Association Between Timing of Percutaneous Dilatational Tracheotomyand Clinical Outcomes of Critically-ill Elderly Patients

Chen Li[1], Ting Wang[1], Donglai Sheng[1], Min Zhang[1], Min Zheng[1] and Xiuhua Li[2]

[1]*Intensive Care Unit, Jingxian Hospital, Anhui, China*
[2]*Emergency Department, Shanghai East Hospital, Tongji University School of Medicine, Shanghai, China*

ABSTRACT

Objective: To determine the effect of timing of tracheotomy on the outcome of critically-ill elderly patients.
Study Design: Descriptive study.
Place and Duration of the Study: Intensive Care Unit, Jingxian Hospital, Anhui, China, from January 2017 to December 2021.
Methodology: Two hundred and thirty-five critically-ill elderly patients who had undergone percutaneous dilatational tracheotomy (PDT) were enrolled. The PDT-related complications and clinical outcomes were analysed.
Results: Overall, the PDT-related complications, including the amount of bleeding (6.1 ± 1.0 *vs.* 5.8 ± 0.9 *vs.* 5.8 ± 0.9, p<0.46) and wound infection [8(5.0%) *vs.* 2 (4.9%) *vs.* 3 (9.1%), p=0.62], showed no significant difference among the three groups. The length of ICU stay (13.3 ± 8.4 *vs.* 18.4 ± 17.8 *vs.* 24.1 ± 16.1 days, p<0.0001) in the very early PDT group was significantly shorter than that in the early and late PDT groups. The lowest hospital mortality rate [(59 (36.6%) *vs.* 28 (68.3%) *vs.* 15 (45.5%), p=0.0012)] was noted in the very early PDT group among the three groups, and a longer postoperative survival was recorded.
Conclusion: A shortened length of ICU stay and a decreased hospital mortality were found in the very early PDT group, while a better postoperative survival rate was achieved.

Key Words: *Percutaneous dilatational tracheotomy, Mortality, Outcome, Timing, Intensive care unit.*

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INTRODUCTION

Tracheotomy is a frequently performed surgical procedure in intensive care unit (ICU) for critically-ill patients who require prolonged endotracheal mechanical ventilation (MV) or protection for airway. Studies have already indicated the advantages of tracheotomy over endotracheal intubation, including shortened length of stay in ICU or hospital, improved airway compliance, fewer pulmonary infections.[1] However, the optimal timing of tracheotomy in MV critically-ill patients remains uncertain, including the fact that the prevalent COVID-19 patients need the operation.[2]

Traditionally, tracheotomy was an open surgical procedure carried out by surgeons. However, this technique was replaced in the last decades by percutaneous dilatational tracheotomy (PDT), which is a bedside procedure mainly conducted by intensivists.[3]

Correspondence to: Dr. Xiuhua Li, Emergency Department, Shanghai East Hospital, Tongji University School of Medicine, Shanghai, China
E-mail: lixiuhua_1968@sina.cn
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However, the effects of PDT timing on the clinical outcomes, especially for critically-ill elderly patients had not yet been determined. At present, COVID-19 is prevalent worldwide, and older age is associated with the severity of the disease and COVID-19.[4] These aged patients with acute respiratory failure due to COVID-19 may have a high likelihood of prolonged intubation and may subsequently require tracheotomy, whereas, the timing of PDT on these elderly patients and its effects on clinical outcomes had not yet been determined and are conflicting.[5] From 2017, PDT was performed mostly for the over 60-year patients of the study. The objective of this study was to compare the postoperative complications of PDT and clinical outcomes among the three groups of critically-ill elderly patients according to the timing of PDT, in order to establish an appropriate timing of PDT in the aged patients more precisely.

METHODOLOGY

This study was conducted from 1 January, 2017 to 30 December, 2021 in the Intensive Care Unit (ICU) of Jingxian Hospital, Anhui, China. The Medical Ethics Committee of the hospital approved the study. As the data were collected retrospectively, the necessity of informed consent was not required by the Medical Ethics Committee. The clinical data were extraced from the hospital servers, which were analysed strictly anonymously.

All patients (≥18 years) who needed PDT were established by the intensivists if they were difficult to wean from MV (needed more than seven days of endotracheal MV) and unable to protect the airways with other measures. Patients were excluded from the operation if they had general contraindications for PDT (inability to extend the neck adequately, significant thyroid gland enlargement, palpable neck vessels that left insufficient space for PDT insertion); aged <18 years; or declined consent to PDT. The included patients were divided into three PDT-based groups: very early PDT group (≤2 days), early PDT group (3-5 days), and late PDT group (≥6 days) of endotracheal intubated MV. PDTs were performed bedside according to Ciaglia technique under the direct vision (Figure 1).[3] The dilatation of the tracheal was achieved by dilating forceps (PORTEX, Smiths Medical Co., Ltd., Prague, Czech Republic) along the Seldinger guidewire. The primary endpoint was PDT-related complications. The secondary endpoints were the length of stay in ICU, hospital mortality, and survival after discharge from the hospital. After patients' discharge, they were followed up for at least 10 months for the mortality.

The Chi-square test or analysis of variance (ANOVO) was used to compare patients' characteristics among the three groups. The univariate and multivariate logistic regression analyses were performed to identify risk factors for the post-surgery mortality. The unadjusted and adjusted odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were then calculated to compare the effects on the mortality. The survival curve was developed to estimate the survival possibility. A p-value of less than 5% was considered significant. The statistical analysis was performed using SAS 9.4 software (SAS Institute, Inc., Cary, NC, USA).

RESULTS

During the study period, a total of 235 patients who underwent PDT at ICU in Jingxian Hospital were evaluated. There were 161 patients in the very early PDT group, 41 patients in the early PDT group, and 33 patients in the late PDT group. Patients' baseline characteristics are summarised in Table I. The average ages among the three groups were older than 60 years, whereas the age in the very early PDT group was significantly younger than that in the early PDT group and late PDT group (64.7 ± 11.9 *vs.* 70.0 ± 11.0 *vs.* 70.2±10.7 years old, p=0.005). The incidence of cardiac diseases was (27(16.8%) *vs.* 17(41.5%) *vs.* 12(36.4%, p=0.0008, the incidence of chronic obstructive pulmonary disease (COPD) was (9(5.6%) *vs.* 13(31.7%) *vs.* 16(48.5%), p<0.0001. The admissions in ICU for pulmonary disease in the very early PDT group were less than those in the early PDT group and the late PDT group (16(9.9%) *vs.* 26(63.4%) *vs.* 27(81.8%), p<0.0001). However, the Apache II scores did not significantly differ among the three groups (21.5 ± 4.7 *vs.* 21.1 ± 4.9 *vs.* 19.8 ± 4.3, p=0.165), which indicated the severity of diseases to be almost the same in the three groups.

The PDT-related complications, including the amount of bleeding (6.1 ± 1.0 *vs.* 5.8 ± 0.9 *vs.* 5.8 ± 0.9, p<0.4667), wound infection (8(5.0%) *vs.* 2(4.9%) *vs.* 3(9.1%), p=0.6278), and the cost of hospitalisation (94641.6 ± 52582.8 *vs.* 99765.0 ± 84320.7 *vs.* 93670.4 ± 75236.4, p=0.8832, Table II) had no significant difference among the three groups. The length of hospital stay did not significantly differ among the three groups, whereas the length of ICU stay (13.3 ± 8.4 *vs.* 18.4 ± 17.8 *vs.* 24.1 ± 16.1, p<0.0001) in the very early PDT group was significantly shorter than that in the early and late PDT groups. Furthermore, the hospital mortality rate was the lowest in the very early PDT group [59 (36.6%) *vs.* 28 (68.3%) *vs.* 15 (45.5%), p=0.0012] among the three groups (Table II).

The graph of the estimated survivor functions is shown in Figure 2. The curves of the very early and the late PDT groups were significantly closer to each other than those of the early PDT group (P<0.0006). The survival rates in the three groups decreased rapidly to approximately 70% after one month. After that, the survival rate of the very early PDT group was stable at 65%, and it was slightly lower in the late PDT group (50%). The survival rate in the early PDT group decreased again from 45 to 25% after 2.5 years, and finally was stable at 10% after around 4 years.

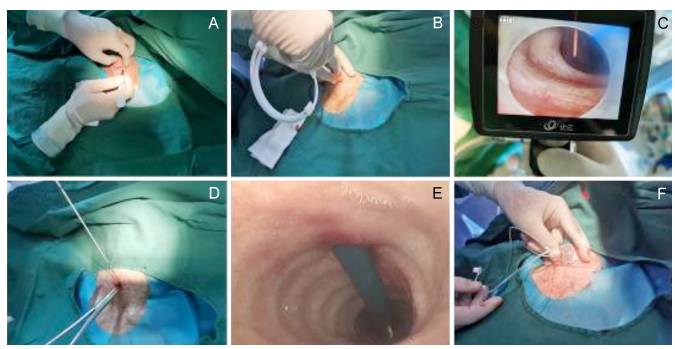

Figure 1: Percutaneous dilatational tracheotomy according to Ciaglia technique. Median incision of the trachea below the second or third tracheal clasp. (A) Insertion of a Seldinger guidewire was performed (B) under visualization. (C). Dilatation of the tracheal accession side was achieved by dilating forceps (D) and (E). The tracheal cannula was inserted using an introducer under visualisation (F).

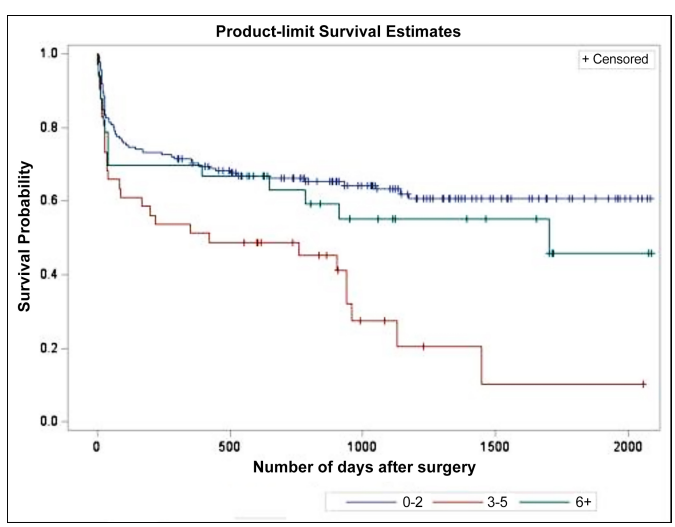

Figure 2: Survival analysis after PDT.
0-2: Very early group; 3-5: Early group; 6+: Late group.

Table I. Baseline characteristics of patients at inclusion in the study.

	Very Early tracheotomy (n = 161)	Early tracheotomy (n = 41)	Late tracheotomy (n = 33)	p-value
Average age (years)	64.7 ± 11.9	70.0 ± 11.0	70.2 ± 10.7	0.005
Male	109 (67.7%)	28 (68.3%)	24 (72.7%)	0.8514
BMI (kg/m^2)	23.0 ± 2.6	22.4 ± 3.0	22.5 ± 3.3	0.4031
Condition (diseases)				
Diabetes	20 (12.4%)	8 (19.5%)	7 (21.2%)	0.2858
Kidney diseases	3 (1.9%)	2 (4.9%)	3 (9.1%)	0.0964
Cardiac diseases	27 (16.8%)	17 (41.5%)	12 (36.4%)	0.0008
Hypertension	106 (65.8%)	23 (56.1%)	14 (42.4%)	0.0338
Liver diseases	1 (0.6%)	1 (2.4%)	0 (0.0%)	0.4472
Cerebrovascular diseases	36 (22.4%)	15 (36.6%)	6 (18.2%)	0.1125
COPD	9 (5.6%)	13 (31.7%)	16 (48.5%)	<.0001
Reasons for ICU admission				
Pulmonary infection	16 (9.9%)	26 (63.4%)	27 (81.8%)	<.0001
CNS	113 (70.2%)	12 (29.3%)	6 (18.2%)	
Injury	13 (8.1%)	1 (2.4%)	0 (0.0%)	
Other	19 (11.8%)	2 (4.9%)	0 (0.0%)	
Apache II	21.5 ± 4.7	21.1 ± 4.9	19.8 ± 4.3	0.1655
GCS	7.5 ± 3.4	8.6 ± 3.5	10.2 ± 4.0	0.0003

BMI: Body mass index, GCS: Glasgow Coma Score, COPD: Chronic obstructive pulmonary disease, CNS: Central nervous system diseases, APACHE II: Acute Physiology and Chronic Health Evaluation II.

Table II. Primary and secondary outcomes.

	Very early tracheotomy (n = 161)	Early tracheotomy (n = 41)	Late tracheotomy (n = 33)	p-value
Bleeding (ml)	6.1 ± 1.0	5.8 ± 0.9	5.8 ± 1.4	0. 4667
Wound infection	8 (5.0%)	2 (4.9%)	3 (9.1%)	0.6278
LOS	45 ± 39.5	42 ± 46.4	38 ± 45.2	0.6623
ICU LOS	13.3 ± 8.4	18.4 ± 17.8	24.1 ± 16.1	<0.0001
VAP	46 (28.6%)	9 (22.0%)	11 (33.3%)	0.5399
MDR	45.7% (21/46)	77.8% (7/9)	63.6% (7/11)	0.1561
Percentage of Gram-Positive bacteria	13.0% (6/46)	0% (0/9)	27.3 (3/10)	0.1826
Costs (CNY)	94641.6 ± 52582.8	99765 ± 84320.7	93670.4 ± 75236.4	0.8832
Death	59 (36.6%)	28 (68.3%)	15 (45.5%)	0.0012

LOS: Length of hospital stay, ICU LOS: Length of intensive care unit stay, CNY : Chinese Yuan, VAP: Ventilator-associated pneumonia, MDR: Multidrug-resistant bacteria.

DISCUSSION

The results of the present study suggested that there were no significant complications in the three groups of critically-ill elderly patients. However, the length of stay in ICU and the hospital mortality rate decreased in the very early PDT group. Furthermore, a longer survival was found in the very early PDT group after the surgery.

Tracheotomy is a common surgical procedure performed in ICU for critically-ill patients. In the recent decades, PDT has become popular with the development of equipment by intensivists.[6] Studies have already shown the advantages of PDT over the traditional open surgical tracheotomy including lower incidence rates of bleeding and infections.[7] However, the timing of tracheotomy including PDT for ICU patients remains a medical concern, and no universal consensus could be achieved even for COVID-19 patients.[8] Since the coronavirus pandemic tend to be more severe for old people, it is necessary to establish a more precise timing for critically-ill elderly patients requiring tracheotomy. Recently, some studies indicated that early tracheotomy is associated with a reduced need for mechanical ventilation and a shorter length of stay in the ICU for COVID-19 disease.[2,8] However, a meta-analysis in 2021 which included 232 unique studies, 18 articles, and 3234 patients revealed that a statistically significant difference in the timing of tracheotomy in these studies and the relationship between tracheotomy timing and death was not found in this systematic review.[9]

In the present study, patients were divided into three PDT-based groups, including very early (0-2 days of MV), early (3-5 days of MV), and late (≥6 days of MV) PDT groups. The results revealed that there were no significant differences in PDT-related complications among the three groups of aged patients, including the amount of bleeding and wound infection. There were also no significant differences in the cost and length of hospital stay. However, it was revealed that the length of ICU stay and hospital mortality was significantly reduced in the very early PDT group. This is similar to a previously published meta-analysis, which defined the early tracheotomy as less than 3 days of MV.[6] Furthermore, the survival rate of the very early PDT group was higher than in the early PDT group and the late PDT group which suggested that the earlier PDT had a better survival.

There were some limitations in the present study. First, this was a retrospective study, and it was less robust as compared to a randomised, controlled trial. Secondly, the sample size was not large enough, hindering the recommendation of early tracheotomy in clinical practice. However, the results indicated that early PDT has a better effect on outcomes in expectedly prolonged endotracheal intubated elderly patients, especially less than 2 days of MV.

CONCLUSION

Among the critically-ill elderly patients, PDT with less than 2 days of MV was associated with a shortened length of ICU stay, a reduced hospital mortality, and a longer survival. The results may be helpful for deciding the timing of PDT in the prevalent COVID-19 elderly patients who require tracheotomy.

ETHICAL APPROVAL:
The study was approved by the Medical Ethic Committee of Jingxian Hospital.

PATIENTS' CONSENT:
As a retrospective study, informed consent of patients was not required by the ethics committee, and the clinical data were extracted from the hospital servers, which were analysed strictly anonymously.

COMPETING INTEREST:
The authors declared no competing interests.

AUTHORS' CONTRIBUTION:
CL,TW: Performed the operation, collected data, reviewed the literature, and wrote the manuscript.
DS, MZ: Performed the operation, and collected the data.
MZ: Analysed data and ensured the quality.
X L: Designed the study, wrote the paper and references, and analysed the data.
All authors approved the final version of the manuscript to be published.

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