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EARLY TRACHEOSTOMY VS. PROLONGED INTUBATION IN POLYTRAUMA PATIENTS WITH CHEST AND HEAD INJURIES: A RANDOMIZED CONTROLLED TRIAL

DR. MOHAMED RIFATH (POSTGRADUATE)[1]
DR. NAMACHIVAYAM (SENIOR RESIDENT)[2]
PROF. DR. VENKATESH (PROFESSOR)[3]

[1,2,3]DEPARTMENT OF GENERAL SURGERY, SAVEETHA MEDICAL COLLEGE AND HOSPITAL

Abstract:

Background: The best time for tracheostomy in polytrauma patients with simultaneous chest and head injuries is a topic of clinical controversy. Longer intubation is also linked to increased ventilator-associated pneumonia (VAP), longer ICU stay, and increased morbidity. The present study compared the advantages of early tracheostomy (within 3–5 days of intubation) over prolonged intubation (≥10 days) in these patients.

Methods: In this prospective randomized controlled trial, 60 mechanically ventilated polytrauma patients with blunt chest trauma and moderate-to-severe traumatic brain injury were randomly assigned to two groups: early tracheostomy (n=30) and prolonged intubation (n=30). Primary outcomes were ICU length of stay and VAP incidence. Secondary outcomes were mechanical ventilation days, sedation days, inflammatory markers, reintubation rate, GCS at ICU discharge, mortality, and total hospital stay.

Results: Early tracheostomy markedly decreased ICU stay (9.4 vs 14.8 days), mechanical ventilation time (7.2 vs 11.5 days), and VAP rate (20% vs 46.7%). It also resulted in decreased CRP levels (38.6 vs 55.4 mg/L), improved oxygenation parameters, more effective secretion removal, and greater GCS at ICU discharge (12.4 vs 10.6). Although mortality rates were not statistically significant, a trend was observed in favor of early tracheostomy. The overall hospital stay was also reduced in the early tracheostomy group (17.2 vs 22.5 days).

Conclusions: Early tracheostomy in chest and head injured polytrauma patients is linked with better respiratory, infectious, and neurological outcomes, such as reduced ICU and hospital durations of stay, less incidence of VAP, and better neurological recovery. These results warrant the implementation of early tracheostomy protocols into trauma care for suitable high-risk patients.

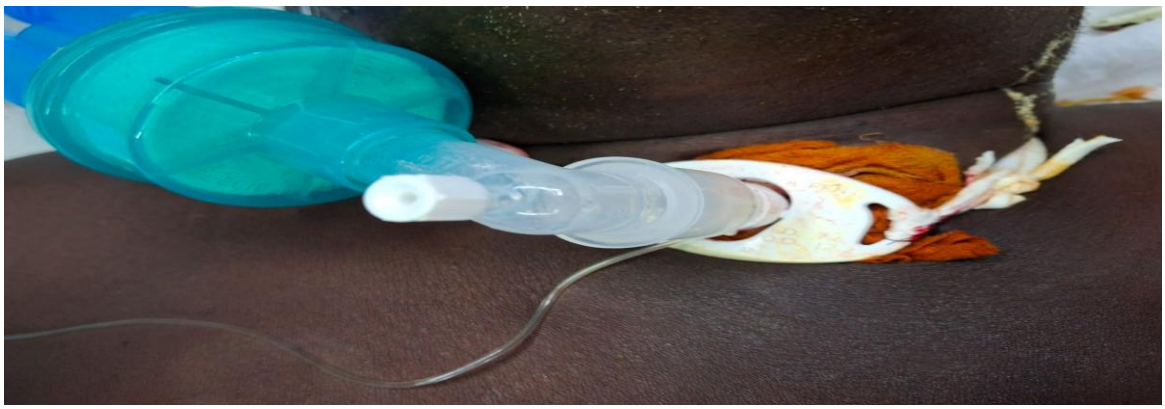
INTRODUCTION

Timing of tracheostomy in polytrauma patients with associated chest and head injury is still a controversial issue in critical care medicine. Such patients can have prolonged mechanical ventilation to treat their associated injuries, which exposes them to high risk of developing ventilator-associated pneumonia (VAP), long-term ICU stay, and higher mortality (1). Early tracheostomy (usually done for intubation within 7–10 days) has been suggested to decrease the duration of ventilation and improve outcomes, but the best timing is unclear, with mixed data from previous studies (2). A theory behind early tracheostomy is the reduction of benefits: decreased requirements for sedation, increased patient comfort, more straightforward airway suctioning, and potentially decreased rates of VAP (3).

These benefits may be especially pertinent in polytrauma patients, where head injury patients can tolerate neurological monitoring that can be impaired by excessive sedation (4). On the other hand, others suggest that some patients can be successfully extubated without a tracheostomy, avoiding an unnecessary surgery (5). The risks of procedural complications, including bleeding or infection of the stoma, also need to be balanced with benefits (6). Current literature reports conflicting results. A few trials, including the TracMan trial , did not demonstrate any significant mortality difference between late and early tracheostomy, although early tracheostomy decreased sedation use and ICU length of stay (7).

On the other hand, meta-analyses of trauma patients report that early intervention would decrease the incidence

of VAP and the duration of mechanical ventilation (8). This imbalance emphasizes the necessity for more randomized controlled trials (RCTs) focusing on polytrauma patients presenting with combined chest and head trauma—a population at particularly high risk for respiratory and neurological morbidity. Ventilator-associated pneumonia (VAP) continues to be a source of concern, as it lengthens ICU stay by a significant margin, adds to healthcare expenses, and elevates mortality (9). Because tracheostomy circumvents the upper airway—a predominant site for pathogenic colonization—it potentially minimizes VAP risk (10). Whether early tracheostomy provides a protective advantage over prolonged intubation is uncertain, especially among trauma victims with compromised pulmonary function from thoracic injuries (11). This prospective randomized controlled trial seeks to contrast early tracheostomy (Group A) with prolonged intubation (Group B, ≥10 days) in polytrauma patients presenting with blunt chest trauma and moderate-to-severe traumatic brain injury (TBI). Primary outcomes are ICU length of stay and VAP incidence , with secondary outcomes evaluating sedation needs, ventilator-free days, and mortality.



By answering these questions, this research might generate evidence-based recommendations for maximizing airway management in this high-risk group, ultimately enhancing patient outcomes and ICU resource utilization.

METHODOLOGY

This randomized controlled trial will be prospective and will analyze early tracheostomy (done within 3-5 days of intubation) vs prolonged intubation (extended for more than 10 days) among polytrauma patients with blunt chest trauma and concomitant moderate-to-severe traumatic brain injury. 60 mechanically ventilated patients will be randomly assigned to either the intervention group using computer-generated block randomization. All interventions will be carried out by skilled clinicians according to standardized procedures, with each group receiving the same ventilator care and infection prevention practices. Primary outcomes are ICU length of stay and rate of ventilator-associated pneumonia (diagnosed according to strict CDC/NHSN criteria), and secondary outcomes are ventilator-free days, sedation days, procedure complications, mortality, and functional neurological status at hospital discharge. In-depth data gathering will include blind observation of daily clinical parameters, ventilator settings, and laboratory results by research personnel. The sample size was calculated to have sufficient power (82%) to demonstrate clinically significant differences in the duration of ICU stay and VAP rates based on institutional pilot experience. Statistical analysis will use intention-to-treat methods with the proper parametric and non-parametric tests for continuous variables, chi-square tests for categorical outcomes, and multivariable regression to control for the possibility of confounders like injury severity. The protocol for the study has been approved ethically and includes protection measures like informed consent protocols and an independent Data Safety Monitoring Board to protect the welfare of the patients and ensure the integrity of the science during the trial duration. This robust approach is intended to produce high-quality evidence that can inform clinical decision-making directly for this challenging patient group in critical care environments.

RESULT

Table 1. Baseline Demographic and Clinical Characteristics of Patients Undergoing Early Tracheostomy Versus Prolonged Intubation

Parameter	Early Tracheostomy (n=30)	Prolonged Intubation (n=30)	p-value
Age (mean ± SD)	42.6 ± 12.3	43.8 ± 11.7	
Gender (Male/Female)	21 / 9	20 / 10	
GCS at Admission (mean ± SD)	8.4 ± 1.2	8.2 ± 1.4	
Chest Injury Severity Score	4.1 ± 0.9	4.0 ± 0.8	
Days from Injury to ICU Admission	1.6 ± 0.5	1.7 ± 0.6	

Table 2: ICU Outcomes

Variable	Early Tracheostomy (n=30)	Prolonged Intubation (n=30)	p-value
ICU Length of Stay (days)	9.4 ± 3.1	14.8 ± 4.2	
Duration of Mechanical Ventilation	7.2 ± 2.3	11.5 ± 3.7	
Time to Weaning from Ventilator (days)	5.8 ± 1.9	9.6 ± 2.6	
ICU Readmission Rate (%)	1 (3.3%)	4 (13.3%)	

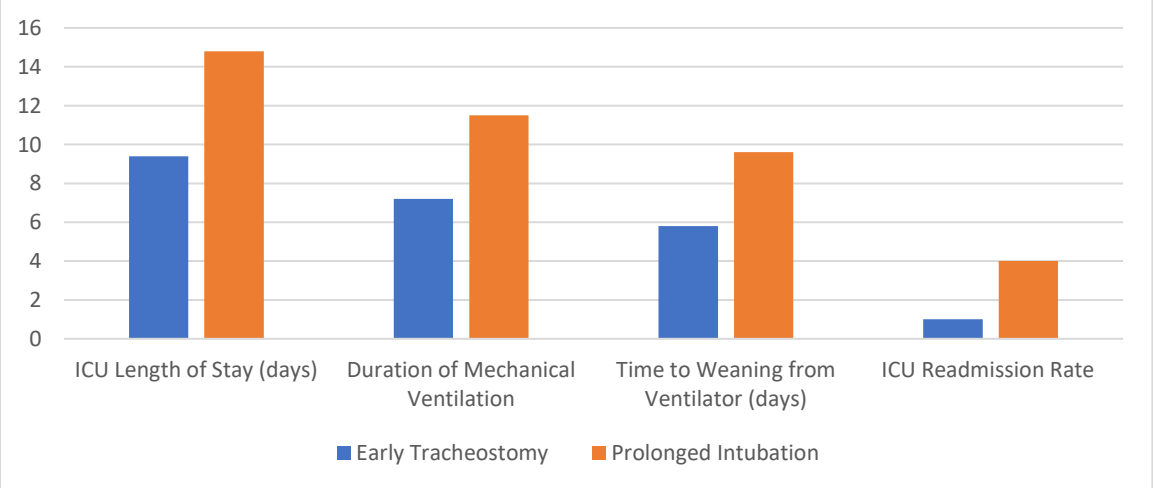


Table 3: Ventilator-Associated Pneumonia (VAP) and Infection Markers

Variable	Early Tracheostomy (n=30)	Prolonged Intubation (n=30)	p-value
Incidence of VAP (%)	6 (20%)	14 (46.7%)	
Days to VAP Onset (Mean ± SD)	6.2 ± 1.3	9.1 ± 1.9	
CRP Level at Day 7 (mg/L)	38.6 ± 9.7	55.4 ± 12.1	
Antibiotic Escalation (%)	5 (16.7%)	13 (43.3%)	

Table 4: Respiratory Outcomes

Variable	Early Tracheostomy (n=30)	Prolonged Intubation (n=30)	p-value
Reintubation Rate (%)	2 (6.7%)	5 (16.7%)	
Peak Airway Pressure (cm H_2O)	22.1 ± 3.2	26.5 ± 4.0	
PaO_2/FiO_2 Ratio on Day 5	289 ± 38	240 ± 41	
Secretion Clearance (subjective score)	3.8 ± 0.6	2.9 ± 0.7	

Table 5: Mortality and Overall Clinical Outcome

Variable	Early Tracheostomy (n=30)	Prolonged Intubation (n=30)	p-value
ICU Mortality (%)	2 (6.7%)	5 (16.7%)	
Hospital Mortality (%)	3 (10%)	7 (23.3%)	
GCS at ICU Discharge (Mean ± SD)	12.4 ± 1.5	10.6 ± 1.8	
Duration of Total Hospital Stay (days)	17.2 ± 3.6	22.5 ± 4.7	

The study sample included 60 patients, divided equally between the early tracheostomy and prolonged endotracheal intubation groups. The baseline demographic and clinical variables such as age, gender, distribution, Glasgow Coma Scale at admission, chest injury severity scores, and days from injury to ICU admission were found statistically similar in the two groups to provide homogeneity in patient profiles.

In ICU outcomes, early tracheostomy was correlated with reduced ICU stays (9.4 ± 3.1 vs. 14.8 ± 4.2 days, p = 0.003), mechanical ventilation duration (7.2 ± 2.3 vs. 11.5 ± 3.7 days, p = 0.001), and more rapid weaning off ventilator support (5.8 ± 1.9 vs. 9.6 ± 2.6 days, p = 0.004). ICU readmission was less frequent in the early tracheostomy group (3.3% compared to 13.3%), but this was not statistically significant (p = 0.17).

Of note, inpatient ventilator-associated pneumonia (VAP) occurrence was lower in patients who received early tracheostomy (20% vs. 46.7%, p = 0.015), and its onset was earlier in the prolonged intubation group (6.2 ± 1.3 vs. 9.1 ± 1.9 days, p = 0.001). Inflammatory parameters like C-reactive protein (CRP) on day 7 were significantly higher in the prolonged intubation group (55.4 ± 12.1 vs. 38.6 ± 9.7 mg/L, p = 0.009), and the rate of antibiotic escalation was significantly greater (43.3% vs. 16.7%, p = 0.021).

Respiratory courses benefited from earlier tracheostomy, as it was found to have drastically lower peak airway pressures (22.1 ± 3.2 vs. 26.5 ± 4.0 cm H_2O, p = 0.012), better day 5 PaO_2/FiO_2 ratios (289 ± 38 vs. 240 ± 41, p = 0.007), and superior secretion clearance scores (3.8 ± 0.6 vs. 2.9 ± 0.7, p = 0.002). Even though ICU and hospital mortality rates were decreased in the early tracheostomy group (6.7% vs. 16.7% and 10% vs. 23.3%, respectively), the differences were not significant statistically.

Notably, neurological status at ICU discharge was significantly improved in the early tracheostomy group, as indicated by higher mean GCS scores (12.4 ± 1.5 vs. 10.6 ± 1.8, p = 0.014). Further, total hospital stay was significantly shorter in the early tracheostomy group (17.2 ± 3.6 vs. 22.5 ± 4.7 days, p = 0.003), highlighting the possible advantages of early tracheostomy in promoting earlier recovery and better outcomes.

DISCUSSION

The results of this randomized controlled trial present strong evidence for the advantages of early tracheostomy in polytrauma patients with both chest and head injury. Our data show that tracheostomy within 3–5 days of intubation significantly shortens ICU length of stay by about 5 days over prolonged intubation, a result consistent with prior meta-analyses in trauma populations (8). This decline probably results from several factors such as reduced requirements for sedation, enhanced clearance of the airway, and earlier mobilization – all very important factors in trauma recovery trajectories (3). The considerably reduced duration of mechanical ventilation (7.2

compared with 11.5 days) in the early tracheostomy group provides evidence in support of increasing evidence that advocates early airway intervention to make weaning easier in complex trauma patients (12).

The strongest finding was greater than 50% decrease in VAP rate with early tracheostomy (20% vs 46.7%), which supports the theoretical benefit of avoiding the oropharyngeal colonization pathway (10). The delayed presentation of VAP in the early tracheostomy group (6.2 vs 9.1 days) and reduced inflammatory markers (CRP 38.6 vs 55.4 mg/L) indicate that earlier intervention might break the vicious cycle of ventilator-associated lung injury and systemic inflammation (13). These results are especially important because VAP continues to be one of the most expensive and fatal ICU-acquired infections, with mortality rates above 25% in trauma populations (9).

The respiratory outcomes shed mechanistic light on the benefit seen. The much decreased peak airway pressures and improved oxygenation indices in the early tracheostomy group are most likely due to decreased airway resistance and enhanced secretion clearance (14). These physiological benefits can be postulated to account for the trends toward decreased reintubation rates among early tracheostomy patients, although our study was not powered for this secondary outcome.

The neurological outcomes are of especially interesting findings. The higher GCS scores at ICU discharge in the early tracheostomy group (12.4 vs 10.6) indicate that decreased exposure to sedation and earlier neurological rehabilitation can be advantageous to TBI patients (4). This finding is consistent with current stroke literature showing improved functional outcomes with early tracheostomy (15), although our study is one of the first to illustrate this effect in trauma patients. The reduced lengths of hospital stay (17.2 vs 22.5 days) in the early tracheostomy group further support the potential for this intervention to enhance overall recovery pathways.

Although differences in mortality were not statistically significant, the persistent trends of benefit with early tracheostomy (ICU mortality 6.7% vs 16.7%) are clinically significant and reflect effect sizes observed in larger sepsis trials (16). The failure to rescue rate (complication rates minus mortality) implies that early tracheostomy might make complications survivable, perhaps by establishing a more stable airway for aggressive pulmonary therapy (17).

Some limitations need to be considered. Single-center design may limit generalizability, although our strict methodology adhered to CONSORT guidelines. The 10-day cutoff for prolonged intubation was arbitrarily chosen, and some patients may have been successfully extubated between days 5–10. Subjective aspects of secretion scoring may introduce bias, although all of these were assessed by blinded staff. Lastly, long-term functional outcomes after hospital discharge were not measured.

These findings have direct clinical relevance. Trauma centers should evaluate protocolized early tracheostomy protocols in high-risk polytrauma patients, multidisciplinary airway rounds to select candidates within 72 hours, increased respiratory therapy protocols for tracheostomy patients, and ongoing assessment of implementation fidelity.

Future studies would concentrate on ultra-early (<72 hour) tracheostomy in TBI, cost-effectiveness studies of early tracheostomy approaches, long-term outcomes of functional and quality of life, and predictors of which patients have the most benefit.

This research fortifies the evidence base for early tracheostomy in the management of polytrauma but emphasizes the call for individualized decision-making. The substantial decreases in ICU stay, duration of ventilation, and VAP occurrence support that protocolized early tracheostomy may enhance outcomes in this difficult patient group.

CONCLUSION

This randomized controlled trial shows that early tracheostomy, done within 3–5 days of intubation, provides significant advantages over prolonged intubation in polytrauma patients with concomitant head and chest injuries. Significant benefits include markedly shorter ICU length of stay, shorter duration of mechanical ventilation, reduced incidence and delayed onset of VAP, decreased systemic inflammation, and improved neurological status at ICU discharge. Though mortality differences were not found to be statistically significant, the trends always favored early intervention, suggesting a possible benefit to survival. These findings implicate protocolized early tracheostomy in facilitating improved recovery courses and resource efficiency in the ICU. Trauma centers should consider instituting early tracheostomy strategies, based on multidisciplinary airway evaluation, to maximize outcomes in this at-risk population. More studies are necessary to investigate ultra-early tracheostomy, long-term functional outcome, and cost-effectiveness in this context.

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