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Research Article

ROLE OF EARLY VS LATE TRACHEOSTOMY IN SEVERE TRAUMATIC BRAIN INJURY OUTCOME TO CHECK IN HOSPITAL ICU STAY

Qasim Yab Khan[1]| Hafiz Anzal Farooqi[1]| Dr Muhammad Khalid[2]| Dr Zohaib Masood[3]| Saad Javed[4]| Adnan Wahab[1]| Anwaar Ul Mustafa[1]

[1]PGT, Neurosurgery, Rawalpindi Teaching Hospital
[2]Consultant Neuro-spine surgeon, CDA hospital, Islamabad
[3]Consultant Neurosurgeon, Brain Surgery Hospital Rawalpindi, Assistant Professor, Neurosurgery
[4]Consultant Neurosurgeon, Brain Surgery Hospital/CDA Hospital, Islamabad; Research Fellow at Violence, Injury Prevention & Disability Unit, Health Services Academy, Ministry of National Health Services, Regulations & Coordination, Islamabad, Pakistan. WFNS GNC Secretariat Team Member

Correspondence
Qasim Yab Khan
Email: qasimkhan117@gmail.com

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ABSTRACT:

Background: Traumatic brain injury (TBI) remains a major cause of morbidity and mortality worldwide, often necessitating prolonged ventilatory support and intensive care. Tracheostomy is commonly performed in such patients to facilitate airway management and weaning from mechanical ventilation. However, the optimal timing of tracheostomy—whether early or late—remains a matter of debate. This study aimed to compare the duration of intensive care unit (ICU) stay in patients with severe TBI undergoing early versus late tracheostomy. **Methods:** This analytical cross-sectional study was conducted in the Department of Neurosurgery, Rawalpindi Teaching Hospital, over six months. A total of 60 patients with severe TBI (Glasgow Coma Scale ≤8) requiring ventilatory support were included through non-probability consecutive sampling and divided equally into early tracheostomy (within 5 days of mechanical ventilation) and late tracheostomy (after 5 days) groups. Data regarding demographic variables, cause and type of injury, complications, and ICU stay were analyzed using SPSS v26. The independent samples t-test and chi-square test were applied, with $p < 0.05$ considered significant. **Results:** The mean age of participants was 44.6 ± 13.2 years, and 61.7% were male. Road traffic accidents accounted for most injuries (58.3%). The mean ICU stay was significantly shorter in the early tracheostomy group (7.25 ± 2.30 days) compared to the late group (16.90 ± 3.33 days; $p < 0.001$). Type of brain injury significantly affected ICU duration ($p = 0.008$), while baseline GCS showed no correlation with ICU stay ($p = 0.143$). **Conclusion:** Early tracheostomy in severe TBI patients significantly reduces ICU stay compared to late tracheostomy. Implementing early tracheostomy protocols may improve patient outcomes and optimize ICU resource utilization, particularly in resource-limited settings like Pakistan.

KEYWORDS: Traumatic brain injury, early tracheostomy, ICU stay, mechanical ventilation, neurosurgery

1 | INTRODUCTION

One of the main causes of illness in the globe is traumatic brain injury (TBI), especially affecting young adults and the elderly. It is estimated that approximately 69 million individuals sustain a TBI each year globally, with the incidence ranging from mild to severe cases [1]. Severe TBI, which accounts for a significant proportion of these cases, often requires intensive medical management due to the risk of life-threatening complications such as increased intracranial pressure (ICP), hypoxia, and cerebral ischemia. The burden of TBI is substantial, leading to prolonged hospital stays, long-term disability, and considerable economic impact [2]. Management of severe TBI focuses on both the prevention of secondary brain injury and the maintenance of physiological homeostasis. Primary injury occurs at the time of trauma and is irreversible, while secondary injury develops over hours to days after the initial insult, exacerbated by factors such as hypoxia, hypotension, and elevated ICP [3]. In the intensive care unit (ICU), maintaining an adequate airway and ensuring proper ventilation are crucial components of managing patients with severe TBI to prevent secondary injury. The management of airway and ventilation in patients with severe TBI is complex and often requires mechanical ventilation due to altered consciousness, which impairs the protective airway reflexes [4]. Risks including ventilator-associated

pneumonia (VAP) are linked to long-term mechanical ventilation, respiratory muscle weakness, and airway trauma. In critically ill patients, tracheostomy is often performed to facilitate long-term ventilation, improve comfort, reduce the risk of laryngeal injury from prolonged endotracheal intubation, and perhaps shorten the length of time spent in the intensive care unit and on mechanical ventilation [5]. Tracheostomy involves creating a surgical opening in the trachea to establish a direct airway. It is considered safer and more comfortable for long-term ventilated patients compared to endotracheal intubation. The procedure reduces airway resistance, enhances suctioning of secretions, and allows for easier weaning from the ventilator [6]. However, despite the advantages of tracheostomy in selected patients, the timing of the procedure, whether performed early or late during ICU treatment, remains a topic of ongoing debate. An early tracheostomy is typically performed during the first five days of mechanical breathing to minimize the need for sedation, shorten the length of time spent in the intensive care unit, and enable an earlier weaning off the ventilator. [7]The rationale behind early tracheostomy is that it provides a more stable airway and reduces the need for prolonged sedation and paralytic agents, which are commonly used to facilitate endotracheal intubation [8]. According to a study carried out in Iraq, that included 48 patients admitted to ICU with severe traumatic brain injury (24 underwent early tracheostomy and 24 underwent late tracheostomy), the length of ICU stay was significantly shorter in early group (12.70±1.80 versus 22.37±7.19 days; $p<0.05$).[9] This study addresses the critical question of whether early tracheostomy (within the first week) or late tracheostomy (beyond the first week) yields better outcomes in patients with severe traumatic brain injury (TBI), focusing on ICU stay duration. Tracheostomy is often necessary for TBI patients who require prolonged mechanical ventilation, yet the timing of this intervention remains debated, with studies showing mixed results. In Pakistan, where TBI cases are common and healthcare resources are limited, understanding the optimal timing could improve patient outcomes, reduce ICU burden, and inform local clinical protocols. By examining the impacts of early versus late tracheostomy in a cohort of severe TBI patients at Rawalpindi Teaching Hospital, this study seeks to generate evidence that may enhance clinical decision-making, streamline ICU resource use, and ultimately contribute to better management of TBI in resource-constrained settings.

2 | MATERIAL AND METHODS

This analytical cross-sectional study was conducted in the department of Neurosurgery, Rawalpindi Teaching Hospital, Rawalpindi. A total of 60 patients were included through non-probability consecutive sampling. Patients between 18 to 75 years of age, who presented to the emergency department with severe traumatic brain injury and were admitted to the ICU were included in the study. Whereas those with brain injuries resulting from non-traumatic causes, such as ischemic stroke, hypertensive bleeding, brain tumors, or infections were excluded. After receiving approval from the, the Ethical Review Board (ERB), and the International Research Form (IRF), this study was carried out at the department of neurosurgery. Patients admitted to the ICU with severe TBI were enrolled in the study based on the inclusion and exclusion criteria. Eligible patients were randomly divided into two groups for severe traumatic brain injury; Group 1: Patients undergoing early tracheostomy, Group 2: Patients undergoing late tracheostomy. These patients were followed throughout the course of their hospital stay to determine the number of days of ICU stay after tracheostomy.

2.1 | Statistical Analysis

IBM SPSS Statistics Software (v.26) was used to conduct statistical analysis. Whereas the mean ± standard was used to describe continuous variables like age, GCS and number of days of ICU stay, frequency and percentages were used to explain categorical variables like gender and type of injury, causes of brain injury and complications. ICU length of stay was compared between the early and late tracheostomy groups using the independent samples t-test. $P<0.05$ was taken as a level of significance.

3 | RESULTS

This study included 60 traumatic brain injury (TBI) patients in total. The majority (41.7%, n = 25) were in the 41–50 age bracket, with the mean age being 44.6 years (ranging from 18–72 years). 61.7% (n=37) of the patients were male, while 38.3% (n=23) were females. The number of patients in the early tracheostomy (n = 30) and late tracheostomy (n = 30) groups were equal. 55.2% of patients had a Glasgow Coma Scale (GCS) score of 6–8 upon admission, while 44.8% had a score of 3–5. Road traffic accidents were the leading cause of TBI (58.3%), followed by assaults (16.7%) and falls (21.7%). The most common injury type was diffuse axonal damage (40.0%), which was followed by acute subdural hematoma (23.3%). This is shown in more detail in Table 1. The most frequent complication during ICU stay was airway obstruction in 50% patients, followed by bleeding in 27.6% cases, as shown in Table 2.

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Table 1 Type of Injury

Variables	Frequency	Percent	Valid Percent	Cumulative Percent
Diffuse axonal injury	24	40.0	40.0	40.0
Acute subdural hematoma	14	23.3	23.3	63.3
Intracranial bleed	10	16.7	16.7	80.0
Intracranial bleed with intraventricular hemorrhage	12	20.0	20.0	100.0
Total	60	100.0	100.0	

Table 2 Type of Brain Injury

Variables	Frequency	Percent	Valid Percent	Cumulative Percent
Bleeding	16	26.7	27.6	27.6
Airway obstruction	29	48.3	50.0	77.6
Both bleeding & airway obstruction	7	11.7	12.1	89.7
None	6	10.0	10.3	100.0
Total	58	96.7	100.0	
Missing	2	3.3		
Total	60	100.0		

3.1 | Complications during ICU stay

The mean ICU stay was 12.16 ± 5.63 days (range 3–23 days; mode 6 days). Patients in early tracheostomy group had a mean ICU stay of 7.25 ± 2.30 days, whereas late tracheostomy patients stayed an average of 16.90 ± 3.33 days. This difference was shown to be statistically significant by the independent samples t-test ($t = –12.67$, $df = 55$, $p < 0.001$; 95% CI –11.17 to –8.12). For statistical purposes, No. of days of ICU stay were grouped into categories: 1-5 days, 6-10 days, 11-15 days, 16-20daysy, 21 or more days. Categorical analysis was done, which again yielded results like that of t-test: most early tracheostomy patients were discharged within 6–10 days, whereas all late tracheostomy patients required ≥11 days of ICU care ($\chi^2 = 50.23$, $p < 0.001$). The baseline GCS score and ICU stay did not significantly correlate (Mann–Whitney $U = 288.5$, $p = 0.143$). However, the type of injury had a significant impact on the length of stay in an intensive care unit as shown by ANOVA ($F(3,54) = 4.379$, $p = 0.008$).

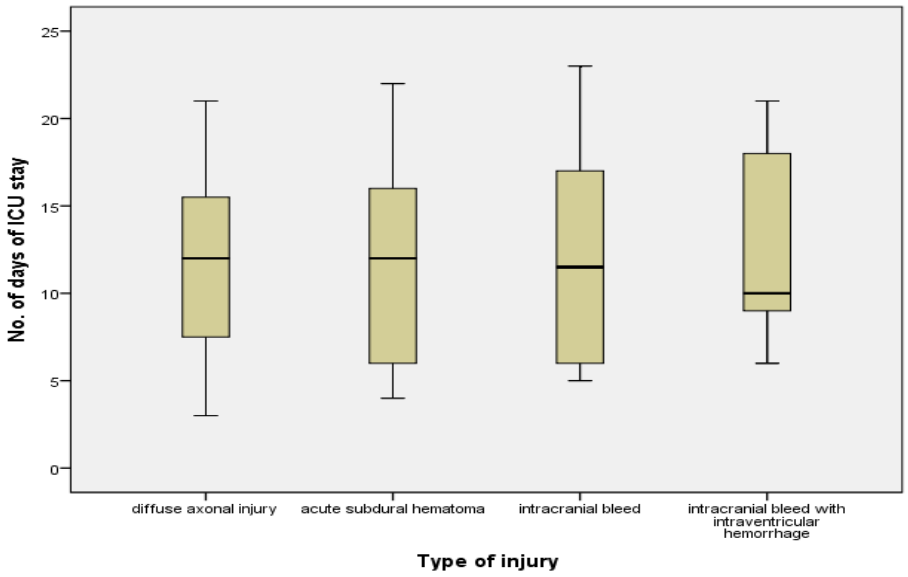

Figure 1: No. of days of ICU stay across various types of injury

An interesting finding of detailed analysis was that a significant correlation was seen between the type of brain injury and the GCS at presentation. Patients with higher GCS scores were more likely to have diffuse axonal injury, whereas those with lower GCS were more likely to have intraventricular hemorrhage ($\chi^2 = 11.35$, $p = 0.010$).

4 | DISCUSSION

This study evaluated the impact of tracheostomy timing on intensive care unit (ICU) stay in patients with severe traumatic brain injury (TBI). The results supported the hypothesis that early airway intervention improves ICU outcomes by showing that patients who received an early tracheostomy (within 5 days of mechanical breathing) had a considerably shorter ICU stay than those who had a late tracheostomy. The early group's mean ICU stay (7.25 ± 2.30 days) was almost half that of the late group (16.90 ± 3.33 days), which is consistent with earlier research supporting early tracheostomy as a way to ease weaning, lessen sedation, and use fewer ICU resources. The study's age and gender distribution (mean age 44.6 years; male 61.7%) is in line with epidemiological data from Pakistan and around the world, which show that TBI primarily affects young to middle-aged males because of increased exposure to road traffic.[2] According to Selvakumar et al in the UK and Marra et al in Italy, who also noted that road traffic collisions were the most common mechanism of severe TBI.[10,11] Likewise, in our study, road traffic accidents were the primary cause of traumatic brain injury (58.3%).

Our findings are consistent with recent research from Pakistan. Raza et al conducted a multicenter observational study at tertiary institutions in Karachi and Lahore, which found that early tracheostomy among TBI and stroke patients dramatically decreased ventilator dependency and ICU stay.[12] Similarly , Naseer et al at Lady Reading Hospital in Peshawar discovered that the mean length of time spent in the intensive care unit for early versus late tracheostomy was 9.2 ± 3.4 days ($p < 0.001$).[13] By lowering sedative exposure, simplifying secretion control, and promoting early weaning, these national data support our results that early tracheostomy is advantageous even in intensive care units with limited resources. In Iraq, Abdul-Samad et al reported mean intensive care unit stays of 12.7 ± 1.8 days for early tracheostomy and 22.4 ± 7.2 days for late tracheostomy ($p < 0.05$), which is consistent with our results.[9] Likewise, Gupta et al in India noted shorter ventilator and intensive care unit stays in early tracheostomy groups, highlighting fewer airway problems and a lower requirement for sedation.[6] However, a research conducted in the USA by Wallen et al found that although early tracheostomy decreased the need for sedation, it had no discernible effect on the length of the ICU stay.[8] This disparity could be caused by variations in intensive care unit procedures, the severity of injuries, and extubation thresholds in resource-rich versus resource-limited settings.

Early tracheostomy (≤ 7 days) significantly reduced the length of ICU stay and mechanical ventilation duration as compared to delayed interventions, according to a 2024 meta-analysis by Merola et al. that included 2,700 ICU patients worldwide.[7] Similarly, Smailes et al showed benefits across many critical care groups by reporting that early tracheostomy enhanced respiratory rehabilitation outcomes in burn ICU patients.[1] All of these research, along with our own, support the idea that early tracheostomy improves intensive care unit efficiency and may lessen healthcare costs without having a negative impact on survival. The type of brain damage and length of stay in the intensive care unit were also found to be significantly correlated in our study. Diffuse axonal injury was linked to a higher GCS and a shorter ICU stay, but intraventricular hemorrhage resulted in a longer ventilation and stay. According to Marra et al, individuals with diffuse axonal injury typically needed less intensive care unit assistance than those with mass lesions.[10] On the other hand, our group showed no association between baseline GCS and ICU length, indicating that tracheostomy timing has a greater impact on ICU stay than patients' initial neurological condition.

5 | LIMITATIONS

This study was conducted at a single centre and included only a limited No. of patients. This limits the generalization of study results.

6 | CONCLUSION

This study supports the growing consensus that early tracheostomy in severe TBI patients significantly reduces ICU stay and may enhance recovery by optimizing airway management and reducing sedation. Adoption of early tracheostomy protocols in Pakistani ICUs could yield substantial benefits in patient outcomes and healthcare resource allocation.

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Disclaimer

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Conflict of Interest

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Ethical Approval: Ethical Review Board (ERB), and the International Research Form (IRF),

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Appendix

Role of early vs late tracheostomy in severe traumatic brain injury Outcome to check in hospital ICU stay

Study Performa

Age:

- 18-30

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- 31-40
- 41-50
- 51-60
- 61 and above

Gender:

- Male
- Female
- Other

Study groups 1) Early Tracheostomy (within the first 5 days) 2) Late Tracheostomy (after 5 days)

Initial Glasgow Coma Scale (GCS) Score on Admission:

- 3-5
- 6-8

Cause of Traumatic Brain Injury:

- Road traffic accident
- Fall
- Assault
- Sports injury
- Other: _____

Total Length of ICU Stay (in days): _____

Complications During ICU Stay:

(Please check all that apply)

- Bleeding
- Airway obstruction
- None

Type of Injuries:

- Diffuse axonal injury
- Acute Subdural hematoma
- Intracerebral Bleed
- Intracerebral Bleed e IVH intraventricular hemorrhage