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ORIGINAL RESEARCH

Analysis of removal time of artificial ventilator in patients submitted to early tracheostomy, after seven days of invasive mechanical ventilation

Análise do tempo de retirada do respirador artificial no paciente submetido a traqueostomia precoce e após sete dias de ventilação mecânica invasiva

Análisis del tiempo de retiro del ventilador mecánico en pacientes sometidos a traqueotomía temprana y después de siete días de ventilación mecánica invasiva

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ABSTRACT | Early tracheostomy can reduce patient ventilation time, facilitating the weaning process and reducing hospitalization costs. This study analyzes the removal time of ventilators in patients submitted to early tracheostomy, after seven days of ventilation. This is a documentary, retrospective, and descriptive research. Data were collected from documents with hospital indicators of an intensive care unit in the Zona da Mata region in Minas Gerais. Data consisted of 50 patients who were successful in the weaning of mechanical ventilation and met the study criteria. They were both men and women, with a mean age of 56.6 years. For statistical analysis, the patients were divided into two groups: an early group - patients who underwent tracheostomy with less than seven days of orotracheal intubation; and a late group - patients who remained for more than seven days with orotracheal tube before tracheostomy. We obtained a significant result (p=0.04) regarding the days on mechanical ventilation after tracheostomy, demonstrating that patients with early tracheostomy remained fewer days on invasive mechanical ventilation than patients with late tracheostomy. A significantly lower result of ventilation time was observed in patients submitted to early compared with late tracheostomy. High-quality randomized clinical trials are needed to better evaluate the possible differences in mechanical ventilation withdrawal among tracheostomized patients.

Keywords | Tracheostomy; Ventilator Weaning.

RESUMO | A realização da traqueostomia precoce pode reduzir o tempo de ventilação do paciente, facilitando o desmame da prótese ventilatória. Além disso, reduz os custos de internação. Este estudo tem como objetivo analisar o tempo de retirada do respirador no paciente traquestomizado precocemente após sete dias de ventilação. Trata-se de pesquisa documental, retrospectiva, de carácter descritivo, sendo a coleta de dados realizada nos documentos de indicadores hospitalares de unidade de terapia intensiva de um hospital da Zona da Mata mineira. Foram coletados dados de 50 pacientes que obtiveram sucesso e preencheram os critérios de desmame da ventilação mecânica, entre homens e mulheres, com média de idade de 56,6 anos. Para análise estatística, os pacientes foram divididos em dois grupos: grupo precoce, de pacientes que realizaram traqueostomia com menos de sete dias de intubação orotraqueal; e grupo tardio, de pacientes que permaneceram por mais de sete dias com tubo orotraqueal até a realização da traqueostomia. Obtivemos um resultado significativo (p=0,04) quanto aos dias em ventilação mecânica após a realização de traqueostomia, demonstrando que nos pacientes com traqueostomia precoce houve menos dias em ventilação mecânica invasiva do que nos pacientes com traqueostomia tardia. Foi constatado um resultado significativamente menor do tempo de ventilação dos pacientes traquestomizados precocemente quando comparados com a traqueostomia tardia. Ensaios clínicos randomizados de alta qualidade são

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necessários para avaliar melhor as possíveis diferenças da retirada da ventilação mecânica entre pacientes traqueostomizados.
Descritores | Traqueostomia; Desmame do Respirador.

RESUMEN | La realización de traqueotomía temprana puede reducir el tiempo de ventilación del paciente, facilitando la desconexión del soporte ventilatorio. Además, reduce los costes de hospitalización. Este estudio tiene como objetivo analizar el tiempo de retiro del ventilador en los pacientes traqueostomizados tempranamente después de siete días de soporte ventilatorio. Se trata de una investigación documental, retrospectiva, descriptiva, que recopiló los datos de documentos hospitalarios de la unidad de cuidados intensivos de un hospital en Zona da Mata en Minas Gerais (Brasil). Se recogieron datos de 50 pacientes, entre hombres y mujeres con promedio de edad de 56,6 años, que tuvieron éxito y cumplieron los criterios para la desconexión del ventilador mecánico. Para el análisis estadístico, se dividieron a los pacientes en dos grupos: Grupo temprano, pacientes que se sometieron a traqueotomía con menos de siete días de intubación orotraqueal; y Grupo tardío, pacientes que permanecieron más de siete días con un tubo orotraqueal hasta la realización de la traqueotomía. Hubo un resultado significativo (p=0,04) con respecto a los días de ventilación mecánica tras la realización de traqueotomía, lo que demuestra que los pacientes con traqueotomía temprana pasaron menos días con ventilador mecánico invasivo que los pacientes con traqueotomía tardía. Se encontró un resultado significativamente menor del tiempo de ventilación de los pacientes con traqueostomía temprana en comparación a los pacientes con traqueotomía tardía. Se necesitan ensayos clínicos aleatorios de alta calidad para evaluar mejor las posibles diferencias en el retiro del ventilador mecánico entre los pacientes traquestomizados.
Palabras clave | Traqueotomía; Desconexión del Ventilador.

INTRODUCTION

Indications for tracheostomy are clear, and include prolonged mechanical ventilation, the need to protect the respiratory tract, difficulty in weaning from mechanical ventilation, persistent score below eight in the Glasgow coma scale, polyneuropathy, and upper respiratory tract obstruction. Patients admitted to the intensive care unit (ICU) frequently present chronic, neurological, and degenerative lung diseases, in addition to the associated comorbidities[1].

The use of early tracheostomy in patients with prolonged mechanical ventilation can help to significantly reduce hospital mortality[2,3].

As soon as the basic problem of the patient on mechanical ventilation is solved, the process of removing artificial respiration begins, with daily evaluations by the responsible professional to determine the right time of extubation or removal of the ventilatory prosthesis. Patients who present a prolonged prognosis will be more likely to use invasive mechanical ventilation for a longer period, and most of them undergo tracheostomy. When an endotracheal tube is replaced by a tracheostomy tube there is reduction in respiratory work, improvement on the clearance of respiratory tract secretion, decrease in the risk of pneumonia associated with mechanical ventilation, reduction of sedation, easier weaning process, and relief in respiratory work. Currently, two surgical techniques are used: open and percutaneous. The percutaneous surgical technique at bedside is increasingly used in tracheostomy and is considered a safe and low-cost procedure[1,4,5].

The ideal time to perform tracheostomy – to improve respiratory physiology, reduce the use of sedatives and increase mobility – is still uncertain. This is due to potential harm, such as the surgical procedure risk and the short- or long-term mortality rate, in addition to our inability to accurately predict which patients will require prolonged mechanical ventilation. According to Mehta et al.[6], delaying the decision to perform tracheostomy may allow patients at high risk of prolonged mechanical ventilation to be released from the ventilator, avoiding an unnecessary tracheostomy[6].

Some studies indicate that early tracheostomy does not influence the mortality rate in patients with prolonged mechanical ventilation[2,6-10].

The Brazilian guideline of mechanical ventlation[11] establishes that the procedure of early tracheostomy is within seven days of ventilation and performed in patients with high cervical spinal cord trauma, traumatic brain injury with Glasgow score below 8 and estimated prolonged ventilation; in other patients it is up to 14 days[11].

Previous studies have addressed the benefits of early tracheostomy, influencing the early removal of the artificial respirator. Our study aims to evaluate whether there is a difference in the time of mechanical

ventilation in early tracheostomized patients, after seven days of mechanical ventilation in a Hospital of the Zona da Mata Mineira.

METHODOLOGY

The project was approved by the Ethics Committee on Research (ECR) with Human Beings of the institution *Sociedade de Ensino Superior de Manhuaçu Ltda.*, with CAAE no.15394619.3.0000.5106. This is a documentary, retrospective, and descriptive research. Data were collected from the hospital indicators documents of intensive care unit, of a hospital of the Zona da Mata region in Minas Gerais.

Subjects of the sample

The research was conducted with all patients who met the criteria for weaning from invasive mechanical ventilation and were successfully removed the artificial respirator, from August 2018 to September 2019.

Data collection instruments

The instrument used for data collection is a standard document that is part of the Systemic Procedure PRS. EMA.009 for admission and control of weaning from invasive mechanical ventilation in the hospital in question. The release of these data for research was authorized by the ICU management and coordination.

Spontaneous Breathing Trial (SBT)

Patients are evaluated three times a day (morning, afternoon and evening); those who meet the criteria for reversal of respiratory failure should be submitted to SBT, which should be done by placing pressure support ventilation (PSV) of 5 to 7cmH_20 for 30 to 120 minutes. If the test is positive, and arterial blood gas is within normal parameters, the removal of mechanical ventilation is decided.

Statistical processing of data

The collected data were entered in Excel for Windows 10 (Microsoft Office Professional Plus 2016*)* and later evaluated by the authors through means and standard deviation. Student's t-test was also performed in the samples and the level of statistical significance adopted was 5% – the p-value is equal to or less than 0.05 for statistically significant results ($p<0.05$).

RESULTS

Data consisted of 50 patients who were successful in the weaning of mechanical ventilation and met the study criteria. They were 28 women (56%) and 22 men (44%). For statistical analysis, the patients were divided into two groups: early group – patients who underwent tracheostomy with less than seven days of orotracheal intubation; and late group – patients who remained for more than seven days with orotracheal tube before tracheostomy (Table 1). The late group remained, on average, for 16.57 days on invasive mechanical ventilation, and the early group for 8.07 days.

The late group was 23 patients, 12 females (52.17%) and 11 males (47.83%). The mean age was 56.67 ± 19.9 years. On average, the period with orotracheal tube was 10.87 days, and in invasive mechanical ventilation after tracheostomy was 5.70 days.

The early group was 27 patients, 16 females (59.25%) and 11 males (40.75%). The mean age was 66.29 ± 16.98 years. On average, the period with orotracheal tube was 4.7 days, and invasive mechanical ventilation after tracheostomy was 3.37 days.

Table 1. Epidemiological data collected in both groups of this study

Variables	n (%) or average ± SD		
	Late group	Early group	P value
Number of patients	23 (46%)	27 (54%)	
Age	56.67±19.9	66.29±16.98	0.09
MV days before TQT	10.87±2.36	4.70±1.77	
MV days before TQT	5.70±3.86	3.37±3.92	*0.04
Discharge	11 (48%)	13 (48%)	0.9
Death	12 (52%)	14 (52%)	
Sex			
Female	12 (52%)	16 (59%)	0.62
Male	11 (48%)	11 (41%)	
OTI Motif			
Neurological	11 (48%)	10 (37%)	
Pulmonary	8 (35%)	11 (40%)	0.8
Cardiac	1 (4%)	4 (15%)	
Renal	1 (4%)	1 (4%)	
Apache II	13±4.51	17±4.7	*0.004

SD: standard deviation; MV: mechanical ventilation; TQT: tracheostomy; OTI: orotracheal intubation.
* statistically significant value.

We did not observe significant differences in the two studied groups regarding age, number of discharges/deaths, sex, and diagnosis.

The median and standard deviation of Apache II scores in the early group was 17±4.7 and in the late group 13±4.51.

For analysis between groups regarding orotracheal intubation, patients were divided into 4 subgroups according to the affected physiological function: neurological, renal, pulmonary, and cardiac. Student's t-test was calculated according to the total number of patients by affected function, therefore with two-tailed distribution and unequal variation of two samples. Data on the number of patients for each type of diagnosis are in Table 2.

Table 2. Number of patients and the diagnoses that led to orotracheal intubation

Affected function and diagnosis		
Late group		
Affected function	**No. of patients**	**Diagnosis**
Neurological	8	Stroke
	3	TBI
	1	Encephalopathy
Renal	1	CRF
Pulmonary	6	
	2	ARF
Cardiac	1	APE
	1	CHF
Early group		
Neurological	4	Stroke
	3	TBI
	1	Encephalopathy
	1	ALS
	1	Cerebral edema
Renal	1	CRF
Pulmonary	4	PNM
	4	ARF
	2	COPD
	1	Pulmonary fibrosis
	1	Pleural effusion
Cardiac	3	CHF
	1	VAB

TBI: traumatic brain injury; CRF: chronic renal failure; PNM: pneumonia; ARF: acute respiratory failure; APE: acute pulmonary edema; CHF: congestive heart failure; ALS: amyotrophic lateral sclerosis; COPD: chronic obstructive pulmonary disease; VAB: ventricular atrium block.

DISCUSSION

When comparing the average number of days on invasive mechanical ventilation after tracheostomy, the results demonstrate that the days on invasive mechanical ventilation was significantly lower (p=0.04) in patients with early tracheostomy.

In 2011, Ferreira e Cavenaghi[10] (in a review article seeking to evaluate early tracheostomy in weaning from mechanical ventilation in São Paulo), concluded that early tracheostomy can reduce mortality, ICU hospitalization and mechanical ventilation time. According to the authors, there were disagreements about the definition of early tracheostomy; however, the advantages and disadvantages of the technique seemed to be well elucidated and with good evidence for clinical practice[10].

A review study published in 2016 with eight randomized clinical trials – totaling 1,977 critically ill patients – concluded that early tracheostomies may be preferred to late tracheostomy and should be performed before 10 days of orotracheal intubation, when the patient is expected to require long-term mechanical ventilation (>21 days)[7].

In a 2017 data collection in Taiwan, with a sample of 401 tracheostomized patients, Huang et al.[2]. observed that early tracheostomy (14 days in this case) may be associated with favorable results in critically ill patients on prolonged mechanical ventilation. Significant values were found regarding hospital mortality and risk of pneumonia associated with mechanical ventilation[2].

Another systematic review of the Cochrane platform was conducted in 2015 by Andriolo et al.[9] with the objective of evaluating the efficacy and safety of early tracheostomy versus late tracheostomy. The potential benefits of early tracheostomy – although not definite – appear in mortality, length of ICU hospitalization, and duration of mechanical ventilation. In addition, it reports lower probabilities of pneumonia and greater weaning success. We also emphasize that in this study, Andriolo et al. established that "early tracheostomy" was performed within 10 days of orotracheal intubation and "late" after 10 days of intubation[9].

Therefore, the current literature seems to agree with the significant value found in this study, regarding the days of mechanical ventilation after tracheostomy.

However, the available evidence should be considered with caution, as the information is insufficient to allow conclusions about any subgroup or individual characteristic associated with the indications for early or late tracheostomy. The Keeping[7] review, for example, shows two meta-analyses that evaluated the time of mechanical ventilation and did not report significant differences between early and late tracheostomy[7].

In 2015, in a retrospective cohort study with 70 cardiac patients from an ICU in Southern Brazil, Sakae et al. does not associate early tracheostomy with reduced mortality[8].

Mehta et al.[6], in 2016 (observing that early tracheostomy rates have increased in the United States in patients at risk of prolonged mechanical ventilation), conducted a study with a significant sample of hospitalized patients, aiming to evaluate separately the use and outcomes in patients with the two most common indications of tracheostomy – trauma and pneumonia/sepsis. For this research, the 2012 National Health Care Research and Quality Agency was used. With a stratified probabilistic sample of all non-federal admissions, it identified data in 20% of administrative complaints of all discharges from more than 4,000 hospitals in 44 states. They investigated the variation of early tracheostomy at the hospital level and the results of patients associated with it. They observed a wide intra-hospital variation in the use of early tracheostomy and concluded that mortality did not differ based on tracheostomy time for trauma or pneumonia/sepsis[6].

The Keeping[7] review also concludes that there is no significant difference in mortality between early and late tracheostomy in critically ill patients[7].

These data of mortality rate in groups of early and late tracheostomy agree with our study, since we also did not obtain significant data regarding the number of discharges and deaths among the studied groups[2,6-10].

We obtained a significant result (p=0.004) when we compared the mean Apache II score between the two groups. In the early group, the mean score and the standard deviation were 17±4.7 and in the late group 13±4.51. Therefore, the estimation of mortality in early tracheostomized patients is significantly higher than in the group in which tracheostomy was performed after seven days of orotracheal intubation. This suggests that the most critical patients are usually electives to the early tracheostomy procedure.

Considering that the early group had, on average, a higher Apache II score and even so, remained less time on mechanical ventilation, and that we did not obtain a significant result of discharges/deaths between the two groups, we can conclude that the risk of death does not influence the time of mechanical ventilation.

This data corroborates a cohort study conducted by Aranha et al.[12] with 190 patients in a hospital in São Paulo, in 2007, in which they sought to compare the effectiveness of tracheostomy regarding the time in which it was performed. The study also did not find significant data associating early tracheostomy and the advantages demonstrated by many authors, such as reduced time of mechanical ventilation and length of ICU hospitalization. In their study, the average number of days of orotracheal intubation of the early tracheostomy group was 10.4±1.54 and the average of the late tracheostomy group was 16.23±1.95 days. In our study, the average of days with an orotracheal tube in the group with late tracheostomy was 10.87±2.36, so we can compare our early tracheostomy group with their late tracheostomy group regarding orotracheal intubation days[12].

The average duration of mechanical ventilation after tracheostomy in patients in the early group of Aranha's study was 29.73±19.1; in our study, the equivalent group would be the late group and the average was 5.70±3,86. We can associate this discrepancy with the temporal cutoff of both studies, evidencing the importance of studies focused on this area and the constant and rapid evolution of resources and care for critically ill patients and their weaning from invasive mechanical ventilation.

CONCLUSION

We identified that, in patients with early tracheostomy, the number of days on invasive mechanical ventilation was significantly (p=0.04) lower than in patients with late tracheostomy. In agreement with the most recent literature, our study emphasizes that early tracheostomy is not related to mortality rate.

The results should be carefully analyzed, as the information is insufficient to allow relevant conclusions associated with the best indications for early or late tracheostomy. This is because clinical heterogeneity is a characteristic of patients in general ICU. Further randomized clinical trials of high quality are necessary to better evaluate the possible differences in the removal of mechanical ventilation in critically ill patients submitted to early or late tracheostomy. As well as criteria to determine the exact time to consider early tracheostomy, due to the variation of days in the studied methodology.

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