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Analysis of the performance of the TRACHY score as a predictive factor for determining the need for elective tracheostomy in patients with head and neck malignancies undergoing extensive excision and reconstruction surgery at Dr. Soetomo General Regional Hospital: An analytical observational study

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Abstract: Head and neck malignancies are the fifth most common type of cancer worldwide, and surgery has become the primary treatment for head and neck cancer. After major surgery in the head and neck region, the risk of upper airway obstruction is very high. This study aims to evaluate the TRACHY Score as a predictive factor for determining the need for elective tracheostomy in patients with head and neck malignancies who undergo extensive excision and reconstruction at Dr. Soetomo General Regional Hospital. This research is an analytical observational study with a retrospective cohort design, using secondary data in the form of medical records from patients with head and neck malignancies who underwent extensive excision and reconstruction at Dr. Soetomo General Regional Hospital from January 2020 to February 2024, and who met the inclusion and exclusion criteria. Clinical data from the TRACHY score parameters were analyzed, and comparisons were made between sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy in predicting the need for elective tracheostomy. A total of 34 study subjects were included, and 10 patients (29.4%) underwent tracheostomy. Using a cutoff score of 2, the sensitivity, specificity, PPV, NPV, and accuracy values for the TRACHY Score were found to be 100%, 66.6%, 55.5%, 100%, and 76.4%, respectively. The TRACHY Score demonstrates strong performance (including specificity, sensitivity, NPV, PPV, and accuracy) as a predictive tool for assessing the need for elective tracheostomy in patients with head and neck malignancies undergoing extensive excision and reconstruction surgery.

Keywords: *Airway management, Head and neck malignancies, Scoring, tracheostomy.*

1. Introduction

Head and neck malignancies are the fifth most common malignancy worldwide. This disease includes a variety of malignant tumors originating from the head and neck region. Ninety percent of these tumors are squamous cell carcinomas that originate from the epithelial surface of the upper respiratory and digestive tracts. The oral cavity is the most prevalent site for head and neck cancers globally (274,000 cases) and ranks as the 12th most common cancer, while laryngeal, pharyngeal, thyroid, and nasopharyngeal cancers are less frequent [1, 2].

For over a century, surgery has been the primary treatment for head and neck malignancies. With the introduction of radiotherapy in the 20th century, radiotherapy became an important modality, used

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either alone or in combination with chemotherapy as primary treatment or as adjuvant therapy following surgery [1]. The local destructive impact, both from the tumor itself and from treatment, can significantly affect the patient's life, impacting appearance, as well as sensory functions such as vision, smell, taste, hearing, and vital functions such as speaking, breathing, and swallowing [2]. Following major surgery in the head and neck region, the risk of upper airway obstruction is significantly elevated.

Common issues include edema of the larynx, pharynx, and posterior tongue, along with the use of large reconstructive flaps. Bilateral neck dissection or the resection of the mandible, tongue, and floor of the mouth also significantly increases the risk of airway complications in these patients. Elective tracheostomy, performed during the initial procedure, can help prevent these complications. However, this procedure carries its own risks. The best approach to postoperative airway management for patients with head and neck malignancies continues to be a topic of debate [3].

Tracheostomy complications can vary from mild issues, such as hypertrophic scarring, to more serious, life-threatening problems, with incidence rates ranging from 4% to 45%. To date, there is no universally accepted algorithm or scoring system to help doctors choose the most appropriate method for airway management. However, reported evidence suggests that patients who do not undergo tracheostomy recover more quickly and have shorter hospital stays compared to those who do undergo the procedure [4, 5].

Limiting the use of tracheostomy to specific cases is also an important component of the ERAS (Enhanced Recovery After Surgery) program. Unfortunately, it is difficult to compare the outcomes of head and neck surgery between patients who underwent tracheostomy and those who did not, due to the varying conditions and different surgeries performed [4].

The debate on the correct airway management for patients with head and neck malignancies undergoing surgery, particularly extensive excision and reconstruction, is still ongoing. This disagreement primarily occurs between surgeons and anesthesiologists. Such differences of opinion often contribute to prolonged waiting times for patients to undergo surgery.

At Dr. Soetomo General Regional Hospital, decisions regarding the airway management of patients undergoing head and neck surgery are still based on the experience of individual doctors, with no objective basis or standardized approach used as a reference. Given this background, the researcher aims to find a scoring system that could serve as a reference and objective basis for making airway management decisions in patients with head and neck malignancies undergoing surgery, particularly extensive excision and reconstruction.

The purpose of this study is to determine whether the TRACHY Score can be used as a predictive factor to determine the need for elective tracheostomy in patients with head and neck malignancies undergoing extensive excision and reconstruction.

2. Methods

This study is an analytical study to assess the performance of the TRACHY Score as a predictive factor for determining the need for elective tracheostomy in patients with head and neck malignancies following extensive excision and reconstruction surgery, with a retrospective cohort study design.

The data for this study is secondary in nature, sourced from the medical records of patients who underwent extensive excision and reconstruction for head and neck malignancies at the Department of Surgery, Head and Neck Surgery Division, and Oncology Surgery at Dr. Soetomo General Regional Hospital in Surabaya, between January 2020 and April 2024. Additionally, the TRACHY Score questionnaire data will be utilized. The study's target population includes all patients with head and neck malignancies who had extensive excision and reconstruction surgeries at the aforementioned departments during the same period.

The sampling method applied is total sampling, with data collection planned for June 2024. Inclusion criteria for the study involve patients with head and neck malignancies who underwent extensive excision and reconstruction surgery by the Head and Neck Division of the Department of Surgery at Dr. Soetomo General Regional Hospital. Medical records should include information such as

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the patient's age, complaints, comorbidities, prior surgery and treatment history, operative reports (detailing the extent of excision, reconstruction methods, and whether neck dissection was performed), operative complications, and the type of airway management used during and after surgery. The study will include a total of 34 patients

The independent variable for this research is the TRACHY Score, specifically for patients with head and neck malignancies undergoing extensive excision and reconstruction surgery. The dependent variable, or outcome, of the study is whether a tracheostomy was performed.

Data analysis in this study will use SPSS 21.0 for Windows. Normality of the data distribution will be assessed using the Shapiro-Wilk test. Sensitivity, specificity, NPV, PPV, and accuracy values will be calculated to assess the performance of the TRACHY Score. This study complies with research ethics guidelines and has received approval from the ethics committee.

Table 1.
Tracheostomy procedure in patients with head and neck malignancies undergoing extensive excision and reconstruction surgery.

	Frequency	Percent (%)
Tracheostomy (+)	10	29.4
Tracheostomy (-)	24	70.6
	34	100

From this study, 34 research subjects were obtained who met the inclusion and exclusion criteria. It was found that, among patients with head and neck malignancies undergoing extensive excision and reconstruction surgery, 10 patients (29.4%) underwent tracheostomy. The data from this study were analyzed based on sociodemographic data and the research variables.

Table 2.
Sociodemographic characteristics.

Characteristic		Frequency (N=34)	Percentage (%)
Gender	Male	19	55.9
	Female	15	44.1
Age group			
	Decade 1-2	11	32.35%
	Decade 3	1	2.94%
	Decade 4	12	35.29%
	Decade 5	6	17.64%
	Decade 6	3	8.82%
	Geriatric (>70 years old)	1	2.94%
		Average	Median (Min.-Max.)
Age (Years)		45 (±16.43)	42,62 (11-78)

3. Results and Discussion

Based on Table 2 above, it was found that the proportion of male patients with head and neck malignancies undergoing wide excision surgery and reconstruction with flap was higher (55.9%) compared to females (44.1%). The average age of the patients was 45 (±16.43) years, with the youngest age being 11 years and the oldest being 78 years. Based on age groups, the largest group was in Decade 4 (41-50 years) with a percentage of 35.29%.

3.1. The Relationship of TRACHY Score Components to Tracheostomy Procedures in Patients with Head and Neck Malignancies Undergoing Wide Excision Surgery and Reconstruction

TRACHY score is a scoring system used to predict the need for tracheostomy in patients with head and neck malignancies undergoing wide excision surgery and reconstruction with a flap. The TRACHY score is an acronym consisting of:

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T-sTage, R-Reconstruction, A-Anatomy, C-Coexisting condition, H-History, Y-lateralit Y, which makes it easier for clinicians to memorize. This study discusses each item in the TRACHY score.

For the T-stage variable, most patients were classified as T3 and T4, totaling 26 individuals. The highest number of tracheostomies was found in this group, with 7 patients (26.9%) undergoing the procedure. However, the relationship between T-stage and tracheostomy in patients undergoing wide excision and reconstruction was not statistically significant (p value = 0.6).

Regarding the type of reconstruction, 20 patients (58.8%) underwent reconstruction using a fasciocutaneous flap. This group also had the highest number of tracheostomies, with 7 patients (35%) requiring the procedure. The association between the type of reconstruction and tracheostomy was not statistically significant (p value = 0.47).

In terms of tumor location, the majority of patients had tumors in the lateral or central areas (20 patients, 58.8%). However, the highest number of tracheostomies was observed in patients with tumors in the anterior or oropharyngeal areas, with 8 patients (23.5%) undergoing the procedure. A statistically significant relationship was found between tumor location and the need for a tracheostomy (p value = 0.003).

For the ASA class, most patients were classified as ASA Class 1 or 2 (19 patients, 55.8%). The highest number of tracheostomies was performed on patients classified as ASA Class 3, with 9 patients (60%) out of 14 in this group. A statistically significant relationship was observed between ASA class and the need for a tracheostomy (p value = 0.002).

Regarding prior head and neck surgery, the majority of the sample had not undergone previous surgery (26 patients, 76.47%). This group also had the highest number of tracheostomies, with 8 patients (30.8%). No significant relationship was found between a history of head and neck surgery and the tracheostomy procedure (p value = 1.00).

For patients with a history of head and neck radiotherapy, the majority had not received prior treatment (84 patients, 85.2%). The highest number of tracheostomies was again in this group, with 8 patients (27.6%). No significant relationship was found between a history of head and neck radiotherapy and the tracheostomy procedure (p value = 0.618).

Regarding neck dissection, 7 patients (33%) who did not undergo neck dissection had a tracheostomy. In those who underwent unilateral neck dissection, 2 patients (16.7%) had a tracheostomy, and 1 patient (100%) who underwent bilateral neck dissection also required the procedure. The relationship between neck dissection and tracheostomy was not statistically significant (p value = 0.16).

Table 5.3 further explains the relationship between the components of the TRACHY score and the tracheostomy procedure in patients with head and neck malignancies undergoing wide excision and reconstruction.

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Table 3.
The relationship between TRACHY score components and tracheostomy procedures in patients with head and neck malignancies undergoing wide excision surgery and reconstruction.

Patient variables		Tracheostomy		Total	Sign. (p)
		Yes	No		
T stage	T1-T2	3 37.5%	5 62.5%	8 100%	0.666
	T3-T4	7 26.9	19 73.1	26 100%	
Reconstruction	Fasciocutaneus	7 35%	13 65%	20 100%	0.467
	Myocutaneous or composite	3 21.4%	11 78.6%	14 100%	
	2 flap	0	0	0	
Anatomy	Lateral or central	2 10%	18 90%	20 100%	0.003
	Anterior or oropharyngeal	8 57.1	6 42.8%	14 100%	
ASA class	1 and 2	1 5.6%	18 94.4%	19 100%	0.002
	3	9 60%	6 40%	14 100%	
History	History of head and neck surgery	2 25%	6 75%	8 100%	0.618
	History of head and neck radiotherapy	8 27.6%	21 72.4%	29 100%	
Neck dissection	Not performed	7 33%	14 66.7%	21 100%	0.174
	Unilateral	2 16.7%	10 83.3%	12 100%	
	Bilateral	1 100%	0 0%	1 100%	

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3.2. The Relationship Between TRACHY Score and Tracheostomy Procedures in Patients with Head and Neck Malignancies Undergoing Wide Excision Surgery and Reconstruction

Table 4.
The relationship between TRACHY score and tracheostomy procedures in patients with head and neck malignancies undergoing wide excision surgery and reconstruction.

TRACHY Score	**Tracheostomy**		**Total**	**P**
	Yes	**No**		**0.000**
>4	8	4	12	
	66.7%	33.3%	100%	
	80%	16.7%	35.3%	
<=4	2	20	22	
	9.1%	90.9%	100%	
	20.0%	83.3%	64.7%	
Total	10	24	34	
	29.4%	70.6%	100%	
	100%	100%	100%	
TRACHY Score	Tracheostomy		Total	P
	Yes	No		0.000
>2	10	8	18	
	55.6%	44.4%	100%	
	80%	33.3%	52.9%	
<=2	0	16	16	
	0%	100%	100%	
	0%	66.7%	47.1%	
Total	10	24	34	
	29.4%	70.6%	100%	
	100%	100%	100%	

From the ROC Curve test conducted by the researcher, a cutoff score of 2 was obtained with an accuracy rate of 88.1%. Based on this result, the researcher then conducted a diagnostic test for cutoff scores of 4 and 2 to determine which cutoff has better performance.

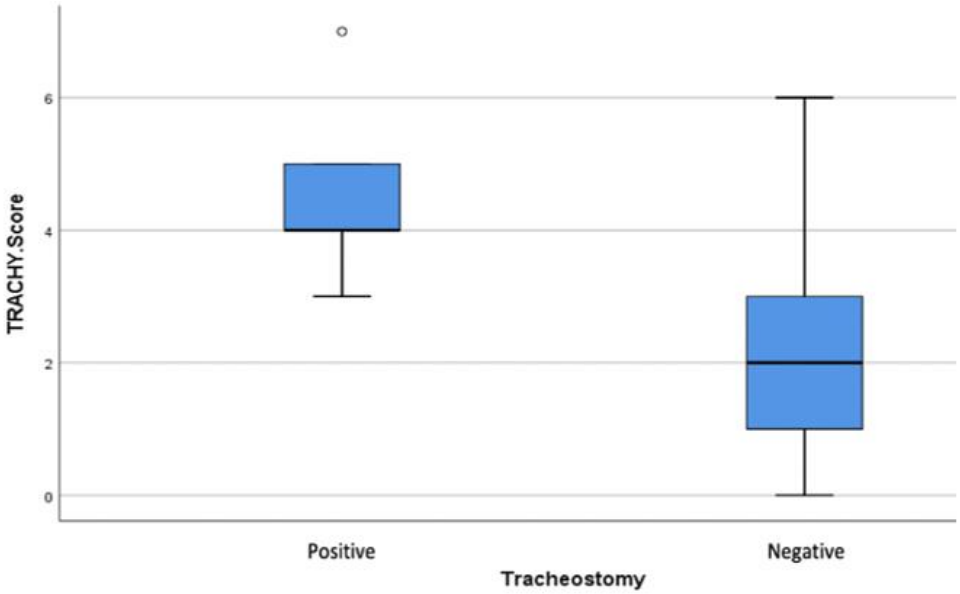

Figure 1.
Boxplot of TRACHY score and tracheostomy procedures in patients with head and neck malignancies undergoing wide excision surgery and reconstruction.

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Boxplot of TRACHY Score and Tracheostomy Procedures in Patients with Head and Neck Malignancies Undergoing Wide Excision Surgery and Reconstruction.

3.3. TRACHY Score Performance Test for Predicting Elective Tracheostomy

We analyzed the performance (sensitivity, specificity, NPV, PPV, and accuracy) of the TRACHY score using two cutoffs: score 2 and score 4, to predict tracheostomy procedures in patients with head and neck malignancies undergoing wide excision surgery and reconstruction. By using the cutoff score of 4 from previous literature studies and the cutoff score of 2 obtained in this study, the sensitivity, specificity, PPV, NPV, and accuracy values for the TRACHY score with a cutoff of 4 were 80.0%, 83.33%, 66.67%, 90.9%, and 82.35%, respectively. For the TRACHY score with a cutoff of 2, the values were 100.0%, 66.67%, 55.56%, 100.0%, and 76.47%, respectively.

Table 5.
Performance of TRACHY score for predicting the need for elective tracheostomy in patients with head and neck malignancies undergoing wide excision surgery and reconstruction.

	Cut off 2	**Cut off 4**
Sensitivity	100.0%	80.0%
Specificity	66.67%	83.33%
PPV	55.56%	66.67%
NPPV	100.0%	90.9%
Accuration	76.47%	82.35%

A safe airway is key in head and neck oncological surgery, considering the significant risk of bleeding and upper airway obstruction post operatively.

The surgeon must decide how to secure a safe airway based on a case-by-case assessment of each patient. Optimal airway management and the appropriate use of elective tracheostomy have been discussed in various studies. Several authors have developed scoring systems to assist doctors in identifying patients at risk for upper airway complications who may require elective tracheostomy [6].

Cameron et al. designed the first scoring system aimed at major head and neck surgeries using a retrospective analysis from 1999 to 2001. Although it resulted in an acceptable-performing scoring system, the study used operational data from 25 years ago [7].

Gupta et al. published the Clinical Assessment Scoring System for Tracheostomy (CASST). Although it provided good sensitivity and specificity, the 10 variables in the CASST system increased its complexity and application. A limitation of the scoring system created by Gupta et al. is the selection of patients**,** most of them underwent minor resections and there was no flap reconstruction, with only 13% requiring tracheostomy. The TRACHY score was first introduced by Mohamedbhai, et al. [8].

In their study, Mohamedbhai, et al. [8] aimed to present a contemporary and simple scoring system that offers high performance in making airway management decisions for patients undergoing head and neck cancer resections with flap reconstruction. This scoring system is based on operational and physiological principles, broadly categorized into variables related to the resection and disease, as well as factors related to patient risk [8].

For the T-stage item, the majority of patients were classified as T3 and T4, with 26 patients in total. The highest number of patients who underwent tracheostomy was in this group, with 7 patients (26.9%). The relationship between T-stage and tracheostomy in patients undergoing wide excision surgery and reconstruction in this study was not statistically significant (p value = 0.6). This differs from the results found in the study by Mohamedbhai, et al. [8] where a statistically significant relationship was found (p value = 0.01) between tumor size (T-stage) and tracheostomy. As the T-stage increases, the flap becomes larger, and more extensive or bilateral neck dissection is required, leading to an increase in inflammatory response and edema. If the swelling occurs in the area of the floor of the mouth or oropharynx, the resulting edema will have a more immediate effect on the airway [8]. This

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theory is also accepted by Janik et al., who conducted a comparative study of three tracheostomy scoring systems in patients who underwent bilateral neck dissection [6].

For the Reconstruction item, patients with head and neck malignancies underwent reconstruction using a fasciocutaneous flap, with 20 patients (58.8%) in this group. The highest number of tracheostomy procedures was also performed in this group, with 7 patients (35%) of the total patients who underwent reconstruction with a fasciocutaneous flap. The relationship between the type of reconstruction used and the tracheostomy procedure in patients with head and neck malignancies undergoing wide excision surgery and reconstruction was not statistically significant (p value = 0.47).

This finding also differs from the results obtained in the study by Mohamedbhai, et al. [8] where a statistically significant relationship (p value = 0.003) was found between the type of flap reconstruction and tracheostomy. This could be related to tumor size, where larger defects require larger flap reconstructions.

For the Anatomy item, the majority of patients had tumors located in the lateral or central areas, with 20 patients (58.8%) from the total sample. Meanwhile, the highest number of tracheostomy procedures were performed in patients with tumors located in the anterior or oropharyngeal areas, with 8 patients (23.5%) from the total sample. A statistically significant relationship was found between the anatomical location of the tumor and the tracheostomy procedure (p value = 0.003). This result is consistent with the analysis in the study by Mohamedbhai, et al. [8] where a statistically significant relationship (p value = 0.001) was also found between the anatomical location of the tumor and the tracheostomy procedure.

For the ASA Class item, the majority of patients were classified as ASA Class 1 and 2, with 19 patients (55.8%) from the total sample. The most tracheostomy procedures were performed on patients classified as ASA Class 3, with 9 patients (60%) from a total of 14 patients in this group. A statistically significant relationship was found between the ASA class and the tracheostomy procedure (p value = 0.002). This result is consistent with the analysis in the study by Mohamedbhai, et al. [8] where a statistically significant relationship (p value = 0.03) was found between ASA classification and tracheostomy procedure. The more severe the comorbid conditions in the patient, the more their functional reserve declines, increasing the risk of surgical burden and pulmonary complications.

For the Head and Neck Surgery History item, the majority of the sample had not previously undergone head and neck surgery, with 26 patients (76.47%) from the total sample. The highest number of tracheostomy procedures were also performed in this group, with 8 patients (30.8%). No significant relationship was found between a tracheostomy procedure and the head and neck surgery (p value = 1.00).

For the Head and Neck Radiotherapy History item, the majority of the sample had not previously undergone head and neck radiotherapy, with 84 patients (85.2%) from the total sample. The highest number of tracheostomy procedures were also performed in this group, with 8 patients (27.6%).

No significant relationship was found between a history of head and neck surgery and the tracheostomy procedure (p value = 0.618). This result differs from the analysis in the study by Mohamedbhai, et al. [8] where a statistically significant relationship was found between a history of surgery and prior head and neck radiation with the tracheostomy procedure (p value = 0.007 and p value <0.0001). According to Mohamedbhai, et al. [8] a history of prior radiation can alter anatomical structure, blood flow, and fluid behavior in tissues, which often results in a prolonged edema period. A history of prior surgery may have a similar effect, though to a lesser degree. This difference may occur due to variations in the radiation dose administered and the type of prior surgery performed.

For the neck dissection item, it was found that 7 patients (33%) who did not undergo neck dissection required tracheostomy. Meanwhile, 2 patients (16.7%) who underwent unilateral neck dissection and 1 patient (100%) who underwent bilateral neck dissection also required tracheostomy. No statistically significant association was observed between neck dissection and the tracheostomy procedure (p value = 0.16). This result differs from the study by Mohamedbhai, et al. [8] which found a significant relationship between neck dissection and tracheostomy (p value <0.0001).

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In this study, the ROC curve test revealed a cutoff score of 2 with an accuracy rate of 88.1%. Based on these results, the researchers then conducted diagnostic tests for cutoff scores 4 and 2 to determine which cutoff had better performance. From the diagnostic tests, the sensitivity, specificity, PPV, NPV, and accuracy for the TRACHY score with a cutoff of 4 were 80.0%, 83.33%, 66.67%, 90.9%, and 82.35%, respectively. For the TRACHY score with a cutoff of 2, the results were 100.0%, 66.67%, 55.56%, 100.0%, and 76.47%, respectively. This was also found in the study by Mohamedbhai, et al. [8] where the highest sensitivity was observed at a cutoff score of 3, which was 93.3%, with specificity of 79.8%, PPV of 83.5%, NPV of 89.5%. The lowest sensitivity was observed at a cutoff score of 5, with sensitivity of 84.8%, specificity of 96.5%, PPV of 96.9%, and NPV of 77.1%. This indicates that as the cutoff score increases, the sensitivity of the TRACHY score decreases.

4. Conclusion

Based on the findings of the study, it can be concluded that the TRACHY Score demonstrates good performance (sensitivity, specificity, NPV, PPV, and accuracy) as a predictive factor for determining the need for elective tracheostomy in patients with head and neck malignancies undergoing wide excision and reconstruction surgery. Using a cutoff score of 4, the sensitivity, specificity, PPV, NPV, and accuracy values for the TRACHY Score were 80.0%, 83.33%, 66.67%, 90.9%, and 82.35%, respectively.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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