

Correlation between age, the clinical status of patients, operator characteristics, and surgical landmarks with the incidence of tracheotomy complications



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ABSTRACT

Background: Tracheotomy is a surgical procedure often performed in the field of ear, nose, throat-head, and neck surgery. This study aims to analyze the risk factors for tracheotomy complications based on age, clinical status, operator characteristics and surgical landmarks.

Methods: This study was analytically observational with a case-control design using secondary data. The study was conducted at Dr. Soetomo Hospital Surabaya. Patients who had a tracheotomy for the period January 1, 2015 to December 31, 2019 and met the research criteria were included as samples.

Results: This study obtained 174 patients with 136 men and 38 women. Analysis of the correlation between age and the incidence of tracheotomy complications obtained $p=0.008$ ($p<0.05$). The correlation between clinical status of patients with complications of tracheotomy was found to be significant ($p=0.001$). The correlation between operator characteristics and tracheotomy complications was significant ($p=0.000$) and the correlation between surgical landmarks and tracheotomy complications was significant ($p=0.000$).

Conclusion: The correlation between age, the patient's clinical status, operator characteristics and surgical landmarks with the incidence of tracheotomy complications from 174 patients who underwent tracheotomy surgery at Dr. Soetomo Hospital Surabaya showed that these factors mutually influence the postoperative complications of tracheotomy.

Keywords: risk factors, tracheotomy, complications.

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INTRODUCTION

Tracheotomy is a well-known procedure in ear, nose, throat-head, and neck surgery. Tracheotomy is performed for several indications, including airway obstruction, prolonged intubation, malignancy in the airway, and excessive bronchial secretions. Tracheotomy has a high risk of complications. The overall complication rate of tracheotomy ranges from 5-49% and the mortality rate is 2%.¹ This complication rate can increase to 2-5 times in severe and fatal cases.²

Some factors often associated with complications include age, obesity, patient's clinical status, surgeon's experience, surgical technique, post-operative care, duration of intubation and patient's medical condition.³ Age, birth weight, and prematurity are among the factors associated with high complication

rates in the pediatric age group for the need for long-term tracheotomy use, especially for those with comorbidities, small cannula diameter, and small airway diameter.⁴ Age differences also slightly affect anatomy, leading to different surgical procedures and tracheal identification.⁵ The clinical status of the patient with upper airway obstruction required immediate treatment. Patients present in panic, and surgical procedures must be prepared quickly.⁶ The risk of pneumothorax in patients with high breathing work increases as the cupula expands into the neck with negative inspiratory pressure.⁷

Operator characteristics will affect clinical decisions and reduce the complication rate.⁸ The American Thoracic Society and European Respiratory Society recommend 5 to 10 procedures before performing tracheotomy independently,

with a minimum of 10 procedures per year to maintain competence.⁹ The surgeon's experience, and discussions between the surgeon and the team, including postoperative care and supervision, play an essential role in the correct tracheotomy procedure for the patient.¹⁰ Surgical landmarks must be identified to determine the difficulty of tracheotomy. Tracheotomy is categorized as difficult if the patient has a short, thick neck, cannot extend, or has a tracheal deviation.¹¹ Anatomical neck abnormalities, including a primary tumour, deep neck space infection, metastasis and obesity, can obscure surgical landmarks. Surgery's great difficulty can lead to complications.¹² This study aims to analyze the risk factors for tracheotomy complications based on age, clinical status, operator characteristics and surgical landmarks.

METHODS

This type of research was analytic observational with a case-control design using secondary data. The study was conducted at Dr. Soetomo Hospital Surabaya. The study was conducted after obtaining ethical clearance from the Health Research Ethics Committee of Dr. Soetomo Hospital Surabaya with reference letter number 1088/LOE/301.4.2/X/2022. The research was completed from October 2022 to November 2022. This study analyses the risk factors for tracheotomy complications based on age, clinical status, operator characteristics and surgical landmarks.

The population of this study were patients who underwent tracheotomy surgery at Dr. Soetomo Hospital Surabaya within five years, from January 1, 2015 to December 31, 2019 with a total of 509 patients. The study sample is part of the study population that meets the inclusion and exclusion criteria of the study. The inclusion criteria were patients with complete medical record data including age, sex, operation reports after tracheotomy surgery from Dr. Soetomo Hospital Surabaya to determine the number and records of the number of tracheotomy operations that operators have performed, and electronic medical records to assess the clinical condition of patients after tracheotomy. Exclusion criteria were tracheotomy patients who came for control over seven days and complications that occurred more than the seventh postoperative day (late complications).

RESULTS

Medical record data of patients who had performed tracheotomy from January 1, 2015 to December 31, 2019 were collected and then selected according to the inclusion and exclusion criteria of the study.

The age of diagnosis was grouped into 10-year intervals. The youngest generation of diagnosis was two years, and the oldest was 84 years, with a median of 54 years and a mean of 50.60 years. The majority of the age group was 51-60 years old, with 53 patients (30.45%), and the least age group was 81-90 years old, with two patients

Table 1. Distribution of patients sex and age.

| | (n) | Percentage (%) |
|------------|-----|----------------|
| Sex | | |
| Male | 136 | 78.16% |
| Female | 38 | 21.84% |
| Age | | |
| 1-10 | 6 | 3.44% |
| 11-20 | 6 | 3.44% |
| 21-30 | 8 | 4.59% |
| 31-40 | 14 | 8% |
| 41-50 | 37 | 21.33% |
| 51-60 | 53 | 30.45% |
| 61-70 | 41 | 23.56% |
| 71-80 | 7 | 4.02% |
| 81-90 | 2 | 1.14% |

Table 2. Distribution of clinical status of patients.

| | (n) | Percentage (%) |
|---|-----|----------------|
| Clinical Status (upper airway obstruction) | | |
| No upper airway obstruction | 49 | 28.16% |
| Mild | 99 | 56.89% |
| Moderate | 12 | 6.89% |
| Severe | 14 | 8.04% |
| Tracheotomy Complications | | |
| Yes (case) | 58 | 33.3% |
| - Immediate complications | 12 | 6.89% |
| - Early complications | 46 | 26.4% |
| No (control) | 116 | 66.7% |

Table 3. Distribution of operator characteristic.

| Operator Characteristic | (n) | Percentage (%) |
|-------------------------|------------|----------------|
| ≥5x | 101 | 58.04% |
| <5x | 73 | 41.95% |
| Total | 174 | 100% |

Table 4. Distribution of surgical landmark.

| Surgical Landmark | (n) | Percentage (%) |
|-------------------|------------|----------------|
| Simple | 134 | 77.01% |
| Difficult | 40 | 22.98% |
| Total | 174 | 100% |

(1.14%). As for sex, the number of male samples was 136 patients, and the number of female samples was 38. The ratio between women and men was 1: 3.57.

The most clinical status group was the mild group, with 99 patients (56.89%), and the group with no upper airway obstruction, with 49 patients (28.16%).

The most operator characteristic group was ≥5x, which were 101 cases (58.04%), and the <5x group were 73 cases (41.95%).

The most frequent surgical landmark group was the simple group, 134 patients (77.01%), and the difficult group, 40 patients (22.98%).

The incidence of tracheotomy complications in the child group was three patients (25%), and in the adult group, it was 55 patients (33.95%). Patients who did not experience tracheotomy complications in the pediatric group were 9 (75%) and 107 (66.05%) in the adult group.

Tracheotomy complications in the group with no upper airway obstruction were three patients (6.10%), in the mild group were 44 patients (44.40%), in the moderate group were four patients (33.30%) and in the severe group were seven patients (50%). Patients who did not experience tracheotomy complications

Table 5. Correlation between age group, clinical status, operator characteristics, and surgical landmarks with the incidence of tracheotomy complications.

| | Complications | | Total |
|--------------------------------|---------------|--------|-------|
| | No | Yes | |
| Age Group | | | |
| Child | 9 | 3 | 12 |
| | 75.0% | 25% | 100% |
| Adult | 107 | 55 | 162 |
| | 66.05% | 33.95% | 100% |
| Clinical Status | | | |
| No upper airway obstruction | 46 | 3 | 49 |
| | 93.90% | 6.10% | 100% |
| Mild | 55 | 44 | 99 |
| | 55.60% | 44.40% | 100% |
| Moderate | 8 | 4 | 12 |
| | 66.70% | 33.30% | 100% |
| Severe | 7 | 7 | 14 |
| | 50% | 50% | 100% |
| Operator Characteristic | | | |
| <5x | 32 | 41 | 73 |
| | 43.80% | 56.20% | 100% |
| ≥5x | 84 | 17 | 101 |
| | 83.20% | 16.80% | 100% |
| Surgical Landmark | | | |
| Simple | 95 | 39 | 134 |
| | 70.90% | 29.10% | 100% |
| Difficult | 21 | 19 | 40 |
| | 52.50% | 47.50% | 100% |

in the group with no upper airway obstruction were 46 patients (93.90%), in the mild group were 55 patients (55.60%), in the moderate group were eight patients (66.70%) and in the severe group were seven patients (50%).

The incidence of tracheotomy complications in the ≥5x group was 17 patients (16.80%) and in the <5x group was 41 patients (56.20%). Patients who did not experience tracheotomy complications in the ≥5x group were 84 patients (83.20%), and in the <5x group were 32 patients (56.20%).

The incidence of tracheotomy complications in the simple group was 39 patients (29.10%), and in the difficult group was 19 patients (47.50%). Patients who did not experience tracheotomy complications in the simple group, 95 patients (70.90%), and 21 patients (52.50%) in the difficult group.

DISCUSSION

Tracheotomy complications can be divided into three categories: immediate, early,

and late.⁸ Bleeding is the most common form of immediate and early tracheotomy complications, with an incidence of major or minor bleeding at tracheotomy of around 5.7%. Stoma infection and subcutaneous emphysema are early complications with 0-5% incidence, while tracheal stenosis is the most common late complication with an incidence of 3-12%.⁴

The age of the patients in this study was grouped into 10-year intervals, with the youngest patient being two years old and the oldest being 86 years old. The largest age group was the age group 51-60 years including 53 patients (30.45%), and the minor age group was the age group 81-90 years, with two patients (1.14%). The study results in Finland obtained an age range of 0-87 years with an average of 55 years, the largest group aged 51-70. Slightly different results were found in Finland in 2019, with an age range of 19-92 years and an average of 65 years.³

The results of this study indicate that age has a significant correlation with tracheotomy complications with a p-value

= 0.008 ($p < 0.05$). This shows that age affects the incidence of tracheotomy complications. In addition, the rate of tracheotomy-related complications was also significantly higher in children aged ten years and younger than in adult patients ($p < 0.001$). Tracheotomy in the pediatric age group has been reported to differ from that in adults. Tracheotomy is also performed more frequently in children with chronic conditions, including neurological disorders and congenital heart and lung diseases. Most children had airway obstruction secondary to recurrent respiratory papillomatosis (17.3%). Factors that may explain the higher incidence in young children range from the need for prolonged use of tracheotomy in the pediatric age group through associated comorbidities finally the tiny diameter of the airway and the cannula itself.¹³

Blockage of the central airways will cause the body to lack oxygen (hypoxia) because inspiration and expiration will be disrupted, increasing body carbon dioxide levels.¹⁴ Patients who come to the hospital with airway obstruction will require a tracheotomy to maintain airway patency.¹⁵ Obstructive sleep apnea (OSA), especially the obesity hypoventilation syndrome (OHS) type, can cause respiratory function disturbances, resulting in respiratory failure.¹⁶ Tracheotomy is often performed in children with upper airway anomalies (congenital or more commonly acquired secondary to prolonged intubation) or requiring prolonged mechanical ventilation due to respiratory failure. The sex distribution in this study found 136 male patients (78.16%) and 30 female patients (21.83%), with a male-to-female ratio of 1:3.57. The study results reported that the largest group undergoing tracheotomy was male, with as many as 193 (63.7%) subjects.¹⁷

Tracheotomy was differentiated based on the patient's clinical status into patients with no upper airway obstruction. Emergency patients with upper airway obstruction are performed urgent or cito surgery, while for patients with no upper airway obstruction can be done selectively. In this study, the most indications for tracheotomy were upper airway obstruction in 125 patients (71.83%), followed by the threat of upper airway

obstruction in 34 (32.24%) subjects. The most clinical status group was the group with mild, with 99 patients (56.89%) and upper airway obstruction, with 49 patients (28.16%). A study by Kawale et al., 2017 showed slightly different results stated that prolonged elective intubation was the most common indication for tracheotomy.¹⁸

The most common group of operator characteristics in this study was the group of the number of actions $\geq 5x$ consisting of 101 actions (58.04%) and the group of the number of actions $< 5x$ including 73 actions (41.95%). In the group that experienced tracheotomy complications, operators who had $< 5x$ the number of operations were 41 cases (70.68%) compared to 17 patients (29.31%) from the group of operators with $\geq 5x$ the number of actions. This may explain the increased time and personnel involved with this technique. However, as with any technique, there is a learning curve where the time required and complications may be higher than after other experiences.¹⁹

In this study, the most common surgical landmark group was found to be the easy group, with 134 patients (77.01%) and the difficult group, with 40 patients (22.98%). The significant effects of pathological conditions of the neck when facing tracheotomy (including primary tumors, deep neck space infections, and metastases) should be given more attention. These conditions may affect exposure to surgical landmarks, control of the operating field, and procedure duration. This study showed that neck conditions significantly impact the occurrence of intraoperative and early postoperative complications.⁸

The results of this study showed that clinical status had a significant association with tracheotomy complications from the simple logistic regression test results, which obtained a p -value=0.000. When this was compared to elective tracheotomy in multivariate analysis, the difference was not significant. Another study found a 35% complication rate in the emergency setting, while another found a 20.9% complication rate in elective tracheotomies. In his study, this rate may be much higher as patients undergoing emergency tracheotomy had advanced diseases than those in more developed countries.²⁰

The findings showed that operator characteristics affect the incidence of tracheotomy complications. This study found that operators with a history of fewer than five procedures were likelier to perform tracheotomies with complications than operators with more experience. This could be due to various factors, including skill, experience and techniques in dealing with different patient conditions. For example, research shows an intraoperative complication rate of 10% for tracheotomies performed by residents in the first year of practice compared to 6% in the second year. The study aimed to document possible differences in tracheotomy complication rates depending on surgical experience.¹⁹ The analysis indicates that the more frequent tracheotomies a surgeon performs, the lower the complication rate.²¹

Tracheal pinpoint (tracheal fibrostenosis) is one of the rare central airway abnormalities that can be caused by trauma from intubation and tracheotomy procedures (10-22%), systemic inflammation, and infection.²² Cases of post-tracheotomy subglottic stenosis often occur at high tracheotomy due to injury to the cricoid cartilage. Procedural tracheotomy can be performed easily but becomes difficult if the action is completed quickly, such as when an emergency tracheotomy, which often causes complications.¹⁸

CONCLUSION

The correlation between age, the patient's clinical status, operator characteristics and surgical landmarks with the incidence of tracheotomy complications from 174 patients who underwent tracheotomy surgery at Dr. Soetomo Hospital Surabaya showed that these factors mutually influenced postoperative tracheotomy complications.

CONFLICT OF INTEREST

The authors confirmed that there were no conflicts of interest in this study.

FUNDING

The authors were responsible for all research funding without any financial support.

ETHICAL CLEARANCE

This study has obtained ethical clearance from the Health Research Ethics Committee of Dr. Soetomo Hospital Surabaya with reference letter number 1088/LOE/301.4.2/X/2022.

AUTHOR CONTRIBUTIONS

All authors contributed equally in this research and publication of this manuscript.

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