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Original Research Article

COMPARISON OF EARLY TRACHEOSTOMY, LATE TRACHEOSTOMY, AND PROLONGED ENDOTRACHEAL INTUBATION IN PATIENTS REQUIRING PROLONGED MECHANICAL VENTILATION

Parimala Devi G[1], Sengottuvelu P[2], Usha S[1], Athira B Sankar[3]

[1]Assistant Professor, Upgraded Institute of Otorhinolaryngology, Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai, Tamilnadu, India
[2]Associate Professor, Upgraded Institute of Otorhinolaryngology, Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai, Tamilnadu, India
[3]Postgraduate, Upgraded Institute of Otorhinolaryngology, Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai, Tamilnadu, India

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Corresponding Author:
Dr. Athira B Sankar,
Email: athirabsankar@gmail.com

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ABSTRACT

Background: Prolonged mechanical ventilation often necessitates prolonged endotracheal intubation, which is associated with airway-related complications. The optimal timing of tracheostomy remains controversial. This study compared the clinical outcomes of early tracheostomy, late tracheostomy, and prolonged endotracheal intubation in patients requiring prolonged mechanical ventilation. **Materials and Methods:** This ambispective comparative study included 100 patients requiring prolonged mechanical ventilation admitted to a tertiary care centre between May 2016 and October 2017. Patients were categorized into early tracheostomy (n=47), late tracheostomy (n=25), and prolonged endotracheal intubation (n=28) groups. Clinical outcomes, procedural complications, reintubation, videolaryngoscopic findings, and subgroup outcomes according to age and diagnosis were compared. **Result:** Of the 100 patients, 72 underwent tracheostomy, including 47 (65.28%) early and 25 (34.72%) late procedures. Early tracheostomy was associated with shorter duration of mechanical ventilation (10.42±4.72 vs. 20.86±8.30 days; p=0.001), ICU stay (13.07±7.07 vs. 27.00±10.62 days; p<0.001), and hospital stay (19.29±8.76 vs. 32.60±10.59 days; p<0.001). Reintubation occurred in 17.02%, 48.00%, and 50.00% of the early, late, and prolonged intubation groups, respectively (p=0.003). Normal videolaryngoscopy at one month was observed in 85.10%, 56.00%, and 21.43% of patients, respectively (p=0.001), while differences were not significant at six months (p=0.09). Clinical outcomes were not significantly associated with age (p=0.41) or diagnosis (p=0.26). **Conclusion:** Early tracheostomy was associated with shorter ventilatory support, reduced ICU and hospital stay, lower reintubation rates, and improved early airway outcomes compared with late tracheostomy and prolonged endotracheal intubation. Early tracheostomy may therefore be considered a safe and effective airway management strategy in patients requiring prolonged mechanical ventilation.

INTRODUCTION

Prolonged mechanical ventilation is frequently required in critically ill patients who are unable to maintain adequate spontaneous breathing because of respiratory failure, neurological impairment, poisoning, trauma, or other severe medical conditions. Although endotracheal intubation is the standard method for establishing an airway during the initial phase of mechanical ventilation, prolonged translaryngeal intubation is associated with several complications, including laryngeal edema, vocal cord injury, tracheal ulceration, ventilator-associated pneumonia, patient discomfort, and difficulty in weaning from ventilatory support. Therefore, selecting the most appropriate long-term airway management strategy is an important aspect of critical care.[1-3]

Tracheostomy is a well-established surgical procedure that provides a secure airway by creating a direct opening into the trachea. Compared with prolonged endotracheal intubation, tracheostomy offers several potential advantages, including

improved patient comfort, reduced airway resistance, enhanced clearance of respiratory secretions, facilitation of oral hygiene, decreased need for sedation, and easier weaning from mechanical ventilation. These benefits may contribute to earlier mobilization, shorter intensive care unit (ICU) stay, and improved overall patient recovery. Tracheostomy is also associated with procedural and postoperative complications such as bleeding, tube obstruction, tube displacement, infection, tracheal stenosis, and laryngeal injury.[2,3]

The optimal timing of tracheostomy in patients requiring prolonged mechanical ventilation remains a subject of ongoing debate. Early tracheostomy has been suggested to reduce the duration of mechanical ventilation, ICU stay, and hospital stay while facilitating earlier rehabilitation and improving patient comfort.[4] In contrast, delaying tracheostomy may avoid unnecessary procedures in patients who recover rapidly but may also prolong exposure to complications related to endotracheal intubation. Previous studies have reported conflicting findings regarding the influence of tracheostomy timing on mortality, ventilator-associated complications, and long-term airway outcomes, and a clear consensus has not yet been established.[5-7]

Assessment of airway morbidity following prolonged intubation and tracheostomy has become important. Videolaryngoscopy provides a reliable method for evaluating laryngeal and tracheal injuries, including glottic and supraglottic lesions, during follow-up. Understanding whether demographic factors such as age and underlying diagnosis influence clinical outcomes may help clinicians identify patients who are more likely to benefit from specific airway management strategies.[8-10]

Considering the continuing uncertainty regarding the optimal timing of tracheostomy and the limited evidence comparing early tracheostomy, late tracheostomy, and prolonged endotracheal intubation within the same cohort, the present study was undertaken. This study compares the clinical outcomes of these three airway management strategies in patients requiring prolonged mechanical ventilation. The study also evaluated procedural complications, airway outcomes assessed by videolaryngoscopy, and the association of age and underlying diagnosis with clinical outcomes to provide evidence that may assist clinicians in optimising airway management in critically ill patients.

Aim: To compare the clinical outcomes of early tracheostomy, late tracheostomy, and prolonged endotracheal intubation in critically ill patients requiring prolonged mechanical ventilation.

Objectives

1. To compare the duration of mechanical ventilation, intensive care unit stay, and hospital stay among patients undergoing early tracheostomy, late tracheostomy, and prolonged endotracheal intubation.
2. To compare tracheostomy-related procedural complications, reintubation, hospital outcomes, and airway complications assessed by videolaryngoscopy among the study groups.
3. To evaluate the association of age group and underlying diagnosis with clinical outcomes in patients requiring prolonged mechanical ventilation.

MATERIALS AND METHODS

This Ambispective Comparative study was conducted at Rajiv Gandhi Government General Hospital, Chennai, in collaboration with the Upgraded Institute of Otorhinolaryngology (UIORL) and the Department of Internal Medicine. The study was carried out over a period of 18 months from May 2016 to October 2017 after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all legally authorised representatives of the patients before participation.

Sample Size: A total of 100 patients requiring prolonged mechanical ventilation were included in the study.

Inclusion and Exclusion Criteria

Patients aged more than 15 years of either sex who required prolonged mechanical ventilation were eligible for inclusion.

Patients younger than 15 years, those with laryngotracheal trauma, and patients with malignant lesions of the larynx were excluded from the study.

Methods: After obtaining Institutional Ethics Committee approval, eligible patients were recruited according to the predefined inclusion and exclusion criteria. Demographic details, clinical history, diagnosis, and Glasgow Coma Scale (GCS) scores were recorded. Patients were categorized into three groups according to airway management strategy: early tracheostomy (≤7 days after intubation), late tracheostomy (>7 days after intubation), and prolonged endotracheal intubation without tracheostomy.

Prolonged mechanical ventilation was defined as ventilatory support required for 24 hours to 21 consecutive days for at least six hours per day. A spontaneous breathing trial (SBT) was attempted on the third day of mechanical ventilation to assess readiness for extubation. Patients who successfully tolerated spontaneous breathing for 30–120 minutes without respiratory distress, haemodynamic instability, or impaired gas exchange were considered suitable for extubation. Failure of the spontaneous breathing trial due to upper airway obstruction, ineffective cough, excessive secretions, impaired airway reflexes, respiratory muscle weakness, aspiration, or newly developed respiratory pathology necessitated either continuation of endotracheal intubation or tracheostomy.

Early tracheostomy was defined as tracheostomy performed within seven days of endotracheal intubation, whereas late tracheostomy was defined as

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tracheostomy performed after seven days. All tracheostomies were performed under local anaesthesia using a standard open surgical technique. A vertical skin incision was made within Jackson's safety triangle, followed by separation of the strap muscles, identification and retraction of the thyroid isthmus, and creation of a tracheal window between the second and third tracheal rings. An appropriately sized Portex cuffed tracheostomy tube was inserted, haemostasis was secured, and the wound was closed in layers. Procedural complications including bleeding, tube displacement, false passage, tube blockage, and desaturation were documented.

Standard postoperative tracheostomy care included cuff pressure management, humidification, regular suctioning, and routine airway care according to institutional protocol. Patients were gradually weaned from mechanical ventilation once they fulfilled predefined clinical criteria, including haemodynamic stability, adequate arterial blood gas parameters, absence of respiratory distress, restoration of protective airway reflexes, and effective expectoration.

Outcome measures included duration of mechanical ventilation, duration of ICU stay, duration of hospital stay, timing of tube change, reintubation, in-hospital complications, mortality, and discharge outcomes. Patients were also followed after discharge with videolaryngoscopic examination at one month and six months to assess laryngeal and tracheal complications, including glottic injury, supraglottic injury, airway stenosis, and overall airway healing. Subgroup analyses were also performed to evaluate the association between age group, underlying diagnosis, and clinical outcomes.

Statistical Analysis: The collected data were analysed using SPSS software. Continuous variables were expressed as mean ± SD or median (range), while categorical variables were presented as frequencies and percentages. Comparisons were performed using one-way ANOVA or appropriate non-parametric tests for continuous variables and the Chi-square test for categorical variables. A p-value <0.05 was considered statistically significant.

RESULTS

Among the 100 patients, 47 underwent early tracheostomy, 25 underwent late tracheostomy, and 28 remained on prolonged endotracheal intubation. Males predominated in all groups (70.21%, 64.00%, and 75.00%). Toxicology was the most common diagnosis (53.19%, 36.00%, and 71.43%). The mean GCS on day 1 was 7.15 ± 1.29, 6.88 ± 1.09, and 6.96 ± 1.04, while the mean GCS on day 3 was 6.48 ± 1.11, 6.08 ± 0.81, and 6.57 ± 2.28 in the early, late, and prolonged groups, with no significant differences (p=0.61 and p=0.44) [Table 1].

Table 1: Baseline Demographic and Clinical Characteristics

	Variable	Early (n=47)	Late (n=25)	Prolonged (n=28)	p-value
Gender	Male, n (%)	33 (70.21%)	16 (64.00%)	21 (75.00%)	–
	Female, n (%)	14 (29.79%)	9 (36.00%)	7 (25.00%)	
	≤20	2 (4.26%)	0 (0%)	3 (10.71%)	
Age group (years)	20–30	10 (21.28%)	4 (16.00%)	10 (35.72%)	–
	30–40	12 (25.52%)	7 (28.00%)	8 (28.57%)	
	40–50	6 (12.77%)	4 (16.00%)	1 (3.57%)	
	50–60	11 (23.40%)	8 (32.00%)	6 (21.43%)	
	60–70	6 (12.77%)	2 (8.00%)	0 (0%)	
Diagnosis	Medical	9 (19.15%)	5 (20.00%)	3 (10.71%)	0.22
	Neurological	10 (21.28%)	10 (40.00%)	4 (14.29%)	
	RTA	3 (6.38%)	1 (4.00%)	1 (3.57%)	
	Toxicology	25 (53.19%)	9 (36.00%)	20 (71.43%)	
GCS	Day 1	7.15 ± 1.29	6.88 ± 1.09	6.96 ± 1.04	0.61
	Day 3	6.48 ± 1.11	6.08 ± 0.81	6.57 ± 2.28	0.44

Prolonged ventilation was the commonest indication for tracheostomy in the early and late groups (38.30% vs. 68.00%; p=0.02). Intraoperative complications were infrequent, with no complications observed in 87.23% of early and 84.00% of late tracheostomy patients (p=0.37). The median time to tube change was 3 days among early tracheostomy patients (n=41) and 4 days among late tracheostomy patients (n=20) [Table 2].

Table 2: Indications for Tracheostomy and Procedural Findings

	Variable	Early	Late	p-value
Reason for tracheostomy	Prolonged ventilation	18 (38.30%)	17 (68.00%)	0.02
	Tracheo-bronchial toileting	11 (23.40%)	4 (16.00%)	
	Respiratory insufficiency	18 (38.30%)	4 (16.00%)	
Intraoperative complications	Bleeding	1 (2.13%)	0 (0%)	0.37
	Bleeding from tracheostomy site	0 (0%)	1 (4.00%)	
	Tube block	4 (8.51%)	1 (4.00%)	
	Tube displacement	1 (2.13%)	2 (8.00%)	
	Nil	41 (87.23%)	21 (84.00%)	
Tube change (days)	Median	3	4	–
	Min–Max	1–7	2–9	

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The mean duration of mechanical ventilation was 10.42 ± 4.72, 20.86 ± 8.30, and 7.33 ± 3.62 days in the early, late, and prolonged intubation groups (p=0.001). The corresponding mean ICU stays were 13.07 ± 7.07, 27.00 ± 10.62, and 8.80 ± 4.02 days (p<0.001), while mean hospital stays were 19.29 ± 8.76, 32.60 ± 10.59, and 13.95 ± 9.53 days, respectively (p<0.001) [Table 3].

Table 3: Ventilation Duration and Hospital Outcomes

Parameter	Early	Late	Prolonged	p-value
Duration of mechanical ventilation (days), Mean ± SD	10.42 ± 4.72	20.86 ± 8.30	7.33 ± 3.62	0.001
ICU stay (days), Mean ± SD (N)	13.07 ± 7.07 (n=42)	27.00 ± 10.62 (n=21)	8.80 ± 4.02 (n=15)	<0.001
Hospital stay (days), Mean ± SD (N)	19.29 ± 8.76 (n=41)	32.60 ± 10.59 (n=20)	13.95 ± 9.53 (n=21)	<0.001

Reintubation occurred in 17.02%, 48.00%, and 50.00% of patients in the early, late, and prolonged intubation groups (p=0.003). During hospitalisation, one patient (4.00%) in the late tracheostomy group declined tracheostomy, and one (4.00%) developed ventilator-associated pneumonia. Five patients (17.86%) in the prolonged intubation group died, while 17 (60.71%) improved without tracheostomy (p=0.001). At discharge, 42 patients (89.36%) in the early tracheostomy group had improved compared with 18 (72.00%) in the late tracheostomy group and 21 (75.00%) in the prolonged intubation group. Mortality was 8.51%, 20.00%, and 21.43% (p=0.41) [Table 4].

Table 4: Reintubation and Hospital Course

	Variable	Early (n=47)	Late (n=25)	Prolonged (n=28)	p-value
Reintubation	Yes	8 (17.02%)	12 (48.00%)	14 (50.00%)	0.003
	No	39 (82.98%)	13 (52.00%)	14 (50.00%)	
Course in hospital	Denied tracheostomy	0 (0%)	1 (4.00%)	0 (0%)	0.001
	Expired	1 (2.13%)	0 (0%)	5 (17.86%)	
	Improved	0 (0%)	0 (0%)	17 (60.71%)	
	Poor	1 (2.13%)	1 (4.00%)	0 (0%)	
	Ventilator-associated pneumonia	0 (0%)	1 (4.00%)	0 (0%)	
	Continued hospital stay	45 (95.74%)	22 (88.00%)	6 (21.43%)	

At 1 month, normal videolaryngoscopy findings were observed in 85.10%, 56.00%, and 21.43% of patients in the early, late, and prolonged intubation groups, respectively (p=0.001). At 6 months, normal findings were observed in 82.97%, 52.00%, and 60.71% of patients, respectively (p=0.09). Among patients with abnormal videolaryngoscopy at one month, most glottic and supraglottic injuries resolved by six months, whereas persistent stenosis required operative intervention in four patients [Table 5].

Table 5: Video laryngoscopy Findings

	VLS Finding	Early (n=47)	Late (n=25)	Prolonged (n=28)	p-value
VDL1 (1 month post-discharge)	Complication	0 (0%)	3 (12.00%)	5 (17.86%)	0.001
	Expired	6 (12.77%)	5 (20.00%)	6 (21.43%)	
	Glottic injury	0 (0%)	2 (8.00%)	6 (21.43%)	
	Normal	40 (85.10%)	14 (56.00%)	6 (21.43%)	
	Operated	0 (0%)	1 (4.00%)	1 (3.57%)	
	Supraglottic injury	1 (2.13%)	0 (0%)	4 (14.29%)	
VDL2 (6 months post-discharge)	Complication	1 (2.13%)	5 (20.00%)	3 (10.71%)	0.09
	Expired	6 (12.77%)	6 (24.00%)	6 (21.43%)	
	Normal	39 (82.97%)	13 (52.00%)	17 (60.71%)	
	Operated	1 (2.13%)	1 (4.00%)	2 (7.14%)	

Outcome distribution according to age group (p=0.41) and diagnosis (p=0.26) showed no statistically significant differences. Improvement was observed across all age groups and diagnostic categories, with the highest number of improved patients among those aged 20–30 years (n=21) and 30–40 years (n=21), and among patients with medical (n=15), neurological (n=16) and toxicological diagnoses (n=16) [Table 6].

Table 6: Outcome According to Age and Diagnosis

	Variable	Complication	Residual Paralysis	Improved	Expired	Total	p-value
By Age Group	≤20	0	0	4	1	5	0.41
	20–30	2	0	21	1	24	
	30–40	0	0	21	6	27	
	40–50	0	0	9	2	11	
	50–60	0	2	19	4	25	
	60–70	0	0	7	1	8	
By Diagnosis	Medical	0	0	15	2	17	0.26
	Neurological	0	2	16	6	24	

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	RTA	0	0	4	1	5	
	Toxicology	2	0	16	6	24	

DISCUSSION

Prolonged mechanical ventilation is frequently required in critically ill patients, and the optimal timing of tracheostomy remains an important clinical consideration because it may influence patient recovery and airway-related outcomes. The present study aimed to compare the clinical outcomes of early tracheostomy, late tracheostomy, and prolonged endotracheal intubation in patients requiring prolonged mechanical ventilation. Early tracheostomy was associated with improved clinical outcomes, fewer airway complications during follow-up, and shorter durations of mechanical ventilation, ICU stay, and hospital stay, while baseline characteristics remained comparable across the study groups.

In the present study, the study groups showed a similar distribution of gender, age, diagnosis, and baseline GCS scores. Males constituted the majority of participants, toxicological poisoning was the most common diagnosis, and baseline GCS scores were similar among the groups. Shah et al., who also reported that most mechanically ventilated patients undergoing tracheostomy were male (74.1%). However, they reported polytrauma and cerebrovascular stroke as the predominant underlying conditions, reflecting differences in the study populations.[11] These findings suggest that differences in clinical outcomes are more likely attributable to the timing of airway intervention than to baseline demographic or clinical characteristics.

With respect to tracheostomy-related characteristics, prolonged mechanical ventilation was the most common indication for tracheostomy. Procedural complications were infrequent in both the early and late tracheostomy groups, and tube change timing was also performed. These findings are comparable with those of Haşimoğlu et al., who reported prolonged mechanical ventilation as the most common indication for tracheostomy (93.4%) and found no significant differences in early (23.8% vs. 30.6%) or late (9.5% vs. 10.2%) tracheostomy-related complications between the early and late tracheostomy groups.[12] Similarly, Zhao et al. reported that prolonged mechanical ventilation was the primary indication for tracheostomy in a mixed ICU population, with neurogenic injury (66.1%) and trauma (16.3%) being the predominant underlying diagnoses and also described tracheostomy as a safe procedure with a low complication rate.[8] These findings suggest that prolonged mechanical ventilation remains the principal indication for tracheostomy, and the procedure can be performed safely with a low risk of complications irrespective of timing.

The duration of mechanical ventilation, ICU stay, and hospital stay differed significantly among the intervention groups. Reintubation rates and the overall hospital course also varied significantly. Although discharge outcomes differed among the groups, the immediate clinical outcomes at discharge were comparable. Similarly, Zhao et al. reported that delayed tracheostomy was independently associated with poorer discharge outcomes, with a lower proportion of patients achieving a good prognosis (78.8% vs. 89.1%) and a higher in-hospital mortality rate (4.7% vs. 1.0%) compared with early tracheostomy.8 Further, Chopra et al. demonstrated significantly lower mortality in the early tracheostomy group than in the late tracheostomy group (21.6% vs. 43.8%; p=0.032), while no significant difference was observed in ventilator-associated pneumonia (5.8% vs. 6.2%; p=0.94) or tracheostomy-related complications.[13] These findings suggest that early tracheostomy may improve the overall clinical course by reducing ventilatory support requirements and facilitating recovery, while maintaining a similar safety profile.

During follow-up, videolaryngoscopy demonstrated differences in airway findings during the early post-discharge period. Most mucosal injuries improved over time, and by six months the differences between the intervention groups were no longer statistically significant. Savery et al. reported significantly fewer laryngeal and tracheal complications following early tracheostomy. At six weeks, patients in the late tracheostomy group had a significantly higher incidence of epiglottic ulceration (6 vs. 0; p=0.01), vocal cord ulceration (2 vs. 0; p=0.01), and tracheal ulceration (14 vs. 7; p=0.054) than those in the early tracheostomy group.[14] Similarly, Lowery et al. demonstrated that early intervention for post-intubation laryngeal injury resulted in improved airway outcomes, with a higher decannulation rate (90% vs. 58%), fewer surgical procedures (mean 2.2 vs. 11.5), and no requirement for open reconstruction compared with late intervention.[15] These findings further support the favourable airway recovery and resolution of most laryngeal injuries observed during follow-up in the present study. These findings suggest that early airway intervention may reduce laryngeal injury, promote faster mucosal healing, and improve long-term airway outcomes while minimising the need for additional procedures.

In the present study, clinical outcomes were similar across different age groups and diagnostic categories, with no statistically significant associations observed. Improvement was seen across all subgroups, indicating that neither age nor underlying diagnosis significantly influenced patient outcomes. These findings suggest that the timing of airway intervention and comprehensive critical care management may play a more important role in determining outcomes than baseline demographic or diagnostic characteristics.

Limitations: This study was conducted at a single tertiary care centre with a relatively small sample

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size, which may limit the generalizability of the findings. The ambispective comparative design and non-randomised allocation of patients to the study groups may have introduced selection bias. The study was conducted at a single institution with a heterogeneous patient population, and follow-up was limited to six months, which may not have captured long-term airway and functional outcomes.

CONCLUSION

Early tracheostomy was associated with shorter duration of mechanical ventilation, reduced ICU and hospital stay, fewer airway complications during follow-up, and lower reintubation rates compared with late tracheostomy and prolonged endotracheal intubation. These findings suggest that early tracheostomy is a safe and effective airway management strategy for critically ill patients requiring prolonged mechanical ventilation.

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