Journal of Otolaryngology and Rhinology Research
Received 30 Sep 2021 | Revised 15 Nov 2021 | Accepted 18 Dec 2021 | Published Online 9 Jan 2022

DOI: https://doi.org/10.52845/JORR/2022/3.1.2
JORR 03 (01), 70–74 (2022)

ISSN (O) 2693-9282

RESEARCH ARTICLE

Prevalence of Airway Abnormality after Tracheotomy at a Tertiary Safety Net Children's Hospital

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Abstract

Introduction: Over 4500 pediatric tracheotomies are performed an-nually in the United States. However, there is no consensus on the appropriate time for surveillance endoscopy. The St. Christopher's Hospital for Children implemented the Trach Safe Initiative to improve airway safety in tracheotomy-dependent children. A major component of this initiative is surveillance endoscopy. The objectives of this study are to describe the prevalence of abnormal airway changes in trach dependent patients, to identify and describe the frequency of airway interventions, and to ultimately minimize morbidity in this population. **Method:** A report consisting of a list of patients meeting our inclusion criteria was generated using CPT codes for tracheotomy and direct bronchoscopy and laryngoscopy at SCHC. A retrospective chart review of patients under the age of 18 who has had a tracheotomy from 2010 to 2020 was conducted in order to describe airway abnormalities after tracheotomy quantitatively and qualitatively. **Result:** 55 patients met inclusion criteria and were included in our study. Our study found the overall rate of abnormal findings on en-doscopy after tracheotomy is 72.7 % ($p < 0.05$). The average time from tracheotomy to the time of initial surveillance endoscopy at SCHC was 884 days (95%CI 684 -1084). The most common abnormal finding was granulation tissue (29.1%), followed by supra-stomal collapse (12.7%), and subglottic stenosis (12.7%). 58.2% of patients undergoing endoscopy had an intervention. The most common intervention during endoscopy was excision of granulation tissue (25.4%) and trach change (23.6%) followed by tracheoplasty/stomoplasty (7.2%). **Conclusion:**Our study found a high rate of airway abnormality on surveillance endoscopy with a significant percentage of our patients requiring airway intervention. Our findings necessitate a guideline for routine surveillance endoscopy for our tracheotomy patients and the development of a database tracking airway abnormalities of patients in order to prepare a safe airway plan.

1 | INTRODUCTION

Over 4,500 pediatric tracheostomies are performed annually in the United States. Pediatric tracheostomies are commonly performed for children with upper airway anomalies and those with chronic diseases. A third of tracheostomies performed in children involve infants, many who are born prematurely. (1)

Complications of pediatric tracheotomy can either early (< 1 week after treatment) or late (> 1 week after treatment). Hemorrhage, infection, obstruction, bronchospasm, atelectasis, and subcutaneous emphysema are typical complications related to tracheostomies. Moreover, the acuity in which the tracheostomy is performed should also be considered. For instance, tracheostomies performed in emergent situations have twice the chance of developing complications (80% vs. 44.4%). Inadequate resources, timing, and technique are possible contributions to the higher rate of complications in emergent settings. (2) Additionally, younger patients have a higher risk of developing complications. A study by Watters *et al.* categorized the risk of postoperative complications at 85% for children under the age of 5.(3)
As a tertiary children's hospital, St. Christopher's Hospital for Children (SCHC) frequently provides care for children who are tracheostomy dependent or require tracheotomy. However, despite the potential complication of tracheostomy there is no national standardized protocol for surveillance of postoperative tracheostomy patients. Utilizing a standardized protocol for surveillance could potentially lead to early intervention and reduced morbidity and mortality. In addition, tailored management plan for airway emergencies can be developed and implemented in these populations.

The aim of this study is to examine the rate of airway abnormalities and airway interventions because of tracheostomy. Currently there is no consensus regarding the interval between tracheostomy and surveillance endoscopy. However, it is generally accepted to perform routine endoscopy every 6–12 months. (4) Our results will help determine if a standardized protocol for surveillance endoscopy is necessary following tracheostomy at tertiary safety-net children's hospitals. The main objectives of surveillance endoscopy include identifying any airway abnormality, quality of airway, appropriate fit of the tracheostomy tube, correctable abnormalities (obstruction, suprastomal granulation tissue, trach malposition, improper tracheostomy size), and being aware of the ability to intubate from above the true vocal folds.

The current post-tracheostomy surveillance protocol at SCHC involves follow up in ENT clinics or aerodigestive clinics, before proceeding with surveillance bronchoscopy depending on clinical findings. However, within the underserved patient population at SCHC there is a high prevalence of lost to follow up thus surveillance may not always occur. Therefore, we proposed to implement a standardized protocol for performing a surveillance endoscopy prior to discharge from the hospital and again at 6 to 12 week post-tracheostomy.

2 | METHODS

This is a retrospective chart review of children with tracheostomy who subsequently underwent surveillance endoscopy. The study was approved by the SCHC Institutional Review Board. Our study inclu-sion criteria include patients under the age of 18 with a tracheostomy and a subsequent surveillance endoscopy at SCHC since January 2010. Exclusion criteria include patients older than 18 years old at the time of endoscopy, patients with no history of tracheostomy, and patients with previous history of decannulation. 55 patients were randomly selected between January 1, 2010, and December 31, 2020 to achieve statistical significance.

Patients with both a tracheostomy and a subsequent flexible laryngoscopy and tracheobronchoscopy at

Supplementary information The online version of this article (https://doi.org/10.52845/JORR/2022/3.1.2) contains supplementary material, which is available to autho-rized users.

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SCHC were identified using the CPT codes for tracheotomy including 31600, 31601, 31603, 31605, 31610, 31611,31612, 31613, 31614. The CPT code for the surveillance endoscopy included 31615, 31622, 31505, 31515, 31520, and 31525.

Clinical variables recorded from patients' operative reports included date of the tracheostomy, date of the endoscopy, airway abnormalities identified during endoscopy, and airway interventions. The primary airway abnormalities recorded included tracheal granulation tissue, laryngomalacia, tracheomalacia, subglottic stenosis, suprastomal collapse, and tracheal edema. The main airway interventions recorded include granulation removal, tracheostomy change, tracheoplasty, stomoplasty, and balloon dilation. The prevalence of abnormal airway changes and the frequency of airway interventions were reported using descriptive statistics. 95% confidence intervals were calculated for abnormal airway findings and airway interventions using Microsoft Excel.

3 | RESULTS

A total of 55 patients who met the inclusion criteria were included in this study. The overall rate of abnormal findings on endoscopy after tracheotomy was 72.7% ($p < 0.05$). The average time from tracheotomy to the time of initial surveillance endoscopy at SCHC was 884 days (95% CI 884.375±200) based on 40 patients whom the date of tracheostomy and surveillance endoscopy were documented.

3.1 | ABNORMAL AIRWAY FINDINGS

40 out of 55 patients (72.7%) had at least one airway abnormality. The most common abnormal finding was granulation tissue 16 (29.1%), followed by suprastomal collapse 7 (12.7%), subglottic stenosis 7 (12.7%), and laryngomalacia 4 (7.2%). A separate category labeled "other" was a compilation of less frequent airway abnormalities during endoscopy, which included 11 (20%) patients. These include tracheal edema, vocal cord paralysis, tracheal fibromas, and severe supraglottic reflux changes (Table 1).

TABLE 1: Abnormal Airway Findings

Type of abnormality	Patients (N)	Percentage (%)
Laryngomalacia	4	7.2
Suprastomal Collapse	7	12.7
Suprastomal Granulation Tissue	16	29.1
Subglottic Stenosis	7	12.7
Other	11	20.0
None	15	27.2
Abnormal Total	40	72.7 ($p < 0.05$)

3.2 | AIRWAY INTERVENTION

32 out of 55 patients (58.1%) had at least one airway intervention during their surveillance endoscopy. The most common intervention during endoscopy was excision of granulation tissue 14 (25.4%) and tracheostomy tube change 13 (23.6%) followed by tracheoplasty/stomoplasty 4 (7.2%), and balloon dilation 2 (3.6%). A separate category labeled "other" was used for a compilation of all other less frequent airway interventions during endoscopy. This group includes excision of fibroma, decannulation, and removal of papilloma and was 7.2% of the total airway interventions (Table 2).

TABLE 2: Airway Interventions

Type of intervention	Patients (N)	Percentage (%)
Granulation removal	14	25.4
Trach change/upsize/downsize	13	23.6
Tracheoplasty or Stomaplasty	4	7.2
Balloon Dilation	2	3.6
Other	4	7.2
None	23	41.8
Intervention Total	32	58.2 ($p=0.148$)

4 | DISCUSSION

Over 4,500 pediatric tracheostomies are performed annually in the United States. Studies have reported a post-tracheostomy complication rate as high as 90%.(5) Given the high rate of post-tracheostomy airway abnormalities and potential complications, a surveillance endoscopy is crucial for patient safety. A prior study from Seattle Children's Hospital demonstrated an average time period of 1.6 month between the time of the tracheotomy and the time of the first surveillance endoscopy. Another study from Boston Children's Hospital demonstrated an average interval of 12 months between tracheostomy and initial surveillance endoscopy. (6) Our chart review revealed an average of 29.5 months (884 days) between the time of the tracheostomy to the time of their first surveillance endoscopy at SCHC based on 40 out of 55 patients whose date of initial tracheostomy procedure could be identified. Our discrepancy may be explained by a few factors. One explanation is that SCHC's tracheostomy patients may receive their tracheostomy from a separate institution and an initial endoscopy was performed there, but patient records were never transferred to SCHC. As a result, the endoscopy performed at SCHC would be a subsequent endoscopy and not the initial surveillance endoscopy. Although, based on our chart review, there were a handful of patients who received their tracheostomy at SCHC and were not re-evaluated via endoscopy immediately after the tracheostomy to confirm proper placement. This observation calls for more stringent guidelines for post-tracheostomy surveillance endoscopy at SCHC.

A large percentage of the SCHC are from the underserved population with a high percentage of medical illiteracy. As a result, our study found a trend of patients who were lost to follow-up and returned only when became symptomatic. The challenge regarding follow-ups can be improved by better communication between the patient's caregiver and the clinician, in addition to better patient education. Furthermore, studies have demonstrated a notification or reminder call greatly enhances patients' compliance to their clinic appointments. (7) For the underserved patient population, and especially patients with tracheostomy, it may be especially important to provide multiple reminders prior to their appointment to ensure follow-up at the appropriate time interval.

A prior study by Smith *et al*. examining the optimal timing for post-tracheostomy endoscopy in the pediatric population did not find a significant difference between early and late surveillance endoscopy in terms of whether a medical or surgical decision was made at the time of first endoscopy. They suggest surveillance endoscopy when children develop tracheostomy-related symptoms. (8) However, in their study the early and late surveillance is defined as less than 6 weeks and 6 to 14 weeks respectively, significantly shorter than the average time of first endoscopy seen at our institution. At SCHC, a majority of our patients are underserved with limited medical literacy. This may impact a caregiver's ability to recognize airway symptoms and seek medical attention in a timely manner. Due to the high percentage of patients with airway abnormalities at SCHC, a definitive time threshold should be established for an initial endoscopy in order to discover airway abnormalities in both symptomatic and asymptomatic patients.Overall, the most common airway abnormality finding in our study was suprastomal granulation tissue. This is consistent with prior studies that examined post-tracheostomy pediatric airway abnormalities. Ong et al. demonstrated a similar rate of suprastomal granulation tissue at 32% compared to our rate of 29%. Furthermore, both studies demonstrated the largest proportion of surgical interventions were related to granulation excision causing increased upper airway resistance. (9) In addition to requiring surgical intervention and exposure to general anesthesia, supra-stomal granulation tissue is a contributing factor to delayed decannulation. Suprastomal granulation can also become a chronic issue that negatively impacts quality of life and serves as a financial burden for these families. (10)

The second most common intervention in this cohort was tracheostomy changes and size adjustments. Pediatric patients grow at a rapid rate and syndromic patients carry additional layers of complexity in airway size and rate of development. When a child is in need of emergent intubation, their tracheostomy tube size is a helpful tool in measuring the diameter of the subglottic airway, thus an ill-fitted tracheostomy tube can create a precarious situation.

Additionally, misfit tracheostomy tubes can cause discomfort for the patient, discordant ventilator settings, and an increased burden on the healthcare system due to repeat admissions for complications such as accidental decannulation. In a retrospective review by Colman *et al*., it was demonstrated that stoma maturation does not reduce the incidence of tracheostomy-related complications. (11) this implicates the potential for tracheostomy related complications throughout a patient's lifetime and reinforces the concept of routine and standardized tracheotomy surveillance, consensus, and collaboration of a multidisciplinary team regarding patients' airway status. Limitations of the current study relate to the relatively small sample size from a single institution and, thus, inability to confidently apply our results to the general population. Retrospective chart reviews are inherently limited due to information bias and a randomized control trial would be ideal, but difficult to execute with pediatric tracheostomy patients.

A future aim of this study includes gathering additional surveillance data to elucidate appropriate endoscopic surveillance guidelines for pediatric patients based on age, indication for surgery and comorbidities (e.g. syndromic patients). While each patient is unique, our eventual goal is to implement the safe trach protocol as an algorithm through which we can continue to better standardize care for all children.

5 | CONCLUSION

There is a high rate of airway abnormality on surveillance endoscopy with a significant percentage of our patients requiring airway intervention at SCHC. Our findings necessitate a guideline for routine surveillance endoscopy for pediatric tracheostomy patients specifically regarding the timing of surveillance endoscopy.

Prior Meeting information: Pennsylvania Academy of Otolaryngology - Head and Neck Surgery: annual Meeting- Poster presentation 2021
American Academy of Otolaryngology- Head and Neck Surgery: Annual Meeting- Poster presentation 2021

Funding and Conflict of Interest: None

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How to cite this article: GARRETT NI, MD ET AL. Prevalence of Airway Abnormality after Tracheotomy at a Tertiary Safety Net Children's Hospital. Journal of Otolaryngology and Rhinology Research. 2022;70−74. https://doi.org/10.52845/JORR/2022/3.1.2