postoperative problems such as hemorrhage, pneumothorax, surgical emphysema, or unintentional decannulation did not occur in any of the children. Peristomal granulations (24%) were the most frequent consequence, but none were severe enough to require surgical intervention. One child had a life-threatening tube block that required CPR. No children accidentally decannulated during the research. Two children (4%) developed tracheocutaneous fistula. These kids needed decannulation surgery. No youngster showed tracheal stenosis or tracheomalacia.

Maunsell, et al (2018)¹¹ conducted a study with 160 children. They showed frequent comorbidities were reported, including 40% neurologic abnormalities, 26.9% lung diseases, and 20% preterm newborns. The most common syndrome was Down's syndrome, which accounted for 23.1% of children. Infection was the most common early consequence, occurring in 8.1% of cases. Stomal granulomas were the most common late consequence, affecting 16.9% of patients. Following endoscopic examinations, airway abnormalities were frequently identified.

In 29.4% of cases, subglottic stenosis was the most common airway diagnosis, followed by laryngomalacia, suprastomal collapse, and vocal cord paralysis. In 22.5% of instances over the three-year period, decannulation was accomplished. The primary reason for chronic tracheostomy was the requirement for additional airway pathology treatment. Over this time span, the mortality rate was 18.1%, however only 1.3% of deaths were directly attributable to the tracheostomy; the remaining deaths were the result of other comorbidities.¹¹

Feehs, et al (2018)¹² showed 31 (54%) of 57 decannulated patients had tracheocutaneous fistulas. After decannulation, patients with tracheocutaneous fistulas had a mean tracheostomy duration of 42 months, compared to 13 months in those without. Gender, age at tracheostomy, and age at decannulation were not independently significant variables in tracheocutaneous fistula development, but duration was ($P < 0.001$). Decannulation to tracheocutaneous fistula repair averaged 132 days. All tracheocutaneous fistulas closed. No patient required hospitalization or surgical revision.

Table 1. The literature include in this study

Author	Origin	Method	Sample	Conclusion
Syed, 2018 ¹⁰	India	Prospective study	50 pediatric tracheotomy cases	Performing a pediatric tracheostomy can be difficult for the surgeon as well as the caregiver, particularly in the early stages of the post-operative recovery process. These concerns are addressed by the modified technique that we have proposed, and there are no major complications involved.
Maunsell, 2018 ¹¹	Brazil	Retrospective cohort study	160 pediatric tracheotomy cases	The majority of children who had tracheostomies were quite young, and co-existing conditions were extremely common. In the majority of cases, a tracheostomy was not reversed in a kid before

the age of one after it had been performed. The stoma infection was the most common early complication, followed by unintentional decannulation as the second most common. Granuloma and suprastomal collapse were the kind of late complications that occurred the most frequently. Because this cohort had a high prevalence of airway anomalies, it is imperative that evaluations be performed prior to any attempts at decannulation.

Feehs, 2018 ¹²	United State of America (USA)	Retrospective cohort study	57 pediatric tracheotomy cases	The given turnover method is easy to understand, uncomplicated, trustworthy, risk-free, and productive, and it yields outstanding cosmetic effects.
Shay, 2018 ¹³	United State of America (USA)	Cross-sectional, population-based study	2,248 pediatric tracheotomy cases	Children who have undergone tracheotomy have a significant 30-day revisit rate, most notably during the first 48 hours after release. These revisits typically involve difficulties with the

tracheotomy tube or with the pulmonary system. The avoidance of these difficulties ought to be a primary focus of the discharge planning improvements.

Schweiger, 2017 ¹⁴	Brazil	Retrospective study	123 children required a more common surgical tracheostom y	Tracheostomies are one of the procedures performed on children. Glossoptosis and subglottic stenosis are the two diagnoses that come up most frequently. It was discovered that there was a significant mortality rate, which might be supported by the fact that this cohort included a large number of intensive care patients who suffered from chronic neurological diseases. Our rate of decannulation is slightly lower than that of other series; this is most likely due to the higher number of patients who also have co-morbidities.
Schwarz, 2017 ¹⁵	Israel	Retrospective cohort study	39 patients	The SPT in children was not related with any significant risks

or side effects. As a result of this, we have come to the conclusion that the SPT should be considered as a safe and advantageous alternative to conventional tracheotomy, particularly in patients who have a low probability of future decannulation and are, as a result, at a low risk of a persistent tracheocutaneous fistula.

30-day revisit mortality rate, 2.7%. "Fitting of prosthesis and adjustment of devices" (25.7%, likely tracheotomy tube adjustment/replacement), respiratory failure (11.0%), intracranial injury (5.4%), pneumonia (4.0%), "other upper respiratory disease" (3.8%), and "complications of surgical procedures or medical care" (3.8%). Most return operations were endotracheal intubation (11.4%), mechanical ventilation (8.8%), and tracheostomy tube replacement (2.7%). Children discharged to a skilled care facility (47.1%) were more likely to have a revisit than those discharged to home (52.9%) (23.3% versus 12.0%, respectively; $p < 0.001$).¹³

Schweiger, et al (2017)¹⁴ showed the results of the study revealed that glossoptosis was the most common indication for tracheostomy (30%), followed by subglottic stenosis (16%) and pharyngomalacia (11%). The death rate was 31% in the population. At the end of this research project, 35 children, or 28.4%, had been decannulated, and the rate of decannulation increased as the number of comorbidities dropped. (0.77 ± 0.84 vs. 1.7 ± 1.00 comorbidities; $p < 0.001$).

According to the findings of other studies, respiratory insufficiency brought on by disorders of the central nervous system was the most common explanation for SPT, with a prevalence of 38.4%, followed by neuromuscular illnesses, which had a prevalence of 14, or 35.0%. kids in the

pediatric intensive care unit (PICU) received surgery at a rate of 74.4 percent, while kids in the neonatal intensive care unit (NICU) underwent surgery at a rate of 25.6%. Despite this, the typical length of stay in the PICU after surgery was just 13.5 days. There were no cases of decannulation or other short-term complications that occurred as a result of SPT, and there were no deaths that were caused by SPT.¹⁵

DISCUSSION

Organ lacerations and bleeding can occur during tracheostomy. Early and late problems can emerge a few days or weeks following the treatment. Over the past decade, pediatric tracheostomies have expanded along with neonatal and pediatric ICU treatment. Tracheostomies and similar devices save most children with them.^{16,17} Tracheostomy is the most common adult ICU surgery. Unlike adults, just 3% of pediatric ICU patients undergo tracheostomy. Endotracheal intubation before tracheostomy varies. Teens and adults should undergo percutaneous tracheostomy.¹⁸

1.8% to 5.2% of children hemorrhage post-stoma formation. Insufficient hemostasis during the process causes it, which can harm a newborn. Possible revision surgery.^{19,20} Accidental primary decannulation is a serious complication with an incidence of 0.8%–20%. 20% of 25 Barcelona tracheostomized patients suffered inadvertent decannulation in the first 48 hours (80% in the first 24). 80% of decannulation patients had cardiorespiratory arrest, and one died. 5.2% of early postoperative Scottish cases had cannula displacement. Brazilian data showed 2.44% unintentional decannulation.^{21–23}

Another series, describing 30 years of pediatric tracheostomy experience at a Zurich university hospital, revealed a 13% cannula displacement rate 48 h after the procedure without specifying when it occurred, making it impossible to define as early or late postoperative. Decannulation can have serious repercussions, thus a good practice is to employ containment sutures on the anterior tracheal wall that leave the stoma or, according to the latest trend, to mature the stoma, especially in newborns and tiny children, to help reposition the cannula quickly and

correctly. Occasionally, one or two anchoring stitches are made from the plastic cannula to the skin.^{10,14,19}

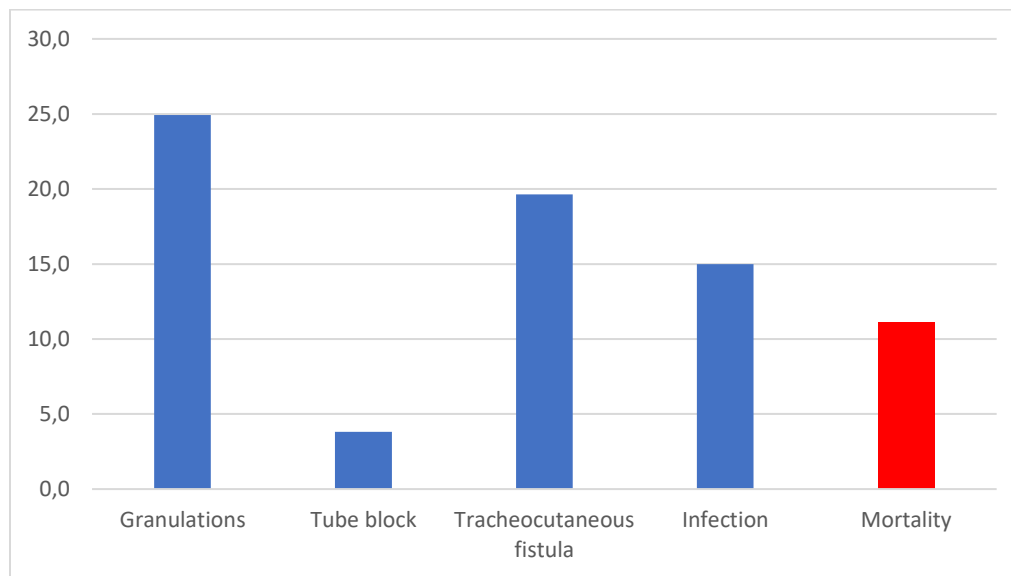


Figure 2. Percentage of complications and deaths in pediatric patients undergoing tracheostomy

Mucus plug blockage follows blood clot obstruction postoperatively. Preterm newborns with underlying disease may develop the block early. In a study on the safety of cannula replacement on the 3rd day after tracheostomy, 4% of pediatric ICU patients and 4.6% of patients up to the 4th postoperative day had early cannula obstruction, with no deaths.^{19,22} A Korean study on tracheostomy with a vertical tracheal incision and stoma maturation showed 0.9% cannula obstruction and no patient deaths, similar to an Indian study with a circular incision. until the first cannula change. Incorrect passage blocked 3.6% of Brazilian cannulas.^{10,14}

Early cellulitis causes peristomal skin hyperemia, hardness, and increased local heat. Secretions vary. Tracheostomized children had 1.6%–14.6% infection. Therapy comprises cannula replacement, local cleanliness, antibiotic ointments, and oral antibiotic medication with spectrum for the most prevalent respiratory pathogens. Cautery overuse in subcutaneous tissue and infrahyoid

muscle dissection can damage tissue. Waterproof dressings with or without antimicrobial qualities and Velcro fastening instead of cotton laces can reduce the appearance of skin lesions such as peritracheostoma skin irritation and pressure ulcers by absorbing less moisture and secretion.^{11,14,20}

Decannulation happened in 3 (5.7%) of 58 Brazilian children, one of whom survived cardiac arrest and the other perished. 5.7% of another Brazilian series had no fatalities. Indian researchers detected no inadvertent decannulation.¹⁰ Decannulation was the most common late tracheostomy problem (6%) in a 30-year Canadian sample. It killed 2% of these kids. In a Korean research (2.7%), late decannulation killed one patient at home.^{21,24} Cannula position changes, tissue granulation around the incision wound, tracheal stenosis, tracheocutaneous fistula, tracheoesophageal fistula, and infections such as aspiration pneumonia are examples of late surgical problems that may arise after three weeks.¹⁶

In tertiary hospitals, tracheostomy surgery on children is a procedure that is performed relatively frequently for a number of reasons. These reasons include neurological sequelae as well as cases of mechanical airway obstruction. There are a number of complications that have been described, and the prevalence percentages of each of these complications are all over the place in the research that has been done on them. Death is a potential undesirable event in tracheostomized patients. Most of the time, it is not correlated with the procedure itself, but occurs secondary to the evolution of the underlying disease.⁶

CONCLUSION

This article shows that the most complications that we got from studies dating back to 2017 above were granulation and fistula. In tracheostomized patients, death is a possible unwelcome event. Most of the time, it is unrelated to the procedure and occurs as a result of the progression of the underlying disease.

REFERENCES

1. Dhingra PL; Dhingra S. Disease of Ear Nose and Throat. 1st ed. Philadelphia: Elsevier Health Sciences; 2016. 47–50 p.
2. Mitchell RB, Hussey HM, Setzen G, Jacobs IN, Nussenbaum B, Dawson C, et al. Clinical Consensus Statement: Tracheostomy Care. Otolaryngol Neck Surg [Internet]. 2012 Sep 18;148(1):6–20. Available from: <https://doi.org/10.1177/0194599812460376>
3. Strychowsky JE, Albert D, Chan K, Cheng A, Daniel SJ, De Alarcon A, et al. International Pediatric Otolaryngology Group (IPOG) consensus recommendations: Routine peri-operative pediatric tracheotomy care. Int J Pediatr Otorhinolaryngol [Internet]. 2016;86:250–5. Available from: <https://www.sciencedirect.com/science/article/pii/S0165587616300222>
4. Marshall V, Holt F, Crowe S. Tracheostomy as a Comfort Measure in Children With Life-Limiting Conditions. J Palliat Care [Internet]. 2017 Jul 1;32(3–4):89–91. Available from: <https://doi.org/10.1177/0825859717740064>
5. Dal'Astra APL, Quirino AV, Caixêta JA de S, Avelino MAG. Tracheostomy in childhood: review of the literature on complications and mortality over the last three decades. Braz J Otorhinolaryngol. 2017;83(2):207–14.
6. Campisi P, Forte V. Pediatric tracheostomy. Semin Pediatr Surg [Internet]. 2016;25(3):191–5. Available from: <https://www.sciencedirect.com/science/article/pii/S1055858616000287>
7. Gergin O, Adil EA, Kawai K, Watters K, Moritz E, Rahbar R. Indications of pediatric tracheostomy over the last 30 years: Has anything changed? Int J Pediatr Otorhinolaryngol [Internet]. 2016;87:144–7. Available from: <https://www.sciencedirect.com/science/article/pii/S0165587616301598>
8. Fuller C, Wineland AM, Richter GT. Update on Pediatric Tracheostomy: Indications, Technique, Education, and Decannulation. Curr Otorhinolaryngol Rep [Internet]. 2021;9(2):188–99. Available from: <https://doi.org/10.1007/s40136-021-00340-y>
9. Prodhan P, Agarwal A, ElHassan NO, Bolin EH, Beam B, Garcia X, et al. Tracheostomy Among Infants With Hypoplastic Left Heart Syndrome Undergoing Cardiac Operations: A

- Multicenter Analysis. *Ann Thorac Surg* [Internet]. 2017 Apr 1;103(4):1308–14. Available from: <https://doi.org/10.1016/j.athoracsur.2016.09.016>
10. Syed KA, Naina P, Pokharel A, John M, Varghese AM. Paediatric tracheostomy: A modified technique and its outcomes, results from a South Indian tertiary care. *Int J Pediatr Otorhinolaryngol*. 2019 Mar;118:6–10.
 11. Maunsell R, Avelino M, Caixeta Alves J, Semenzati G, Lubianca Neto JF, Krumenauer R, et al. Revealing the needs of children with tracheostomies. *Eur Ann Otorhinolaryngol Head Neck Dis*. 2018 Sep;135(5S):S93–7.
 12. Feehs KR, Maslan JT, Kirse DJ. Superiorly-based turnover skin flap: Pediatric tracheocutaneous fistula closure. *Int J Pediatr Otorhinolaryngol*. 2018 Apr;107:21–4.
 13. Shay S, Shapiro NL, Bhattacharyya N. Revisits after pediatric tracheotomy: Airway concerns result in returns. *Int J Pediatr Otorhinolaryngol*. 2018 Jan;104:5–9.
 14. Schweiger C, Manica D, Becker CF, Abreu LSP, Manzini M, Sekine L, et al. Tracheostomy in children: a ten-year experience from a tertiary center in southern Brazil. *Braz J Otorhinolaryngol*. 2017;83(6):627–32.
 15. Schwarz Y, Muhanna N, Raveh D, Shaul C, Shahroor S, Peleg U, et al. Starplasty tracheostomy: case series and literature review. *Eur Arch oto-rhino-laryngology Off J Eur Fed Oto-Rhino-Laryngological Soc Affil with Ger Soc Oto-Rhino-Laryngology - Head Neck Surg*. 2017 May;274(5):2261–6.
 16. Johnson-Obaseki S, Veljkovic A, Javidnia H. Complication rates of open surgical versus percutaneous tracheostomy in critically ill patients. *Laryngoscope*. 2016;126(11):2459–67.
 17. Klotz R, Probst P, Deininger M, Klaiber U, Grummich K, Diener MK, et al. Percutaneous versus surgical strategy for tracheostomy: a systematic review and meta-analysis of perioperative and postoperative complications. *Langenbeck's Arch Surg*. 2018;403:137–49.
 18. Watters KF. Tracheostomy in Infants and Children. *Respir Care*. 2017 Jun;62(6):799–825.
 19. Douglas CM, Poole-Cowley J, Morrissey S, Kubba H, Clement WA, Wynne D. Paediatric tracheostomy-An 11 year experience at a Scottish paediatric tertiary referral centre. *Int J Pediatr Otorhinolaryngol*. 2015 Oct;79(10):1673–6.

20. Pereira KD, MacGregor AR, Mitchell RB. Complications of neonatal tracheostomy: a 5-year review. *Otolaryngol neck Surg Off J Am Acad Otolaryngol Neck Surg.* 2004 Dec;131(6):810–3.
21. Song J-J, Choi IJ, Chang H, Kim DW, Chang HW, Park G-H, et al. Pediatric tracheostomy revisited: a nine-year experience using horizontal intercartilaginous incision. *Laryngoscope.* 2015 Feb;125(2):485–92.
22. García-Urabayen D, López-Fernández YM, Pilar-Orive J, Nieto-Faza M, Gil-Antón J, López-Bayón J, et al. [Analysis of tracheostomies in a pediatric intensive care unit during the period 2003-2013]. *An Pediatr (Barc).* 2016 Jan;84(1):18–23.
23. Carr MM, Poje CP, Kingston L, Kielma D, Heard C. Complications in pediatric tracheostomies. *Laryngoscope.* 2001 Nov;111(11 Pt 1):1925–8.
24. Al-Samri M, Mitchell I, Drummond DS, Bjornson C. Tracheostomy in children: a population-based experience over 17 years. *Pediatr Pulmonol.* 2010 May;45(5):487–93.