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Early Complications of Open Surgical Tracheostomy

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ABSTRACT

Background: Tracheostomy is an ancient surgical intervention for managing airway obstruction, with evidence of its use dating back to 3600 BCE. It gained widespread application during the polio epidemic, particularly following the introduction of standardized techniques by Chevalier Jackson in the 20th century, which improved safety and outcomes. The objective was to evaluate the early complications associated with open surgical tracheostomy. **Methodology:** A cross-sectional study was conducted in the Department of ENT at MTI - Lady Reading Hospital, Peshawar. The study was conducted over six months, from July 29, 2022, to January 29, 2023. A total of 159 patients undergoing open surgical tracheostomy were included using non-probability consecutive sampling. Data on patient demographics, area of residence, and early complications were collected and analyzed. **Results:** The age distribution of participants was as follows: 18–30 years (18.2%), 31–40 years (33.3%), 41–50 years (13.2%), 51–60 years (26.4%), and 60–70 years (8.8%), with a mean age of 45.72 years ± 2.45. Females constituted 59.1% of the cohort, and rural residents comprised 57.2%. The most common early complications were surgical emphysema (44.7%), followed by infection (38.4%) and tube obstruction (17.0%). **Conclusion:** Open surgical tracheostomy remains vital for managing upper airway obstruction and facilitating prolonged mechanical ventilation. However, early complications such as surgical emphysema and infection are significant concerns, particularly in patients with more complex surgical revisions. Improved surgical techniques and postoperative care are crucial to minimizing these complications.

INTRODUCTION

Tracheostomy is one of the oldest surgical procedures, dating back to ancient Egyptian civilization around 3600 BCE, as documented in historical records [1]. It is a critical intervention for managing airway obstructions, facilitating prolonged mechanical ventilation, and improving pulmonary clearance[2]. The procedure involves creating an opening in the trachea, enabling direct access to the airway, either temporarily or permanently. Over centuries, tracheostomy techniques have evolved significantly, with modern surgical innovations emphasizing safety and efficacy[3].

Historically, tracheostomy gained widespread adoption during the 20th century, particularly following the polio epidemic, when airway obstruction necessitated surgical intervention. Chevalier Jackson introduced a standardized method during this era, enhancing procedural safety and reducing associated risks[4]. Today, tracheostomy remains a life-saving intervention, often employed in patients with upper airway obstruction, prolonged ventilation needs, or conditions like sleep apnea, among others[5].

Despite its advantages, tracheostomy is not without complications. These complications are categorized into immediate, early, and late

occurrences. Early complications, which manifest within the first-week post-procedure, include tube obstruction, surgical emphysema, infection, and tracheal necrosis [6]. Surgical emphysema, characterized by trapped air beneath the skin, and infection are particularly concerning due to their potential to escalate morbidity [6].

Advances in surgical techniques and postoperative care have reduced complication rates, yet certain demographic factors, age, gender, and area of residence, influence the incidence and severity of these complications. Urban-rural disparities, for instance, may reflect differences in healthcare access, hygiene practices, and patient education. Similarly, gender differences in complication rates may be influenced by anatomical and physiological variations.

This study aims to assess the frequency of early complications associated with open surgical tracheostomy in a specific clinical setting, providing valuable insights for optimizing surgical practices and preventive strategies. Healthcare professionals can tailor interventions to minimize risks and improve patient outcomes by understanding demographic variations and their impact on complications.

METHODOLOGY

This research was conducted as a cross-sectional study to identify the early complications associated with open surgical tracheostomy. It was conducted over six months, from July 29, 2022, to January 29, 2023, in the department of ENT at Lady Reading Hospital, Peshawar, a tertiary care centre providing comprehensive otolaryngology services.

The study included 159 patients. The sample size was calculated using the World Health Organization sample size calculator, with an assumed infection rate of 2.67%, a 95% confidence level, and a margin of error of 2.5%. Before the study was initiated, approval was obtained from the institutional ethics committee. Written informed consent was secured from all participants, ensuring confidentiality and the right to withdraw at any stage.

Participants were selected using non-probability consecutive sampling, which ensured the inclusion of all eligible patients presenting during the study period.

Inclusion Criteria: Patients of both genders, individuals aged 18 to 70, and patients undergoing open surgical tracheostomy for airway management.

Exclusion Criteria: Patients with incomplete medical records, those who developed complications unrelated to tracheostomy, patients who underwent emergency or percutaneous tracheostomy procedures, and patients with pregnancy.

Data were gathered prospectively from patient medical records and clinical observations. A structured proforma was designed to document patient demographics, including age, gender, and area of residence, as well as details of early complications such as tube obstruction, surgical emphysema, and infection.

Definitions of Early Complications

Tube Obstruction: Defined as a blockage caused by mucus, blood clots, or airway wall pressure.

Surgical Emphysema: Air trapped beneath the skin near the tracheostomy site.

Infection: Presence of clinical signs such as fever (>100.4°F), cough, and discolored or foul-smelling mucus (yellow/green).

Data were entered into statistical software for analysis. Frequencies and percentages were used for categorical variables, while means and standard deviations were calculated for continuous variables. Stratification was performed to analyze early complications across demographic parameters and chi-square tests were applied to assess statistical significance, with p-values <0.05 considered significant.

RESULTS

Table 1 Demographic and Clinical Data of Participants. This table provides a clear overview of participant demographics and clinical data, including age distribution, gender, area of residence, and observed early complications. The mean age of 45.72 years with a standard deviation of ±2.45 indicates a middle-aged cohort.

Table 1

Demographic and Clinical Data of Participants (n=159)

Parameter	Category	Frequency	Percentage (%)
Age Group	18-30 Years	29	18.2
	31-40 Years	53	33.3
	41-50 Years	21	13.2
	51-60 Years	42	26.4
	60-70 Years	14	8.8
Gender	Male	65	40.9
	Female	94	59.1
Area of Residence	Urban	68	42.8
	Rural	91	57.2
Early Complications	Tube Obstruction	27	17.0
	Surgical Emphysema	71	44.7
	Infection	61	38.4

Mean Age: 45.72 years ± 2.45

Table 2 Stratification of Early Complications by Age, Gender, and Area of Residence. This table stratifies the occurrence of early complications by age, gender, and area of residence, highlighting that complications are more common in certain demographic groups (e.g., surgical emphysema is most frequent in rural areas). The significant p-values ($p<0.05$) indicate statistical relevance in the stratification.

Table 2

Stratification of Early Complications by Age, Gender, and Area of Residence (n=159)

Parameter	Category	Tube Obstruction	Surgical Emphysema	Infection	Total	Percentage (%)	P-Value
Age Group	18-30 Years	5	2	22	29	100.0	0.000
	31-40 Years	9	23	21	53	100.0	
	41-50 Years	6	5	10	21	100.0	
	51-60 Years	7	27	8	42	100.0	
	60-70 Years	0	14	0	14	100.0	
	Total	27	71	61	159	100.0	
Gender	Male	7	23	35	65	100.0	0.000
	Female	20	48	26	94	100.0	
	Total	27	71	61	159	100.0	
Area of Residence	Urban	21	24	23	68	100.0	0.000
	Rural	6	47	38	91	100.0	
	Total	27	71	61	159	100.0	

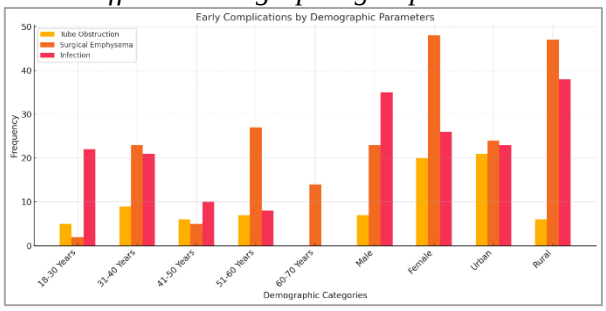
The study highlights the demographic and clinical characteristics of participants undergoing open surgical tracheostomy and their associated early complications: The mean age was 45.72 years, primarily female (59.1%) and from rural areas (57.2%). Surgical emphysema was the most common early complication (44.7%), followed by infection (38.4%) and tube obstruction (17.0%).

Stratification revealed that surgical emphysema was more frequent in rural residents and females, while infections were higher in younger age groups (18–30 years) and males. Tube obstruction showed a relatively even distribution across demographics. Statistically significant differences ($p<0.05$) were observed in complications across age, gender, and area of residence.

In summary, the findings emphasize the need for focused preventive strategies and postoperative care tailored to demographic risk factors, particularly for rural residents and individuals at higher risk of surgical emphysema.

Figure 1

Frequency of early complications (tube obstruction, surgical emphysema, and infection) across different demographic groups.



Among age groups, surgical emphysema is most common in individuals aged 51–60 years, while infection is prevalent in those aged 18–30 years. Tube obstruction is observed relatively evenly, with a slight peak in the 31–40 years group. Gender-wise, females exhibit a higher frequency of surgical emphysema, while males are more affected by infections. When analyzed by area of

residence, surgical emphysema is significantly more frequent in rural participants compared to urban residents. Infection rates are slightly higher in rural participants, while tube obstruction shows no significant difference between urban and rural groups. This analysis highlights notable demographic variations in early complications, with age, gender, and residence being influential factors. Surgical emphysema was the most frequent complication overall, suggesting the need for targeted management strategies in high-risk groups.

DISCUSSION

This study investigated the early complications of open surgical tracheostomy, analyzing their occurrence with demographic factors of age, gender, and area of residence. The findings revealed significant variations, highlighting the need for targeted interventions to improve outcomes.

The overall complication rates observed in this study were consistent with global reports but higher than those documented in studies from high-income settings [7, 8]. Surgical emphysema, the most common complication (44.7%), has been reported in similar studies to occur at rates between 3–10% in settings utilizing advanced techniques of percutaneous tracheostomy or bronchoscopic guidance. Studies emphasized that complications like surgical emphysema can be minimized with precise surgical protocols and proper positioning of the tracheostomy tube[9-11].

Infections observed in 38.4% of patients in this study were significantly higher compared to the 10–20% reported in high-resource environments. This discrepancy aligns with studies that noted robust infection control measures, including prophylactic antibiotics and standardized postoperative care, are critical in reducing postoperative infections [12-14]. The high infection rates in this study suggest improving aseptic techniques and increasing awareness among healthcare providers and patients regarding postoperative care.

Tube obstruction (17.0%) was within the range reported in prior research. Studies show that regular suctioning, humidification, and patient education effectively minimize this complication [15, 16]. The findings reinforce the importance of consistent monitoring and timely intervention to prevent airway blockages caused by mucus or clots.

This study showed that rural residents experienced higher rates of surgical emphysema and infections compared to urban participants. Similar disparities were noted in studies that attributed such trends to differences in healthcare infrastructure, availability of trained personnel, and access to follow-up care[17, 18]. Addressing these disparities through targeted outreach programs, mobile healthcare units, and telemedicine could significantly improve outcomes for rural populations.

Age-specific differences were also observed, with younger patients (18–30 years) exhibiting higher rates of infections. This finding may correlate with delayed presentations, higher exposure to risk factors, or variations in immune response. Studies have shown that younger individuals may experience higher rates of infections due to inconsistent adherence to postoperative instructions, as reported by studies [19].

Females in this study showed higher rates of surgical emphysema, which is less frequently documented in existing literature. Studies suggest that anatomical differences or sociocultural factors, such as delayed healthcare access for females in certain regions, might contribute to this finding [20, 21]. Meanwhile, infections were more prevalent among males, which could be linked to lifestyle factors, including higher smoking rates or differences in occupational exposure to pathogens.

Compared to international studies, this research highlights the pressing need for improving surgical and postoperative care. Studies conducted in high-income countries report less than 20% overall complication rates, significantly lower than those observed here [22, 23]. The findings emphasize the importance of adopting evidence-based surgical practices, such as minimally invasive techniques and advanced monitoring systems.

Recommendations for improvement include incorporating minimally invasive approaches and using tools like bronchoscopic guidance, which can significantly reduce complications. These techniques not only decrease rates of surgical emphysema but also minimize intraoperative

challenges. Providing comprehensive postoperative monitoring, particularly in rural settings, is essential. Regular follow-up and telemedicine consultations can lower complication rates by over 30%. Educating healthcare providers, patients, and caregivers on tracheostomy care and early complication management can prevent infections and tube obstruction. Patient education programs reduced complication rates by improving adherence to care guidelines. Bridging the urban-rural healthcare divide by equipping rural facilities with trained personnel and essential resources is crucial. Outreach programs have successfully reduced disparities in complication rates.

CONCLUSION

The findings of this study highlight the high frequency of early complications following open surgical tracheostomy, with significant variations based on demographic factors. Addressing these challenges requires targeted strategies, including advanced surgical techniques, robust infection control measures, and improved rural healthcare infrastructure. Future research should focus on long-term outcomes and explore innovative technologies' potential to reduce complications further and enhance patient care.

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