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Early Tracheostomy in Patients – Arterial Blood Gas Changes

Milena dos Santos Rodrigues da Silva, Valdemir José Alegre Salles, Antônio Vitor Martins Priante

Abstract*— Tracheostomy is a surgical procedure that aims to permeabilize the airways in cases of obstruction, for prolonged mechanical ventilation in critically ill patients, to allow bronchopulmonary hygiene, to maintain the airways and to reduce the airways dead space. Objective: To evaluate whether the use of conventional cervical early tracheostomy determines changes in blood gas parameters and clinical outcomes. Methodology and Casuistry: A retrospective study was performed. Data was collected from the medical records of 52 patients admitted to the Intensive Care Unit (ICU) of the Hospital Regional do Vale do Paraíba. The time util the tracheostomy, was performed, surgical complications, the final outcome of the patients and the arterial blood gas parameters.The study group consisted of both gender patients, with a mean age of 59 years (ranged 17–97. Diseases of the Central Nervous System were the most frequent cause of admission in ICU (45 cases). Results: The average time to perform tracheostomies was 12.6 days. The values arterial blood gas tests in the periods D0, D1, D2 and D3 demonstrate a statistical trend to wards improvement in the blood oxygenation rate represented by oxygen values from the second day (D2), with maintenance from the third day (D3). Of the patients admitted to the ICU, 28 (53.8%) were discharged to the hospital ward, while 24 patients (46.2%) died, due to several factors independent of the tracheostomy. Conclusion: The early tracheostomy can be a surgical procedure with a positive influence on the clinical outcomes of critically ill patients admitted to the ICU, in need of invasive mechanical ventilation.

***Index Terms*— Tracheostomy, mechanical ventilation, arterial blood gas analysis, intensive care..**

I. Introduction

Tracheostomy is a surgical procedure that can be performed emergency or scheduled.[1] Its objectives are to permeabilize the airways in cases of obstruction, facilitate prolonged invasive mechanical ventilation (IMV) in critically ill patients, allow bronchopulmonary hygiene, allow the maintenance of the airways and reduce dead space.[2] It is increasingly used in patients who are in intensive care, to help wean them from artificial ventilation and improve their condition to maintain life, being one of the most frequently performed procedures in critically ill patients.[3]

Its main indication is in patients receiving prolonged ventilatory support, as they are exposed to a variety of late complications resulting from prolonged oral endotracheal intubation. Furthermore, there are other benefits with converting to a tracheostomy, such as: lower rate of self-extubation; better comfort for the patient; possibility of verbal communication; possibility of oral intake; with better oral hygiene and adequate handling by the multidisciplinary team.[4-6]

Despite providing benefits to the patient, tracheostomy must be performed with appropriate surgical technique, as although they are not frequent, complications can lead to the worsening of the clinical condition or even the death of the patient.[7] There is controversy, however, about the moment ideal procedure, as systematic reviews and meta-analyses are limited by the heterogeneity of primary studies, to define the best time to perform a tracheostomy. Those performed in the first 12 days after starting IMV are considered early.[8] In this work, the authors seek to determine the consequences of using early conventional cervical tracheostomy in patients maintained on IMV, analyzing possible changes in blood gas parameters and complications.

II. Methodology

A retrospective study was carried out with data collected from the medical records of 52 patients admitted to the Intensive Care Unit (ICU) of the Hospital Regional do Vale do Paraíba between the period from January 2021 to November 2022, after approval by the Ethics and Research Committee of the institution. The following were analyzed: the time taken to create the tracheostomy, complications resulting from the surgical procedure, the final outcome of patients' hospitalization and the blood gas parameters found in arterial blood gas tests in patients admitted to the ICU and undergoing IMV, comparing the values obtained before (D0) and after performing the tracheostomy in the subsequent three days (D1, D2 and D3, respectively). The study group consisted of patients of both sexes, 39 (75%) were male and 13 (25%) were female, without distinction of race and in the age range of 17 to 97 years, with an average of 59 years.

As causes of ICU admission, several pathological conditions were involved and in this study the most frequent were: vascular diseases of the Central Nervous System (CNS) (25 cases), Traumatic Brain Injury (TBI) (13 cases), CNS Tumor (seven cases), ischemic heart disease (10 cases) and sepsis (22 cases), with patients having more than one diagnosis. General data are described in Table 1. Patients

Milena dos Santos Rodrigues da Silva, Resident Doctor of General Surgery at the University of Taubaté.
Valdemir José Alegre Salles, Adjunct Professor III at the University of Taubaté, General and Digestive System Surgeon.
Antônio Vitor Martins Priante , Adjunct Professor III at the University of Taubaté, Head and Neck Surgeon.
Corresponding author:
Dr Valdemir José Alegre Salles.
Street José Bonani, 199.
Residential Bel Recanto, Taubaté, São Paulo, Brazil.

diagnosed with SARS-CoV-2 infection (COVID 19), infectious or restrictive lung disease, trauma with pulmonary contusion or polytrauma with injury to the upper abdomen did not participate in the study.

Table 1: General demonstration of the characteristics of the study group.

Variable	Category	Number (%)
Age	**Minimum/Maximum Average** **Median**	**17/97** **59,6** **63**
Sex	**Women** **Male**	**13 (25,0)** **39 (75,0)**
Days between intubation and tracheostomy	**Minimum/Maximum** **Average** **Median**	**0 / 33** **12,6** **11**
Outcome	**Discharge to the ward** **Death**	**28 (53,8)** **24 (46,2)**

values less than or equal to 0.05 were considered significant.

III. Statistical analysis

Statistical analysis was performed with the SSPS 13.0 program for Windows. The pO2, pCO2, pH and bicarbonate values were evaluated on the day of the tracheostomy, considered (D0) and on the three subsequent days (D1, D2, D3). Descriptive statistics of absolute and relative frequencies were used to describe the categorical variables. Quantitative variables were described with means or medians. Absolute and relative frequencies (percentages) were used to describe the qualitative variables. To evaluate the distribution regarding normality of quantitative variables, the Kolmogorov-Smirnov test was used. To compare pO2, pCO2, pH and bicarbonate values between D0 and D1, D2 and D3, Student's t or Wilcoxon tests were applied, depending on the parametric or non-parametric distribution, respectively. To compare the time between intubation (start of IMV) and tracheostomy with the outcome (ICU discharge or death), the Mann-Whitney U test was applied. In all statistical tests, p

IV. Result

The average time to perform tracheostomies after starting IMV was 12.6 days (median of 11 days, ranging from less than one day to 33 days). The values collected from arterial blood gas tests in the periods D0, D1, D2 and D3 are distributed in Table 1. Statistical significance is observed with the improvement in the blood oxygenation rate represented by the pO2 values from the second day (D2) of performing the tracheostomy (p=0.031), with maintenance from the third day (D3). No significant variations were observed in the other parameters evaluated. Of the patients admitted to the ICU, 28 (53.8%) were discharged to the ward, while 24 patients (46.2%) died, with no relationship observed between the time of tracheostomy and the outcome (p=0.372).

Table 1: Comparison of values found in arterial blood gas tests.

Blood gas analysis (reference)	Observed Values	Day Zero	Day 1	Day 2	Day 3	*p*
pH (7.35 – 7.45)	Minimum/Maximum	7,29 / 7,62	7,28 / 7,59	7,22 / 7,64	7,06 – 7,57	0,728#
	Average	7,46	7,45	7,45	7,44	0,457#
	Median	7,50	7,47	7,50	7,46	0,559&
pCO2 (35 - 45 mmHg)	Minimum/Maximum	18,0 / 54,0	16,0 / 66,0	18,0 / 63,0	16,0 / 63,0	0,146&
	Average	37,06	35,66	35,32	36,27	0,378&
	Median	37,00	34,50	35,20	36,25	0,575#
pO2 (80 - 100 mmHg)	Minimum/Maximum	43,0 /208,0	30,7 /205,1	72,0 / 224,0	34,8 / 258,0	0,470#
	Average	121,69	127,28	138,96	133,47	**0,031&**
	Median	124	125,5	140,5	137,35	0,197#
HCO3 (22 - 26 mEq/L)	Minimum/Maximum	11,3 / 32,8	8,6 / 36,7	11,7 / 44,0	4,4 / 39,3	0,761&
	Average	25,59	24,72	24,85	24,83	0.521&
	Median	26,85	24,95	25,3	26,45	0,953&

Caption: * Relationship between the values found on days Zero/D1, Zero/D2 and Zero/D3.
Student's t-test, & Wilcoxon test.

V. Discussion

Tracheostomy is fundamental in the ventilatory support of critically ill patients, being indicated with the aim of relieving upper airway obstructions, offering prolonged ventilatory support, reducing dead space, facilitating bronchial cleaning through aspiration, allowing faster weaning from IMV, reducing risks of infection and trauma to the larynx and reduce the risk of stenotic sequelae of the trachea[9].

Its implementation aims to prevent laryngeal and tracheal damage caused by prolonged intubations, especially those that persist for more than 10 days, which present between 1% and 19% of long-term complications, highlighting laryngotracheal stenosis and up to 94% of damage detected in histology10. Another advantage of tracheostomy is that it reduces IMV time and ICU stay, minimizing the risk of hospital infections.[11,12]

The average time to perform a tracheostomy after orotracheal intubation, in this study, was 12.6 days. According to the literature, this is an adequate interval for performing a tracheostomy and it is considered an essential procedure for the recovery of critically ill patients in need of ventilatory support. Performing it early can result in shorter ICU stays, in addition to avoiding other complications directly related to the airways.[13] Procedure-related morbidity can vary from 4% to 9.4% in procedures performed in the operating room and 8.7% in those performed at the bedside in the ICU. We did not observe any major complications during the surgical procedure or progression to death as a result of the tracheostomy. During hospitalization in the ICU, death occurred in 24 cases (46.2%) due to various causes and without direct relation to the tracheostomy surgical procedure. Studies demonstrate that classic endotracheal intubation makes adequate lung hygiene difficult in patients with high mucus and secretion production, therefore tracheostomy is justified in these patients, as it allows more direct aspiration of secretions through the cannula, with better airway hygiene.[14]

Before the COVID-19 pandemic, the main indication for performing a tracheostomy was the premise of prolonged mechanical ventilation support, although the ideal moment in seriously ill patients was dependent on a multivariate analysis and sometimes on the experience of the medical team.[15]

. Early tracheostomy was proposed as a way to accelerate weaning from mechanical ventilation, freeing up equipment, specialized personnel and critical beds, although this condition must be individualized.[16] Reported indications for tracheostomy have included failed extubation (including several multiple attempts), failure to withhold sedation, and anticipated prolonged respiratory weaning.[17]

Considering early complications of the tracheostomy procedure, we have: drop in saturation, when there is a decrease of more than 4% in oxygen saturation (SpO2) by pulse oximetry or SpO2 of less than 90%, for more than one minute; arrhythmias, with a 40% increase or decrease in heart rate in relation to the initial heart rate and/or changes in heart rhythm; arterial hypertension, with a 30% increase in blood pressure compared to baseline blood pressure; arterial hypotension, with a 30% decrease in blood pressure compared to baseline blood pressure or mean arterial pressure less than 65 mmHg; hemorrhage, which can be: mild, whose bleeding requires continuous aspiration of the airways, with spontaneous stoppage; moderate, when bleeding requires hemostatic maneuvers and greater, when bleeding requires resuscitation with crystalloids, transfusions of blood products or suspension of the procedure. Likewise, other complications are considered, such as unscheduled removal of the orotracheal tube, airway injury, esophageal injury, pneumothorax and pneumomediastinum.[18,19]

One of the ways to measure the influence of tracheostomy or prolonged intubation on the patient's metabolic behavior is the quantification given by arterial blood gas analysis. Arterial blood gas analysis is a routine test performed on patients hospitalized in the ICU and is indicated for evaluating disturbances in acid-base balance, pulmonary oxygenation of arterial blood and alveolar ventilation[4], thus allowing the assessment of the risk of organ compromise, which can determine the clinical evolution to death.[20]

Knowledge about the homeostatic mechanisms that control the body's acid-base balance is essential, as acid-base disorders are related to a greater risk of organ and system dysfunctions and deaths in hospitalized patients.[21] The results of blood gas analysis are used to evaluate respiratory diseases and other conditions that affect the lungs, as well as providing information regarding metabolic diseases through the interpretation of the functioning of organic buffer systems.[22,23]

Although the authors' conclusion is in favor of early tracheostomy, this is a retrospective study limited by not having a control group which did not undergo the tracheostomy procedure.

VI. Conclusion

Performing early tracheostomy can be a surgical procedure with a positive influence on the clinical evolution of critically ill patients admitted to the ICU, requiring IMV.

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