Retrospective Review of Acute Post-Tracheostomy Complications in Patients with Obstructive Pulmonary Diseases

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September 27, 2022

Abstract

Objective Tracheostomy is performed for various indications ranging from prolonged ventilation to airway obstruction. Many factors may play a role in the incidence of complications in the immediate post-operative period including patient-related factors. The relationship between obstructive pulmonary diseases and acute post-tracheostomy complications has been incompletely studied. Chronic obstructive pulmonary disease (COPD), obstructive sleep apnea (OSA), and asthma are some of the most common pulmonary pathologies in the United States and given the clinical utility of tracheostomies among these patients, it is important to characterize the risk of acute post-operative complications. Design A retrospective chart review identified tracheostomy patients from January 2017 through December 2018 at an academic cancer center. Medical records were reviewed for the technique used, complications, and contributing patient factors. Post-operative complications were defined as any tracheostomy-related adverse event occurring within 14 days. Patient factors examined included demographics, comorbidities, and body mass index (BMI). Results The most common indication for tracheostomy among the 321 patients that met inclusion criteria was airway obstruction or a head and neck cancer surgical procedure. Obstructive pulmonary pathology (COPD, OSA, asthma) was moderately associated with acute complications in bivariate analysis (13.4% complications, $p = 0.039$). Among the secondary outcomes measured, radiation was associated with early complications occurring in post-operative days 0-6 (1.1%, $p = 0.029$). Conclusion Obstructive pulmonary patients may have a higher risk of acute post-tracheostomy complications which is clinically significant when considering the utility of ventilation and tracheostomy in the management of acute respiratory failure secondary to these conditions.

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Results

The most common indication for tracheostomy among the 321 patients that met inclusion criteria was airway obstruction or a head and neck cancer surgical procedure. Obstructive pulmonary pathology (COPD, OSA, asthma) was moderately associated with acute complications in bivariate analysis (13.4% complications, p = 0.039). Among the secondary outcomes measured, radiation was associated with early complications occurring in post-operative days 0-6 (1.1%, p = 0.029).

Conclusion

Obstructive pulmonary patients may have a higher risk of acute post-tracheostomy complications which is clinically significant when considering the utility of ventilation and tracheostomy in the management of acute respiratory failure secondary to these conditions.

Key Points

1. In severe cases, tracheostomies are essential in management of chronically obstructed patients suffering from acute respiratory failure, however, the impact of chronic obstruction on tracheostomy complication incidence has not been characterized.
2. The most common acute post-tracheostomy complications in this cohort were bleeding, infection, and dislodgement, which was consistent with prior studies.
3. Patients with obstructive pulmonary pathologies had a moderate association with an increased risk in complications.
4. Radiation was moderately associated with early complication (post-operative day 0-6) which could be attributed to delayed wound healing seen in patients with a history of radiation therapy.
5. The possible increased risk of complications in patients with obstructive pulmonary diseases should be noted but should not serve as a contraindication when considering the life-saving benefit from tracheostomy in these patient populations.

Introduction

Tracheostomies remain an essential part of care Intensive Care Units around the world.[1] As of 2014, approximately 800,000 tracheostomies were performed in the United States and studies have documented a statistically significant increase in tracheostomies.[2] Indications for tracheostomies are semi-elective and are determined on an individual basis while considering the patient's future complication risk.[3]Although more invasive than endotracheal intubation, tracheostomies are safer, more comfortable, allow easier verbal communication, shorter intensive care unit stays, days spent on mechanical ventilation, and hospital stay lengths.[4] The only absolute indication for tracheostomy placement is a difficult airway, while the most common indication is airway security following prolonged mechanical ventilation.[5] An estimated 10% of mechanically ventilated patients undergo tracheostomy.[2] Other common indications include catastrophic neurologic insult, copious secretions, upper airway obstructions, and severe obstructive sleep apnea.[2,6]

Tracheostomies are placed most often through an open surgical technique (OST) or percutaneous dilational technique (PDT). Complications significantly increase the mean cost and total charges burden on ICU patients and any attempt to mitigate complications benefits the patient as well as the healthcare system.[7] Early complications include bleeding, infection, subcutaneous emphysema, tube dislodgement, posterior tracheal wall injury, and tracheostomy tube obstruction.[8,9] The incidence of serious and fatal complications as well as readmission, however, is miniscule in comparison.[9] While PDT and OST have similar overall complication rates, OST does have higher incidence of bleeding and infections[8] and bleeding remains the most common complication in both techniques.[10]

Other predictors of complication incidence have been thoroughly studied. When considering overall complication incidence, several studies show that age, gender, smoking status, anatomical variants, tracheostomy size, tracheostomy type, and suture stabilization are not highly predictive of acute complications.[11,12] In contrast, obesity is a highly described predictor of tracheostomy complications.[13] Obesity was found to be independently associated with an increased risk of all complications, acute kidney injury, and unplanned readmission within the first 30 days of tracheal tube placement.[14] Beyond obesity, factors that were also

predictive of increased complications include number of comorbidities, neck pathology, tracheostomy placement in operating room vs inpatient unit, previous radiotherapy, and previous tracheotomy.[11] Additionally, certain demographic groups may be associated with increased mortality in tracheostomy patients. Specifically, African American children, Hispanic adults, and adults with lower levels of education have a higher mortality rate, but the same complication rate as other groups with tracheostomy.[15]

The relationship between obstructive pulmonary diseases and acute post-tracheostomy complications has been incompletely studied. Chronic obstructive pulmonary disease (COPD), obstructive sleep apnea (OSA), and asthma are some of the most common pulmonary pathologies in the United States and worldwide and are associated with high disease burdens.[16-18] Mechanical ventilation, and in severe cases, tracheostomy are fundamental tools in the management of patients with COPD and asthma suffering from acute respiratory failure.[19] Given the high incidence of obstructive lung diseases worldwide and the clinical utility of tracheostomies among patients with these diseases, it is important to characterize the risk of post-procedure complications.

Objectives

The primary objective of this study was to compare incidence of acute post-tracheostomy complications in patients with obstructive pulmonary diseases (COPD, OSA, and asthma) to patients without pulmonary disease. Secondary objectives included comparison of complication rates based on age, sex, Body Mass Index (BMI), chemotherapy, radiation treatment, and nutrition, as these measures were used in multivariable models.

Methods:

Study Design

A retrospective chart review was performed on patients >18 years old who underwent a tracheostomy from January 2017 through December 2018 at an academic cancer center. Exclusion criteria for the patient cohort included presence of stomaplasty, total laryngectomy, and tracheostomies performed at outside hospitals. These parameters identified 321 eligible patients. Each medical record was reviewed to assess the tracheostomy technique used, post-operative course, and patient demographics and comorbidities. Specific comorbidities evaluated were body mass index, use of anticoagulation, prior chemoradiation, and history of obstructive pulmonary diseases such as COPD, OSA, and asthma. The research question for this study focused on patients with pulmonary disease processes such as asthma, COPD, and OSA. Other variables were collected for a comprehensive analysis and for statistical evaluation models.

Main Outcome Measures

The primary outcome measure for this study was post-tracheostomy complications as the primary objective was to examine if obstructive lung pathologies led to higher risk of complication. Postoperative complications were characterized by tracheostomy-related adverse events occurring within fourteen days of the procedure. Complications were defined as mucus plugging, trach dislodgement, hemorrhage, wound breakdown, and infection. Early complication events were those that occurred on postoperative days zero through six. Late complication events occurred on postoperative day seven or later.

Data Analysis

Statistical analysis was performed with Chi squared and Fisher's exact test for categorical values to assess correlation between the variables in question and postoperative complications. An alpha level of 0.05 was determined for bivariate analyses and alpha levels of 0.05 and 0.10 were used for multivariable models. Further logistic regression models were utilized to categorize the strength of the correlations. All statistical analyses were performed in R studio and figures were created in Microsoft Excel or R Studio.

Ethical Considerations

Institutional Review Board approval was obtained, and consent was not required due to the retrospective nature of the study.

Results:

In the study cohort of 321 patients, the most common indications for tracheostomy were a head and neck cancer surgical procedure (247/321, 77%) and acute airway management (58/321, 18%). The majority of the procedures were performed by otolaryngologists (297/321, 93%) via an open surgical technique (256/321, 80%), typically with a Bjork flap (236/321, 74%). The cohort was predominantly male (227/321, 71%) with the mean age being 62 years old and 42% of the cohort being older than 65 years old.

Acute postoperative tracheostomy complications were not common in this study (29/321, 9%). The more common complications were bleeding (33%), tracheitis (15%), and dislodgement (10%). Other, less common, complications included dysphagia, mucus plugging, revisions, and wound dehiscence.

Initially, bivariate analysis with Chi-Squared and Fischer Exact tests for association were used to analyze the risk of complications during the acute post-operative day period (days 0-14) based on sex, BMI >30, chemotherapy, and obstructive lung disease (COPD, OSA, or asthma). Obstructive lung disease (13.4% complications, $p = 0.039$) and chemotherapy (4.3%, $p = 0.04$) were possibly associated with higher risk of complications while BMI >30 and sex were not ($p = 0.435$ and $p = 0.828$, respectively). Logistic regression models to further characterize the relationship included chemotherapy, obstructive lung disease, age, BMI, nutrition (albumin), and neck circumference (cm) as continuous predictors. Through backward selection, the final model contained only obstructive lung disease (COPD, OSA, asthma) as a predictor of complication. The associated was significant < 0.1 and insignificant <0.05 ($p = 0.0502$), implying this association may be moderate.

Similarly, early post-tracheostomy complications (post-operative days 0-6) were evaluated with bivariate analysis, and radiation was found to be a possible predictor of early complication (1.1%, $p = 0.029$). Chemotherapy was associated with early complication as well ($p = 0.007$), though chemotherapy and radiation were highly correlated with each other ($p = 0.000$) and the decision was made to include only radiation in multivariable analysis. Logistic regression models for early complications included radiation, age, BMI, nutrition (albumin), neck circumference (cm) as continuous predictors. Through backward selection, the final model contained only radiation as a predictor of early complication with moderated significance under 0.1 level ($p = 0.060$).

Discussion

The analysis of this study highlights the relationship between obstructive lung pathology and acute tracheostomy complications. Obstructive pulmonary pathologies, specifically COPD, OSA, and asthma, were more likely to endure acute post-tracheostomy complications with a moderate statistical significance. While the statistical significance was moderate, it does carry clinical implications. COPD is an independent predictor of the need for tracheostomy,[20]and thus, any increased risk for post-tracheostomy complications impacts this vulnerable population with an already tenuous respiratory status. Tracheostomy has also been shown to improve the cardiovascular endpoints of patients with OSA,[21] but it is not without risk. Considering that the chronic obstructive pulmonary patients are more likely to require mechanical ventilation and therefore tracheostomy than patients without these diseases,[19] a higher complication rate is a risk that should be considered when making decisions regarding tracheostomy. Ultimately, the benefit from early tracheostomy to avoid prolonged intubation, and its complications, likely outweighs the potential risk of acute post-tracheostomy complications. Therefore, electing for tracheostomy while focusing on the prevention of common complications is warranted.

In this cohort, the overall complication rate was 9% and complication types were consistent with prior studies with bleeding being the most common (33%) followed by tracheitis (15%) and dislodgement (10%). The most common early complication of tracheostomy is bleeding, and prevention of clot descent through the distal airward is essential.[22] Tracheostomy infections are also a common complication and maintaining a

high clinical suspicion for them is important.[23] Additionally, counseling patients on recognizing early signs of major complications as well as close follow up and monitoring is crucial.

One of the secondary outcomes examined in this study was BMI. BMI was not a significant predictor of acute tracheostomy complications in this patient cohort, as shown through the bivariate analysis and multivariable regression models. This is in direct contrast to existing studies that show that obesity, measured by BMI, carries a higher risk of tracheostomy complications.[13,14] This could be due to the timeline of complications assessed in different studies. Complications such as unplanned readmissions occur further from surgery while this study specifically looked at the first 14 days of the post-operative period. Therefore, even though this study demonstrated no significant correlation with acute tracheostomy complications, clinicians should be aware of this existing association if a patient has a high BMI, neck circumference, or skin-to-tracheostomy site distance.

The other secondary outcome measure was complication rate among patients with chemotherapy and radiation treatment in the early post-tracheostomy window (post-operative day 0-6). Radiation was found to have a moderate association in multivariable analysis, and chemotherapy and radiation were highly correlated with one another. The increased risk of early complication likely occurred due to poor wound healing considering chemotherapy and radiation are well described causes of poor wound health irrespective of the surgical procedure performed. Chemotherapy frequently slows wound healing, as some widely used chemotherapeutic drugs directly impact cell cycle progression and new tissue deposition. Radiation increases inflammation in local tissues, promoting cell death and slowing wound healing.[24] In head and neck cancer patients particularly, many have received neck radiation prior to surgery, impacting the tissues around the tracheostomy site. Slow healing wounds have a higher incidence of infection, recurrent bleeding, and more serious invasive processes including osteomyelitis.[25] Considering infection and bleeding are two of the most common complications in the acute post-tracheostomy setting, close monitoring of the tracheostomy site is warranted. It is important to note the limitations of this study. Data collection and medical record review may have been subject to sampling bias, as the cohort was not randomized. Additionally, as a retrospective analysis, there may be bias when interpreting results.

Conclusion

The moderate increased risk of acute tracheostomy complications in obstructive pulmonary patients should not necessarily be a reason for contraindication. Tracheostomies are lifesaving treatments, especially in patients with pre-existing pulmonary comorbidities and should be conducted as indicated by critical care decision-making algorithms. Though considering the moderate association with acute complications, these patients should be counseled appropriately, and care teams should be vigilant in this crucial post-operative period.

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