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Indications and complications of tracheostomy

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Abstract

Background: Tracheostomy is a commonly performed airway procedure in critically ill and surgically managed patients. While it offers significant benefits in airway protection and ventilatory support, it is also associated with early and late complications. Understanding the indications and complication profile is essential for optimizing patient outcomes. **Objectives:** To evaluate the indications for tracheostomy and to assess the pattern and frequency of early and late complications associated with the procedure. **Methods:** A prospective observational study was conducted on 100 patients who underwent tracheostomy at a tertiary care center. Demographic details, clinical indications, procedural characteristics, and complications were recorded. Patients were categorized into emergency and elective tracheostomy groups. Statistical analysis was performed using appropriate tests, and results were expressed as frequencies, percentages, mean $\pm$ SD, relative risk, and 95% confidence intervals. **Results:** The mean age of patients was 51.8 ± 17.6 years, with male predominance (63%). Prolonged mechanical ventilation was the most common indication (48%), followed by upper airway obstruction (27%). Emergency tracheostomies accounted for 57% of cases and were associated with higher complication rates compared to elective procedures (47.4% vs 27.9%). Early complications included hemorrhage, stoma infection, and tube displacement, while late complications included granulation tissue formation and tracheal stenosis. Although many associations did not reach statistical significance, a consistent trend toward higher morbidity in emergency tracheostomy was observed. **Conclusion:** Emergency tracheostomy is associated with a higher rate of complications compared to elective tracheostomy. Early identification of patients requiring airway support and timely elective tracheostomy may reduce procedure-related morbidity. Structured protocols and vigilant postoperative care are essential to optimize outcomes.

Keywords: Tracheostomy. Airway management. Tracheostomy complications.

Introduction

Tracheostomy is one of the oldest and most life-saving surgical procedures in otorhinolaryngology, involving the creation of a surgical opening in the anterior wall of the trachea to establish a direct airway. It is primarily performed to bypass upper airway obstruction, facilitate prolonged mechanical ventilation, ensure effective pulmonary toileting, and protect the airway in patients with compromised consciousness or neuromuscular dysfunction. The procedure has evolved significantly over time, transitioning from an emergency life-saving intervention to a planned and strategic airway management tool in modern critical care settings.[1]

Historically, tracheostomy was associated with high morbidity and mortality; however, advancements in surgical techniques, anesthesia, intensive care management, and postoperative care have significantly reduced procedure-related complications. With the advent of percutaneous and bedside techniques, tracheostomy has become safer, more efficient, and increasingly common in intensive care units. Despite these advances, the procedure is not without risks and requires careful patient selection and meticulous perioperative care.[2] The indications for tracheostomy are broadly classified into prolonged mechanical ventilation, upper airway obstruction, facilitation of pulmonary toileting, and airway protection. Prolonged endotracheal intubation is currently the most common indication, particularly in patients requiring long-term ventilatory support due to neurological disorders, severe head injury, or critical illness. Upper airway obstruction may arise from tumors, trauma, infections, congenital anomalies, or inflammatory conditions. Tracheostomy also plays a vital role in patients with neuromuscular disorders such as Guillain-Barré syndrome, myasthenia gravis, and motor neuron disease, where ineffective cough and airway clearance compromise ventilation.[3]

Aim

To study the indications and complications of tracheostomy in patients undergoing the procedure at a tertiary care center.

Objectives

1. To evaluate the demographic and clinical profile of patients undergoing tracheostomy and identify the primary indications for the procedure.
2. To assess early and late complications associated with tracheostomy and analyze their frequency and clinical patterns.

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Materials and Methods

Source of Data

Patients admitted to the Department of Otorhinolaryngology of a tertiary care hospital who underwent tracheostomy during the study period were included. Data were collected from patient records, operative notes, and follow-up documentation.

Study Design

Prospective observational study.

Study Location

Department of ENT, Tertiary Care Teaching Hospital.

Study Duration

The study was conducted over a period of 24 months.

Sample Size

A total of 100 patients undergoing tracheostomy were included in the study.

Inclusion Criteria

- All patients undergoing emergency or elective tracheostomy
- Patients of all age groups and both sexes
- Patients who provided informed consent (or consent from legal guardians)

Exclusion Criteria

- Patients who refused consent
- Patients not willing to participate in follow-up
- Patients with incomplete clinical records

Procedure and Methodology

All eligible patients were enrolled consecutively. Detailed history regarding presenting complaints, duration of symptoms, and associated comorbidities was obtained. A thorough general physical and ENT examination was performed. Relevant investigations including hemogram, coagulation profile, imaging (X-ray chest, CT/MRI where indicated), and pre-anesthetic evaluation were conducted. Tracheostomy was performed under aseptic precautions using standard surgical techniques. The indication, type (elective/emergency), timing, and intraoperative findings were documented. Postoperative monitoring included assessment for immediate and delayed complications. Patients were followed up during hospital stay and subsequent outpatient visits.

Sample Processing

Clinical data were recorded in a predesigned proforma. Complications were categorized as early (within 7 days) and late (after 7 days). Data were compiled systematically for analysis.

Statistical Methods

Data were entered into Microsoft Excel and analyzed using statistical software. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used. Categorical variables were analyzed using Chi-square or Fisher's exact test where applicable. A p-value <0.05 was considered statistically significant.

Data Collection

Data were collected prospectively using structured case record forms, ensuring confidentiality and ethical compliance throughout the study period.

OBSERVATION AND RESULTS

Table 1: Indications and overall complications profile (N = 100)

Variable	Total (N=100) n(%) / Mean±SD	Emergency (n=57)	Elective (n=43)	Test of significance	Effect size (95% CI)	P-value
Age (years)	51.8 ± 17.6	49.3 ± 18.2	55.1 ± 16.3	Welch t = -1.68	Mean diff = -5.8 (-12.7 to +1.1)	0.097
Male sex	63 (63.0)	39 (68.4)	24 (55.8)	$\chi^2 = 1.69$	RR = 1.23 (0.91 to 1.66)	0.194
Primary indication					(Ref = Elective)	
Prolonged mechanical ventilation	48 (48.0)	21 (36.8)	27 (62.8)	$\chi^2 = 5.61$	RR = 0.59 (0.39 to 0.88)	0.018
Upper airway obstruction	27 (27.0)	20 (35.1)	7 (16.3)	$\chi^2 = 3.50$	RR = 2.16 (1.00 to 4.63)	0.061
Neuromuscular disorder	14 (14.0)	7 (12.3)	7 (16.3)	$\chi^2 = 0.08$	RR = 0.75 (0.29 to 1.99)	0.780
Head injury (IPPV)	9 (9.0)	8 (14.0)	1 (2.3)	Fisher exact	RR = 6.04 (0.78 to 46.45)	0.074
Other indications	2 (2.0)	1 (1.8)	1 (2.3)	Fisher exact	RR = 0.75 (0.05 to 11.67)	1.000
Any complication (early/late)	39 (39.0)	27 (47.4)	12 (27.9)	$\chi^2 = 3.13$	RR = 1.70 (0.98 to 2.95)	0.077

In this cohort of 100 tracheostomy patients, the mean age was 51.8 ± 17.6 years, with emergency cases (49.3 ± 18.2 years) being slightly younger than elective cases (55.1 ± 16.3 years); however, this difference did not reach statistical significance (Welch t = -1.68; mean difference -5.8 years, 95% CI -12.7 to +1.1; p = 0.097). Male predominance was observed overall (63%), and males were more frequent in the emergency group (68.4%) than in the elective group (55.8%), though the association was not significant ($\chi^2 = 1.69$; RR = 1.23, 95% CI 0.91-1.66; p = 0.194). Regarding indications, prolonged mechanical ventilation was the commonest overall (48%), but it was significantly more frequent in elective tracheostomy (62.8%) compared to emergency tracheostomy (36.8%), indicating a significantly lower likelihood of this indication in emergency cases ($\chi^2 = 5.61$; RR = 0.59, 95% CI 0.39-0.88; p = 0.018). Conversely, upper airway obstruction was more common in emergency cases (35.1%) than elective cases (16.3%), showing a strong trend toward significance ($\chi^2 = 3.50$; RR = 2.16, 95% CI 1.00-4.63; p = 0.061). Head injury requiring IPPV was relatively uncommon overall (9%), but occurred predominantly in emergencies (14.0% vs 2.3%), again demonstrating a trend without statistical significance due to small numbers (Fisher's exact; RR = 6.04, 95% CI 0.78-46.45; p = 0.074). The overall complication rate (any early/late complication) was 39%, with complications occurring more often after emergency tracheostomy (47.4%) than elective tracheostomy (27.9%); although the risk was higher (RR = 1.70, 95% CI 0.98-2.95), this did not achieve statistical significance ($\chi^2 = 3.13$; p = 0.077).

Table 2: Demographic & clinical profile with primary indications (N = 100)

Variable	Total (N=100) n(%) / Mean±SD	Emergency (n=57)	Elective (n=43)	Test of significance	Effect size (95% CI)	p-value
Age group (years)					(Ref = Elective)	
≤18	7 (7.0)	5 (8.8)	2 (4.7)	Fisher exact	RR = 1.88 (0.38 to 9.25)	0.695
19-40	23 (23.0)	16 (28.1)	7 (16.3)	$\chi^2 = 2.06$	RR = 1.72 (0.81 to 3.64)	0.151
41-60	39 (39.0)	23 (40.4)	16 (37.2)	$\chi^2 = 0.10$	RR = 1.09 (0.70 to 1.69)	0.748
>60	31 (31.0)	13 (22.8)	18 (41.9)	$\chi^2 = 4.26$	RR = 0.54 (0.31 to 0.94)	0.039
Comorbidity present (any)	44 (44.0)	21 (36.8)	23 (53.5)	$\chi^2 = 2.78$	RR = 0.69 (0.46 to 1.04)	0.095
ICU admission at time of trach	66 (66.0)	45 (78.9)	21 (48.8)	$\chi^2 = 9.85$	RR = 1.62 (1.19 to 2.21)	0.002
Emergency tracheostomy	57 (57.0)	—	—	—	—	—
Type of anesthesia					(Ref = Elective)	
Local anesthesia (LA)	29 (29.0)	24 (42.1)	5 (11.6)	$\chi^2 = 10.64$	RR = 3.63 (1.52 to 8.68)	0.001
General anesthesia (GA)	71 (71.0)	33 (57.9)	38 (88.4)	$\chi^2 = 10.64$	RR = 0.66 (0.54 to 0.82)	0.001
Primary indication (summary)						
Prolonged ventilation	48 (48.0)	21 (36.8)	27 (62.8)	$\chi^2 = 5.61$	RR = 0.59 (0.39 to 0.88)	0.018
Upper airway obstruction	27 (27.0)	20 (35.1)	7 (16.3)	$\chi^2 = 3.50$	RR = 2.16 (1.00 to 4.63)	0.061
Neuromuscular disorder	14 (14.0)	7 (12.3)	7 (16.3)	$\chi^2 = 0.08$	RR = 0.75 (0.29 to 1.99)	0.780
Head injury (IPPV)	9 (9.0)	8 (14.0)	1 (2.3)	Fisher exact	RR = 6.04 (0.78 to 46.45)	0.074
Other	2 (2.0)	1 (1.8)	1 (2.3)	Fisher exact	RR = 0.75 (0.05 to 11.67)	1.000

Age-group analysis showed that the largest proportion belonged to 41-60 years (39%) followed by >60 years (31%). Importantly, patients aged >60 were significantly less represented in emergency tracheostomy (22.8%) compared with elective tracheostomy (41.9%), indicating that older patients were more likely to undergo elective procedures ($\chi^2 = 4.26$; RR = 0.54, 95% CI 0.31-0.94; $p = 0.039$). Comorbidity was present in 44% overall, with a lower prevalence in emergencies (36.8%) versus electives (53.5%), showing a near-significant trend ($\chi^2 = 2.78$; RR = 0.69, 95% CI 0.46-1.04; $p = 0.095$). ICU admission at the time of tracheostomy was markedly more common in emergency cases (78.9%) compared to elective cases (48.8%), and this association was statistically significant, implying that emergency tracheostomy was strongly linked with critical care settings ($\chi^2 = 9.85$; RR = 1.62, 95% CI 1.19-2.21; $p = 0.002$). With respect to anesthesia, local anesthesia was significantly more frequent in emergency tracheostomy (42.1%) than elective tracheostomy (11.6%) ($\chi^2 = 10.64$; RR = 3.63, 95% CI 1.52-8.68; $p = 0.001$), whereas general anesthesia predominated in elective cases (88.4% vs 57.9%), reflecting procedural planning and stability (RR = 0.66, 95% CI 0.54-0.82; $p = 0.001$). The indication pattern mirrored Table 1: prolonged ventilation was significantly more common in electives (62.8%) than emergencies (36.8%) ($p = 0.018$), while upper airway obstruction and head injury were more frequent in emergency tracheostomy, though both remained statistically borderline due to limited counts ($p = 0.061$ and $p = 0.074$ respectively).

Table 3: Early and late complications profile (N = 100)

Complication	Total (N=100) n(%)	Emergency (n=57)	Elective (n=43)	Test of significance	Effect size (95% CI)	p-value
EARLY COMPLICATIONS						
Hemorrhage	14 (14.0)	10 (17.5)	4 (9.3)	Fisher exact	RR = 1.89 (0.63 to 5.61)	0.383
Pneumothorax	3 (3.0)	2 (3.5)	1 (2.3)	Fisher exact	RR = 1.51 (0.14 to 15.88)	1.000
Subcutaneous emphysema	6 (6.0)	4 (7.0)	2 (4.7)	Fisher exact	RR = 1.51 (0.29 to 7.84)	0.695
Stoma/insertion-site infection	9 (9.0)	7 (12.3)	2 (4.7)	Fisher exact	RR = 2.64 (0.58 to 12.08)	0.293
Accidental decannulation/displacement	4 (4.0)	3 (5.3)	1 (2.3)	Fisher exact	RR = 2.26 (0.24 to 20.84)	0.627
Other early (false passage/aspiration/air leak)	2 (2.0)	1 (1.8)	1 (2.3)	Fisher exact	RR = 0.75 (0.05 to 11.67)	1.000
LATE COMPLICATIONS						
Granulation tissue formation	11 (11.0)	8 (14.0)	3 (7.0)	Fisher exact	RR = 2.01 (0.57 to 7.14)	0.343
Tracheal stenosis	9 (9.0)	6 (10.5)	3 (7.0)	Fisher exact	RR = 1.51 (0.40 to 5.70)	0.744
Persistent stoma-site infection	3 (3.0)	2 (3.5)	1 (2.3)	Fisher exact	RR = 1.51 (0.14 to 15.88)	1.000
Difficulty with decannulation	7 (7.0)	5 (8.8)	2 (4.7)	Fisher exact	RR = 1.88 (0.38 to 9.25)	0.695
Tracheoesophageal fistula	1 (1.0)	1 (1.8)	0 (0.0)	Fisher exact	RR = —	1.000
Other late (scar/keloid/voice change etc.)	2 (2.0)	1 (1.8)	1 (2.3)	Fisher exact	RR = 0.75 (0.05 to 11.67)	1.000
Any complication (overall)	39 (39.0)	27 (47.4)				

Early complications (within 7 days) showed hemorrhage as the most frequent event (14%), occurring more commonly in emergency tracheostomy (17.5%) than elective (9.3%); however, the difference was not statistically significant (RR = 1.89, 95% CI 0.63-5.61; $p = 0.383$). Stoma/insertion-site infection was observed in 9% overall, again higher in emergency cases (12.3%) than elective cases (4.7%), suggesting a clinically higher infection risk in emergencies, although statistical significance was not reached (RR = 2.64, 95% CI 0.58-12.08; $p = 0.293$).

Subcutaneous emphysema (6%), pneumothorax (3%), tube displacement/accidental decannulation (4%), and other early events (2%) were relatively infrequent and showed no significant emergency-elective differences, largely due to small event numbers.

Late complications (after 7 days) were dominated by granulation tissue formation (11%) and tracheal stenosis (9%). Both were more frequent in emergency cases (14.0% and 10.5%, respectively) compared to elective cases (7.0% and 7.0%), but neither reached statistical significance ($p = 0.343$ and $p = 0.744$). Difficulty with decannulation was seen in 7% overall and was almost twice as frequent in emergency cases (8.8%) compared with elective cases (4.7%), though without significance ($RR = 1.88$; $p = 0.695$). Tracheoesophageal fistula was rare (1%) and occurred only in the emergency group, reflecting its low incidence but serious clinical relevance.

Discussion

1. Indications and Overall Complication Profile (Table 1): In the present study, the mean age of patients undergoing tracheostomy was 51.8 ± 17.6 years, with emergency cases being relatively younger than elective cases, although this difference did not reach statistical significance ($p = 0.097$). This finding is consistent with reports by Avery B et al. (2021)[4], who observed that emergency tracheostomies are more frequently required in younger patients due to trauma, acute airway compromise, and neurological emergencies, whereas elective tracheostomies tend to be performed in older patients with chronic illnesses and prolonged ventilation needs.

Male predominance (63%) was noted in the present cohort, which is comparable to findings reported by Neto JF et al. (2022)[5], where male patients constituted 60-70% of tracheostomy cases. This gender difference is commonly attributed to higher exposure of males to trauma, smoking-related airway pathology, and occupational hazards.

Prolonged mechanical ventilation emerged as the most common overall indication (48%), particularly in elective tracheostomies (62.8%), which was statistically significant ($p = 0.018$). This observation aligns closely with studies by Murray M et al. (2022)[6], both of whom identified prolonged ventilation as the predominant indication in ICU-based tracheostomy cohorts. Conversely, upper airway obstruction was more frequent in emergency tracheostomies (35.1%), reflecting acute presentations such as malignancy-related obstruction, edema, or trauma—findings consistent with reports by Kligerman MP et al. (2020)[7].

Although neuromuscular disorders and head injury were less frequent overall, head injury-related tracheostomy showed a strong association with emergency procedures ($RR = 6.04$), consistent with trauma-focused series by Fuller C et al. (2021)[8], where emergency airway control was common in severe neurological injury. The overall complication rate of 39% was higher in emergency tracheostomies (47.4%) than elective cases (27.9%), a trend also reported by Nyanzi DJ et al. (2023)[2], reinforcing that emergency tracheostomy carries higher procedural risk due to unstable physiology and limited preparation time.

2. Demographic and Clinical Profile (Table 2): Age-wise distribution demonstrated that patients above 60 years were significantly more likely to undergo elective tracheostomy ($p = 0.039$), reflecting planned airway management for chronic respiratory failure or prolonged ventilator dependence. Similar age trends have been reported by Neto JF et al. (2022)[5], where elective tracheostomies were commonly performed in elderly ICU patients.

Comorbidities were more frequent in elective cases (53.5%) compared to emergency cases (36.8%), though not statistically significant. This aligns with the observation by Murray M et al. (2022)[6], who emphasized that patients with chronic comorbid conditions are more likely to undergo planned tracheostomy rather than emergency airway intervention.

ICU admission at the time of tracheostomy was significantly higher in emergency cases (78.9% vs. 48.8%; $p = 0.002$), supporting findings from Kligerman MP et al. (2020)[7], where emergency tracheostomy was closely linked with ICU dependency and acute respiratory failure.

Regarding anesthesia, local anesthesia was significantly associated with emergency tracheostomy (42.1%), whereas general anesthesia predominated in elective cases (88.4%). This pattern has been consistently reported in prior studies, including Fuller C et al. (2021)[8], where emergent airway compromise necessitated bedside or awake tracheostomy under local anesthesia.

3. Early and Late Complications (Table 3): Early complications were more frequent in emergency tracheostomies across nearly all categories. Hemorrhage was the most common early complication (14%), followed by stoma infection (9%) and subcutaneous emphysema (6%). Although statistical significance was not reached, the trend toward higher early complication rates in emergency cases is consistent with findings from Strober W et al. (2024)[9], where emergency procedures were associated with poorer local tissue conditions and limited optimization time. Late complications such as granulation tissue formation (11%) and tracheal stenosis (9%) were also more frequent in emergency tracheostomy, reflecting prolonged inflammation and mechanical irritation. Similar rates have been reported by Markov S et al. (2025)[10], who noted granulation tissue as the most common late complication. Difficulty with decannulation and tracheoesophageal fistula were rare but clinically significant events, emphasizing the need for long-term follow-up.

Overall, although many comparisons did not reach statistical significance due to sample size constraints, the consistent pattern of higher complication rates in emergency tracheostomy mirrors trends reported across international literature, supporting the concept that elective, well-planned tracheostomy offers a safer profile with fewer adverse outcomes.

Conclusion

This study highlights the evolving indications and complication profile of tracheostomy in a tertiary care setting. Prolonged mechanical ventilation emerged as the most common indication, particularly in elective tracheostomies, reflecting the increasing role of tracheostomy in intensive care management. Emergency tracheostomies were more frequently associated with upper airway obstruction, head injury, and acute respiratory compromise. Although the overall complication rate was moderate, complications were notably higher in emergency procedures compared to elective ones, emphasizing the impact of clinical urgency, patient instability, and limited preparation on procedural outcomes.

Early complications such as hemorrhage, stoma infection, and tube displacement were more frequent in emergency tracheostomies, while late complications like granulation tissue formation and tracheal stenosis were observed predominantly in patients with prolonged cannulation. Although many comparisons did not reach statistical significance, likely due to sample size limitations, consistent trends demonstrated increased morbidity in emergency tracheostomy cases. The study reinforces that careful patient selection, timely decision-making, appropriate choice of anesthesia, and meticulous postoperative care play a crucial role in reducing tracheostomy-related morbidity.

Overall, elective tracheostomy performed under controlled conditions was associated with fewer complications and better outcomes. These findings emphasize the importance of early airway planning and structured tracheostomy care protocols to improve patient safety and clinical outcomes.

LIMITATIONS OF THE STUDY

1. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other healthcare settings.

2. The sample size of 100 patients, although adequate for descriptive analysis, may have limited the statistical power to detect significant differences in less frequent complications.
3. Being an observational study, causal relationships between risk factors and complications could not be definitively established.
4. Follow-up duration was limited, which may have led to underestimation of late complications such as tracheal stenosis or long-term voice and swallowing disorders.
5. Variability in surgical expertise and postoperative care among different operators was not controlled and may have influenced outcomes.
6. Some complications were identified clinically without routine endoscopic confirmation, potentially leading to underreporting of subclinical events.

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