Timing of Tracheostomy in Intensive Care Unit Patients

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Int Arch Otorhinolaryngol 2018;22:437–442.

Abstract

Introduction The ideal timing of tracheostomy in intensive care units (ICUs) for critically ill patients undergoing prolonged mechanical ventilation (MV) is still a controversial issue.

Objectives To determine the proper timing of tracheostomy and its impact on various clinical outcomes of adult patients in ICUs undergoing prolonged MV.

Methods The present study consisted of a sample of 67 ICU adult patients who were submitted to open surgical tracheostomy and divided into two groups: 30 patients in the early tracheostomy (ET) group (within 1–10 days post intubation), and 37 patients in the late tracheostomy (LT) group (within 11–21 days post intubation). The correlation between the timing of tracheostomy of each group and various associated ICU clinical parameters were analyzed.

Results The sample consisted of 61.19% male and 38.81% female patients, with a mean age of 47.263 $\pm$ 7.581 years. The mean MV duration in days was 7.91 $\pm$ 4.937 standard deviation (SD) in the ET group, and 15.32 $\pm$ 7.472 SD in the LT group ($p = 0.001$), with a mean sedation time of 6.13 $\pm$ 4.647 SD in the ET group, and of 11.98 $\pm$ 6.596 SD in the LT group ($p = 0.001$). The duration of the weaning process duration had a mean of 2.75 $\pm$ 2.586 SD days in the ET group, and of 5.39 $\pm$ 5.817 SD days in the LT group ($p = 0.025$), with a weaning failure rate of 28.57% in the ET group and 71.42% in the LT group ($p = 0.01$). The Mean ICU stay was 26.18 $\pm$ 4.732 SD in the ET group, and 11.98 $\pm$ 6.596 SD in the LT group ($p = 0.879$), and the incidence of ventilator-associated pneumonia (VAP) of 23.33% in the ET group and of 27.02% in the LT group ($p = 0.15$).

Conclusion Early tracheostomy had a notable benefit in shortening the duration of the MV, lessening the sedation time and minimizing the risks of weaning failure, but it had no significant impact on both the overall duration of ICU stay and VAP incidence.

Keywords

- tracheostomy
- timing
- intensive care unit
- mechanical ventilation

Introduction

Mechanical ventilation (MV) is a useful tool for those who are unable to maintain the level of ventilation necessary to sustain gas exchange. It is indicated in various conditions, such as those related to physiologic changes that lead to deterioration of the lung parenchyma, respiratory distress syndrome, and medical and/or surgical procedures, such as postanesthesia recovery, as well as in many other circumstances, such as in cases of head trauma or drug overdose that lead to ventilatory failure.[1]

As the ideal concept is to transfer the MV support and the breathing function from the ventilator to spontaneous breathing, this is done through a weaning process, which means a gradual reduction in the level of ventilatory support until a complete discontinuation of the ventilator support is reached, that is, the overall process of removing the patient

received
October 21, 2017
accepted
April 4, 2018
published online
August 9, 2018

DOI https://doi.org/10.1055/s-0038-1654710.
ISSN 1809-9777.

from the ventilator.[2] To achieve this timely discontinuation of the mechanical ventilatory support, and also to reduce the rate of complications related to the status of the artificial airway and prolonged MV, such as ventilatory-induced lung injury (VALI) and nosocomial infections, a constant and close evaluation of the medical conditions of those patients was required, as well as an assessment of their spontaneous breathing capacity. In contrast, premature discontinuation can result in severe respiratory and/or cardiovascular decompensation, and thus expose the patient to reintubation-associated risks, such as prolonged intensive care unit (ICU) stay and long-term rehabilitation facility care. – However, this is due to undefined reasons, since $\sim$ 3 to 7% of the patients remain in need of prolonged MV support.[3]

Tracheostomy is usually indicated for ICU critically ill patients who require prolonged mechanical ventilation, in order to facilitate the removal from the ventilator machine through a weaning process. It has many beneficial effects, such as improved pulmonary mechanics, lessened laryngeal or tracheal nociceptive stimuli, shorter requirement of sedatives and analgesic medications, easier oral hygiene and nutrition, and improved communication. However, it may be associated with some complications related to its surgical technique.[4–6]

In 1989, the American College of Chest Physicians (ACCP) guidelines on artificial airways consensus conference recommended considering performing a tracheostomy in patients receiving MV for more than 21 days,[7] but the proper timing to perform the tracheostomy remained a matter of debate over the last two decades. Some international surveys record the preferable timing of tracheostomy between 7 to 15 days postintubation.[8,9] However, the definition of early versus late tracheostomy timing varies among several different studies. In some reviews, it is defined as either before or after 7 days,[10] but in a Cochrane Review[13] of randomized controlled trials (RCTs) published in 2015 defined tracheostomies performed before 10 days postintubation as early, and those performed after 10 days as late.[11–13]

Along with this concept, some studies suggested that early tracheostomy was more associated with better outcomes than late tracheostomy,[14] while other studies disagreed with this finding.[15] However, the tracheostomy must be customized to the patient's medical condition, recovery course expectation, risk of continuous endotracheal intubation, and ventilatory machine support, as well as to the complications of the surgical procedure, and it must also be adapted to the balance of wishes between the pathology-patient.[16]

Several important questions still have to be answered regarding the timing to perform a tracheostomy (early or late), and if there are certain types of indications (medical versus surgical or traumatic) that are more likely to present more benefits to the patients. However, there are no definite answers provided in the literature.[6] Therefore, many researchers declared that the selection and identification of an ideal timing to perform a tracheostomy in MV patients in the ICU remain a clinical challenging issue, with considerable variations in practice.[17] With this dilemma in mind, the present study was performed in an attempt to determine the convenient timing to perform tracheostomies in ICU critically ill patients receiving MV, and to evaluate its impact on the outcomes of their clinical condition.

Patients and Methods

After receiving the approval from the institutional review board, and obtaining the consent of the families of the patients and recording an ICU hospital registration number, a prospective study was conducted at the ICU of the Al-Yarmuok teaching hospital, in Baghdad, Iraq, from August 1, 2016 to September 1, 2017.

The present study selected 67 ICU adult patients who had been submitted to bed-side open surgical tracheostomy. They were divided into two groups: the early tracheostomy (ET) group, consisting of 30 patients who were submitted to tracheostomy between 1 and 10 days postintubation, and the late tracheostomy (LT) group, consisting of 37 patients who were submitted to tracheostomy between 11 and 21 days postintubation.

The exclusion criteria were: patients in the pediatric age group, comatose patients with severe respiratory distress with refractory hypoxemia and hypercapnia or/and cardiovascular insufficiency, those with chronic coagulation disorders, as well as those who were tracheostomized prior to ICU admission.

The present study aimed to determine and analyze the correlation between the timing of tracheostomy and various associated ICU clinical parameters, such as duration of MV support, duration of sedation based on our regimen of sedation and anesthesia, and duration of the weaning process trials, as well as overall ICU stay and associated translaryngeal complications and morbidities. Also multiple post translaryngeal extubation fibre-optic endoscopy was performed. The follow up was scheduled for 6 months.

The ICU at our institution is composed of a 14-bed medical unit authorized by a qualified and well-trained medical staff and has many ventilator systems and essential equipment for monitoring, resuscitation and management.

The decision concerning the timing of the tracheostomy was taken by the attending physician. It was based on several factors, such as the duration of the MV, the anticipation of prolonged MV, and the frequency of weaning failures. Along with those factors the ICU staff performed a constant observation of the patients, in order to evaluate the if the medical condition enabled them to be removed from MV, taking into consideration all the facilities for early diagnosis and immediate management for any adverse events that might be encountered, as well as the regulation of the recommended dosage of sedative and analgesic agents, which were administrated either by continuous dripping with an interruption period, or by regular intermittent dosage, as indicated, with close monitoring by the ICU staff.

Once the medical status of the patient met the estimated criteria of positive end expiratory pressure (PEEP) $<$ 0-8 cm H_2O, and fraction of inspired oxygen (FiO_2) $<$ 0.4-0.5 L/min, hemodynamic stability (avoidance of vasoconstrictor agents, no serious cardiac arrhythmia), as well as initiation of inspiratory efforts capacity, which indicated that the

underlying pathology had been stabilized or resolved, thus enabling us to consider initiating the weaning process, the patients were subjected to airway pressure support ventilation (maintaining a spontaneous respiratory rate of 20-28 breaths per minute), which was accompanied by a judicious reduction of positive airway pressure support, or intermittent T-piece for trail of spontaneous breathing when the medical status improved. Therefore, the weaning from MV was considered successful if it lasted for more than 72 hours. Then, once the weaning process and the tracheostomy were accomplished, the patients were transferred to the long-term care setting with regular and close observation, unless there were any impediments due to other active medical problems.

However, the weaning process was considered a failure when it showed evidences of acute respiratory distress, which included an increased positive airway pressure support demand synchronized with increased mandatory ventilation rate confirmed by the following parameters: $PaO_2 < 60$ mmHg, $PaCO_2 > 50$ mmHg, respiratory rate > 30/min, heart rate > 120 beats per minute, systolic blood pressure < 90mmHg or >180 mmHg, in addition to the clinical signs of the patient, such as sweating, agitation and usage of accessory muscles of respiration.

Statistical Analysis

The analysis of the data was performed using the Statistical Package for the Social Sciences (SPSS, IBM Corp., Armonk, NY, US) software, version 20. The data were presented in simple measures of percentage, mean, range (minimum-maximum) values, and standard deviation (SD). The level of significance for the differences in the quantitative data was tested using the Student *t*-test, and the level for the differences in the qualitative data, using the Pearson chi-squared test. Values of $p < 0.05$ were considered statistically significant.

Results

Among the 67 adult patients that composed the sample, there were 41 (61.19%) male and 26 (38.81%) female patients, who were aged between 18 and 76 years, with a mean age of 47.263 $\pm$ 7.581 years ($p = 0.58$).

In the ET group, there were 19 (63.33%) male and 11 (36.67%) female patients, with a mean age of 46.741 $\pm$ 6.537 years ($p = 0.57$). In the LT group, there were 24 (64.87%) male and 13 (35.13%) female patients, with a mean age of 47.392 $\pm$ 4.768 years ($p = 0.59$).

There were various indications for tracheostomy among the ICU patients, the most common being chronic obstructive pulmonary disease (COPD) (29.85%). ►**Table 1** highlights the distribution of the various indications for tracheostomy among the studied patients.

The overall rate of successful weanings was 68.65%, while the failure rate was 28.57% in the ET group compared to 71.42% in the LT group ($p = 0.01$). ►**Table 2** shows the impact of tracheostomy on the weaning rates among the studied groups according to their reasons for intubation.

The most present morbidity was ventilator-associated pneumonia (VAP), which was detected in 17 cases (25.37%), being 7 cases (23.33%) in the ET group and 10 cases (27.02%) in the LT group ($p = 0.15$).

Some secondary clinical outcomes were detected, such as 2 cases (6.66%) of minor bleeding in the ET group and 3 cases (8.08%) in the LT group, as well as 1 case (3.33%) of mild localized surgical emphysema in the ET group and 4 cases (10.81%) in the LT group. However, all these morbidities were considered very mild, and were resolved spontaneously within hours or a few days, without reflecting any adverse effects.

Multiple postextubation endoscopic sessions were performed within 6 months to reveal laryngeal ulcer at the arytenoid area in 8 cases (11.94%), which was the most common laryngotracheal injury detected. ►**Table 3** demonstrates various lesions detected by fiber-optic endoscopy in the studied groups.

The impact of the timing of the tracheostomy on the outcomes of the various study parameters revealed statistically significant results for some parameters, such as the duration of the MV, the weaning process, and the sedative exposure ($p < 0.05$), while no statistically significant result was found for the overall duration of the ICU stay ($p = 0.879$). ►**Table 4** highlights the impact of the timing of the tracheostomy on several studied parameters.

Discussion

Tracheostomy is frequently needed in ICU critically ill patients on prolonged MV, in order to simplify long-term airway management. While this concept remains unchanged, its prevailing timing is still a matter of debate, and needs continued investigation, since it depends basically on the prediction of the

Table 1 Indications for tracheostomy among the studied patients

Indications	Total	ET group	LT group	*p*-value
COPD	20 (29.85%)	10 (33.33%)	10 (27.02%)	0.78
Circulatory failure	13 (17.1%)	6 (20%)	7 (18.91%)	0.68
Multiple trauma victim	11 (16.42%)	5 (16.67%)	6 (16.21%)	0.67
Guillain-Barré syndrome	10 (14.92%)	4 (13.33%)	6 (16.21%)	0.67
Neurological diseases	8 (11.94%)	3 (10%)	5 (3.51%)	0.55
Drug toxicity	5 (7.46%)	2 (6.67%)	3 (8.1%)	0.55

Abbreviations: COPD, chronic obstructive pulmonary disease; ET, early tracheostomy; LT, late tracheostomy.

Table 2 Weaning rates according to the reasons for intubation

Reason for intubation	Total ($n = 67$)	Successful weaning ($n = 46$)	Weaning failure ($n = 21$)
Respiratory disease	31 (46.27%)	23 (50%)	8 (38.1%) ET: 2 (25%) LT: 6 (75%)
Circulatory disease	19 (28.35%)	13 (28.26%)	6 (28.57%) ET: 2 (33.33%) LT: 4 (66.67%)
Neurological disease	17 (25.38%)	10 (21.74%)	7 (33.33%) ET: 2 (25.57%) LT: 5 (71.43%)

Abbreviations: ET, early tracheostomy; LT, late tracheostomy.

Table 3 Postextubation endoscopy

Findings	Total	ET group	LT group	*p*-value
Laryngeal ulceration	8 (11.94%)	3 (10%)	5 (13.51%)	0.35
Laryngeal granuloma	5 (7.46%)	2 (6.67%)	3 (8.1%)	0.40
Subglottic stenosis	3 (4.47%)	1 (3.33%)	2 (5.4%)	0.55

Abbreviations: ET, early tracheostomy; LT, late tracheostomy.

physician regarding the need for prolonged MV[18] rather than on evidence-based practice. Having performed studies with different designs, the authors of the studies consulted in the literature differ in opinion regarding the exact definition of early and late tracheostomy timing[15,16,19]

Since there were no obvious evidence-based guidelines available, the convenient timing to perform tracheostomies in ICU critically ill patients on MV will vary according to their medical conditions, the judgment of the authorizing physician, along with counseling and communication with the families of the patients.

Regarding the clinical outcomes of the patients included in the present study, the main observation was a significant shorter duration of MV in the ET group when compared to the LT group, a finding also presented by many studies.[6,20–23] This is also reflected in the present study by both a statistically lower duration of the weaning process required to accomplished the MV discontinuation and a higher successful weaning rate in the ET group than in the LT group. These observations were supported by Hsu et al[24] in a study that reported that the patients of the ET group had a higher rate of successful weaning, as well as by Boynton et al[25] in a study that determined that the median duration of the weaning process was shorter in the ET group. However, a few other studies[10,11] did not show a significant difference in the reduction of MV duration between the ET and LT groups.

The intended mechanisms of the advantages of performing an early tracheostomy in order to facilitate the weaning process from MV are believed to reduce the amount of sedation, minimize the dead air space in the breathing system, enable a better removal of secretions (as many patients had a remarkable and/or persistent amount of orotracheal secretion), in order to reduce the risk of aspiration, as well as to improve the comfort of the patient.[26]

The present study revealed a statistically significant reduction in the sedation time in the ET group compared to the LT group, which is in accordance with other studies,[12,19,27,28] as well as its desirable impact in lessening the risk of cumulative side effects of sedative drugs, minimizing delirium attacks resulting from longer MV duration, prolonged ICU and hospital stay, several post ICU adverse sequelae, as well as a lower mortality rate.[29] The practical explanation of these issues is that an early tracheostomy alleviates both oral and throat discomforts, and facilitates the suctioning of secretions. However, Blot et al[30] revealed a non-statistically significant difference in sedation-free days in the ET group compared to the LT group.

The current study found that the incidence of VAP was slightly higher in the LT group than in the ET group. However, this numerical difference was considerably small, and did not reach a statistically significant level, and it was also related to the pre-tracheostomy clinical status of the patients. This observation is in accordance with data from meta-analytic and recent Cochrane Review pooled outcome studies.[10–12,28,31]

However, Moller et al[22] showed that early tracheostomy minimized the incidence of VAP. Frutos-Vilar et al[32] have also

Table 4 Impact of tracheostomy timing distribution on various studied parameters

Indications	Total	ET group	LT group	*p*-value
MV duration (days)	9.63 ± 5.182 SD (1.0–21.0)	7.91 ± 4.937 SD (1.0–10.0)	15.32 ± 7.472 SD (11.0–21.0)	0.001
Weaning process duration (days)	3.57 ± 3.294 SD (3.0–9.0)	2.75 ± 2.586 SD (3.0–5.0)	5.39 ± 5.817 SD (4.0–11.0)	0.025
Overall ICU stay (days)	27.26 ± 4.387 SD (22.0–49.0)	26.18 ± 4.732 SD (21.0–36.0)	27.39 ± 6.237 SD (23.0–47.0)	0.879
Sedation duration (days)	8.19 ± 5.769 SD (4.0–16.0)	6.13 ± 4.647 SD (3.0–8.0)	11.98 ± 6.596 SD (7.0–17.0)	0.001

Abbreviations: ET, early tracheostomy; ICU, intensive care unit; LT, late tracheostomy; MV; mechanical ventilation; SD, standard deviation.

shown a statistical difference of VAP incidence between the tracheostomized and non-tracheostomized groups, while Hsu et al[24] mentioned that a statistically significant occurrence of post-tracheostomy nosocomial pneumonia was non-dependent on failure and during weaning period. The statistical heterogeneity that was found among the various studies accounts for the fundamental clinical and methodological differences in those same studies.[33]

However, the higher incidence of VAP found in the late tracheostomy group is thought to be attributed to the fact that a prolonged MV period leads to local barrier and bronchial hygiene impairment, which results in an increased risk of bacterial colonization, which, in turn, accounts for a higher rate of post-tracheostomy pneumonia. Therefore, post tracheostomy pneumonia, prolonged MV, poor pre-tracheostomy conditions and late tracheostomy, in addition to various reasons for intubation, influence the weaning process in a univariate analysis.[24]

The present study revealed that there was no statistically significant difference regarding the overall duration of ICU stay in the ET group compared to the LT group. This finding is in accordance with some studies that concluded that the timing of the tracheostomy has no impact on the duration of the ICU stay.[19,25,33,34] However, the authors of other studies have different opinions, and reported that early tracheostomy shortens the duration of the ICU stay.[13,22,23] It is worth mentioning that a careful intensive judgment in the selection of the preferable timing of the tracheostomy, as well as the absence of significant VAP incidence, were considered the most relevant factors regarding the duration of the ICU stay. This noticeable heterogeneity among the various studies is also possibly attributed to diverse patient groups and characteristics, as well as various tracheostomy timings.[27]

Another secondary outcome in the present study were post-intubation laryngotracheal injuries, such as laryngeal ulcer, laryngeal granuloma and subglottic stenosis, which were detected at a higher rate in the LT group than in the ET group, but with no statistically significant value. These findings were supported by other studies[35–37] that state that the concept of prolonged translaryngeal intubation is considered the most important factor in the incidence of these injuries. However, in the present study, all these pathologies were resolved with conservative management, without the need of surgical intervention.

The comparison of various parameters related to the timing of the tracheostomy outcomes among the aforementioned studies imposed some difficulties, as there was a notable heterogeneity in various studies due to many factors, such as the non-consensus definition of the timing of the tracheostomy, different study designs, and the clinical and methodological differences among patient groups.

The limitations of the present study were that it was performed at a single ICU center with a small sample size, with a non-randomized study design (not blinded), because decision on the timing of the tracheostomy was judged according to the opinion of the attending physician and to the clinical status of the patient. Therefore, a probable interpretation bias may have influenced some of the outcomes of the study parameters. However, strict compliance of the ICU policy rules may have controlled these issues.

Conclusion

Early tracheostomy had a remarkable effect in shortening the duration of MV, lessening sedation time, and minimizing the risks of weaning failure, but had no significant impact on the overall duration of the ICU stay and on the incidence of VAP. However, no objective evidence-based guidelines for a proper definition of tracheostomy timing for ICU critically ill patients receiving prolonged MV were meticulously clarified.

Conflicts of Interest

The authors have no conflicts of interest to disclose.

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