Journal of Surgery
2023; 11(5): 113-118
http://www.sciencepublishinggroup.com/j/js
doi: 10.11648/j.js.20231105.15
ISSN: 2330-0914 (Print); ISSN: 2330-0930 (Online)

Tracheostomy in Critically Ill Patients Due to COVID-19 Before the Vaccine, Cases and Controls

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To cite this article:

María Norma Gómez Herrera, Aurora García Gómez, María Enriqueta Baridó Murguía, Jaime Carranza Madrigal, Lizbeth Corzo Aguilar, Elena López Gavito. Tracheostomy in Critically Ill Patients Due to COVID-19 Before the Vaccine, Cases and Controls. *Journal of Surgery*. Vol. 11, No. 5, 2023, pp. 113-118. doi: 10.11648/j.js.20231105.15

Received: September 10, 2023; **Accepted**: October 4, 2023; **Published**: October 28, 2023

Abstract: *Objective*: This study aims to identify factors associated with death in seriously ill patients with SARS CoV-2 pneumonia who required a tracheostomy and the time in which the procedure was performed. *Patients and methods*: The study was observational, analytical, prospective, cross-sectional, and case-control in nature. The decision to perform a tracheostomy was based on the clinical conditions and the approval of the Institutional COVID Committee. To compare means of continuous numerical variables, paired and unpaired Student's t test was used depending on the variables analyzed; to establish correlation between continuous numerical variables, the Pearson correlation coefficient was calculated; to analyze the probability of death with respect to the variables studied, the odds ratio was calculated with a 95% compatibility interval. *Results*: a total of 47 severely ill patients with COVID-19, who were admitted to the Intensive Care Unit, and required a tracheostomy, 17 women and 30 men, underwent an open tracheostomy. The population was predominantly male, and blood type A+ was more common. Most of them had at least one of the following comorbidities: Diabetes, hypertension, obesity or smoke. Only 10 patients survived until the end of following. All tracheostomies were performed in the first days of the illness, even in the first seven days, except for one patient. All tracheostomies were performed openly, almost all within a conventional operating room and performed by General Surgeons; We have not had any early or late complications, although the risk of tracheal stenosis remains latent; none of the surgeons presented symptoms of the disease, although detection test were never applied to us. *Conclusion*: In this group of patients, diabetes, systemic arterial hypertension, obesity, blood type "A" and age over 65 years were associated with higher mortality, while no improvement was shown when tracheostomy was performed early, even the first 7 days.

Keywords: COVID-19, Tracheostomy in COVID, Early Tracheostomy, Cases and Controls, Pandemic, COVID Risk

1. Introduction

The worldwide pandemic caused by the SARS-CoV-2 virus, which causes COVID-19, results in rapid respiratory decompensation when severe in 10-15% of cases [1, 2]. Therefore, endotracheal intubation and assisted mechanical ventilation are necessary. COVID-19 is more frequent in men (58.1%) than in women (41.9%) [3, 4]. Tracheostomy or Tracheotomy is the surgical incision made in the anterior aspect of the trachea to facilitate pulmonary ventilation. Early tracheostomy is effective in critically ill patients because: 1. It reduces respiratory effort in patients with limited pulmonary reserve. 2. It decreases dead space. 3. It allows easy secretion management. However, a critically ill patient with COVID-19 also has fluctuating levels of structural lung damage. The tracheostomy is a procedure associated with lessening invasive mechanical ventilation time, mortality, and length of stay in intensive care units for critically ill patients [5]. A group of researchers ascribed a

favorable prognosis in the evolution of patients with SARS CoV-2 who underwent tracheostomy [6, 7]. The benefits of this surgical procedure would be to reduce ventilation time, less sedation, and consumption of muscle relaxants [8], a significant reason in our environment since there is a limited number of ventilators. This study aims to identify factors associated with death in severe COVID-19 patients who underwent tracheostomy and the timing of the procedure.

2. Patients and Methods

A study was carried out on COVID-19 patients who needed mechanical ventilation and underwent tracheostomy at the General Hospital "Dr. Miguel Silva" in Morelia, Michoacan. The study was observational, analytical, prospective, cross-sectional, and case-control in nature. The decision to perform a tracheostomy was based on the clinical conditions and the approval of the Institutional COVID Committee.

From April 1, 2020 to May 30, 2021, we provided patients with endotracheal cannulas of varying sizes (6, 7, or 8 Fr.) based on their trachea diameter. We only considered patients who survived as cases, while those who passed away were considered controls. We documented important patient information such as their gender, age, disease progression timeline, tracheostomy timing, length of hospital stay, blood type, and any related medical conditions such as diabetes, obesity, overweight, hypertension, and smoking. Additionally, we recorded laboratory test results taken at the time of tracheostomy, including blood cytometry, and systemic inflammation markers such as C-reactive protein, D-dimer, ferritin, serum electrolytes, and uremia.

We analyzed the data using different statistical methods. We determined the central tendency using arithmetic mean and measures of dispersion. We compared categorical variables using Chi-square and compared continuous numerical variables using paired and unpaired Student's t-tests. We calculated Pearson's correlation coefficient to establish correlations between continuous variables. To determine the probability of death relating to the variables studied, we calculated the odds ratio with a 95% compatibility interval. We considered P values significant if they were less than 0.05. Additionally, we followed up with survivors for a period of ten months.

3. Results

The study included 47 patients with COVID-19 who were critically ill and required tracheostomy during their stay in the Intensive Care Unit. The group consisted of 17 women and 30 men, with the average age being lower than that reported in other similar studies. The population was predominantly male, and blood type A+ was more common.

Most of them had at least one of the following comorbidities: Diabetes, hypertension, obesity or smoke. Only 10 patients survived until the end of following.

Table 1 presents the characteristics of the study population, including absolute numbers and averages with DE.

Table 1. *Characteristics of the studied population. Values in absolute numbers and average with SD.*

Variable	Valor
Age (years)	56.4±10.6
Sex (M/F)	30/17
Hospital stay (days)	21.2±9.2
SOFA	9.04±2.6
Blood Type (A+/others)	18/29
Lymphocytes /mcL	1900.4±1587
Hemoglobin (g/dL)	11.7±2.2
Platelets /mcL	270894±123092
Creatinine (mg/dl)	1.19±1.18
Serum Na (meq/l)	142.5±4.9
Comorbidities (any/none)	37/10
Evolution time (days)	11.8±6.8
Day of tracheostomy performance	11.8±5.1
Ferritin (ng/ml)	1651.8±1365.9
D-dimer (mcg/ml)	4.9±4.1
CRP (mg/dL)	248.7±135.4
Intubation duration (days)	16.3±8.5
Outcome (living/deceased)	10/37

Table 2 displays the correlation between SOFA, an indicator of multiple organ damage, and other continuous numerical variables. The table highlights that serum ferritin concentrations had the highest correlation with SOFA, followed by creatinine, CRP, hemoglobin, and lymphocyte count, in that order.

Table 2. *Correlation with respect to the SOFA of the continuous numerical variables.*

Variable	r
Age	-0.09
Lymphocytes /mcL	0.10
Hemoglobin (g/dL)	0.15
Platelets /mcL	-0.10
Creatinine (mg/dl)	0.39
Na serum (meq/l)	-0.07
Evolution time (days)	0.16
Days of tracheostomy performance	-0.03
Ferritin (ng/ml)	0.41
D-dimer (mcg/ml)	-0.21
CRP (mg/dL)	0.17

In table 3, we can see a comparison between patients who survived and those who didn't. The table indicates that patients who passed away had longer stays at the hospital, higher SOFA scores, a higher proportion of blood type A+, and a higher presence of comorbidities.

Table 3. *Characteristics of the studied population divided by outcomes. Values in absolute numbers and average with SD. * = $p<0.05$ vs deaths.*

Variable	Deceased (37)	Alive (10)
Age (years)	56.9±11.2	55.7±8.2
Sex (M/F)	22/15	6/4
Hospital stay (days)	20.05±8.4	27.1±10.6*
SOFA	9.1±2.6	7.3±3.1*
Blood Type (A+/others)	15/22	2/8
Lymphocytes /mcL	1895.09±1666.9	1690.9±1266.8

Variable	Deceased (37)	Alive (10)
Hemoglobin (g/dL)	11.6±2.4	11.8±1.4
Platelets /mcL	273135±128312	266400±106535
Creatinine (mg/dl)	1.3±1.3	0.7±0.3
Serum Na (meq/l)	142.8±5.1	141.5±3.6
Comorbidities (any/none)	30/7	3/7
Evolution time (days)	12.2±7.2	11.1±5.2
Day of tracheostomy performance	12.6±5.1	10.1±4.1
Ferritin (ng/ml)	1606.8±1485.3	1587.1±875.4
D-dimer (mcg/ml)	4.9±4.5	4.6±2.8
CRP (mg/dL)	250.4±131.5	213.04±114.6
Intubation duration (days)	16.8±8.8	16.2±7.4

Figure 1 illustrates the probability of death for the variables studied.

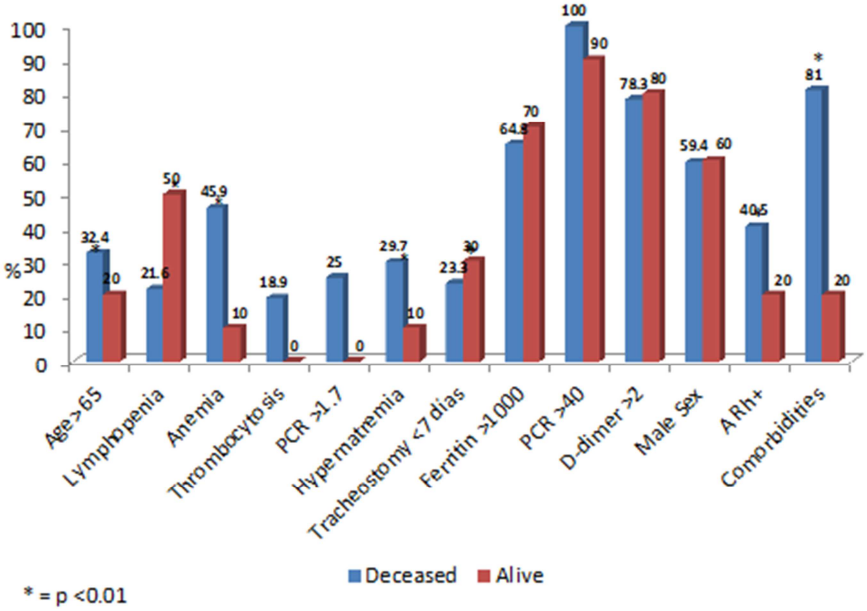

Figure 1. *Percentage of Alterations and Survival.*

The analysis shows that patients over 65 with anemia, thrombocytosis, hypernatremia, blood type A+, and other comorbidities have a higher risk of death issues are more prone to pass away. Contrarily, survivors showed a greater likelihood of lymphopenia. Both groups had in common the tracheostomy was performed early, even in the first seven days.

All patients were diagnosed with COVID-19 upon admission or during their hospital stay. They were all very ill, with a SOFA (Sequential Organ Failure Assessment) index of 9.04 ± 2.6. Unfortunately, 30 patients passed away, and only ten survived. A tracheostomy was performed early in this population, even if it had been less than seven days since the onset of the disease. On average, the tracheostomy was performed 11.8 days after diagnosis. The surgeons performing the procedure wore personal protective equipment, including an N95 mask, goggles, and a waterproof gown. The tracheostomies were open and performed by two surgical teams of general surgeons. After the procedures, none of the surgeons showed clinical signs of the disease, although no surgeons were screened

Figure 2 Ilustrates the odds ratio of dying and shows that patients over 65 with anemia, hypernatremia, blood type A+, and other comorbidities had a death risk several times higher that patients without these features.

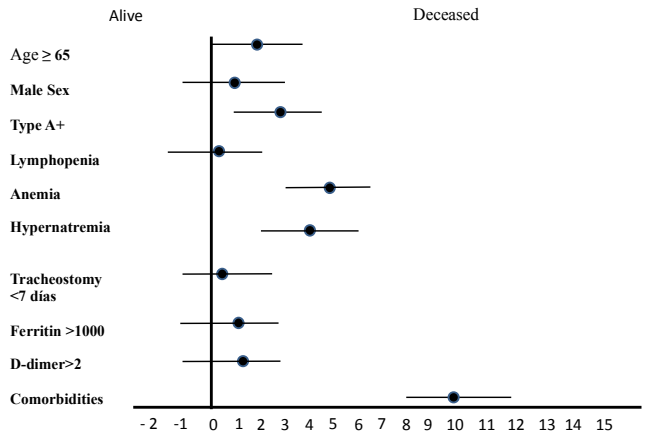

Figure 2. *Conditions associated with the probability of dying in tracheostomized patients with COVID-19.*

4. Discussion

The General Hospital "Dr. Miguel Silva" is it is also teaching hospital and referral hospital too, converted to a hybrid during the pandemic; Many patients arrived in critical condition due to atypical pneumonia caused by SARSCoV-2, which caused varying degrees of respiratory failure, and tracheostomy is a life-saving surgical procedure; in this group all tracheostomies were performed in open surgery by

general surgeons because this is the technique we apply, and we have the necessary equipment for it. Most of the procedures occurred in a conventional operating room. In contrast, in other centers, more than 78% of the tracheostomies were by puncture [9]. Many researchers prefer it because they performed the surgery at the patient's bedside [7, 11], and not all centers have a bronchoscope available to all, which is necessary to avoid blindly performing the puncture and injuring the posterior wall of the trachea, which would cause fatal complications [11, 12]. Furthermore, a second surgeon to handle the bronchoscope during the surgical procedure is preferred [13, 14]. Several studies have shown no differences in morbidity and mortality when comparing open and puncture techniques [15, 16]. We consider that conditions at every hospital vary and influence the approach technique. It is worth mentioning that after the tracheostomies took place, despite being a highly aerosolizing procedure, no one from the surgical team showed symptoms, even though several manuscripts refer to it as highly contagious [17, 18]. However, we do not precisely know if any contagion occurred in the surgical team since tests were scarce during the pandemic's peak and when no one was vaccinated.

The time within the literature recommended performing a tracheostomy in these patients varied to such an extent that 17 guidelines referring to this aspect were published from March 16 to April 9, 2020 [19]. Some guidelines considered early tracheostomy when performed on day 12, other groups on day 14 after the onset of the disease, and most recommended performing it after day 21, after catching the disease, to reduce the risk of contagion to healthcare workers and because patients who require assisted mechanical intubation have a poor prognosis [20-24]; therefore, we recommend reevaluating the cases objectively, before performing a tracheostomy.

Something that differs from what is reported in the literature, in our group, a tracheostomy was not delayed in any patient being performed even in the first seven days of the disease and was the cause of great debate. Nevertheless, only one case was carried out in this series after day 21 from the start of COVID-19. When decisions were necessary, the conduct to follow was not yet standardized and decided on the fly. Even though it facilitated the management of secretions in the patient, the odds ratio calculation did not show any improvement in these cases, even in patients who underwent a tracheostomy in the first seven days of the disease.

Metabolic disorders such as diabetes, obesity, and systemic arterial hypertension are serious pathologies that severely affect a patient who suffers from them already. Many Mexicans who lost their battle during the COVID-19 pandemic had one or more of these diseases, which are known to predispose COVID-19 carriers to a dismal outcome because of the alteration in ACE2 (Angiotensin-converting enzyme 2) under these pathological conditions [25]. ACE2 is also the cause of systemic arterial hypertension prone to SARS CoV2 infection [26]. The above mentioned has been demonstrated in other works and by different authors [27, 28], and there are no different opinions. Diabetes and obesity also predispose the patient to an excessive proinflammatory response, something also validated in this group [29] where CRP, ferritin, and dimer were high in both groups, but the increase of the last two was higher in the deceased group, while C-reactive protein remained elevated in both groups. Men were more affected than women due to the presence of the risk factors described, and experts have shown that women respond more effectively to viral infections [30].

The many benefits of tracheostomy have led to a global upward trend in the frequency, let us also remember that tracheostomy is not harmless, although in this group no complications are reported, it does not mean that the risk of developing them has ended; complications secondary to the procedure are divided into early and late, the most frequent being bleeding, infection, obstruction of the tracheostomy tube, and injury to the posterior wall of the trachea; at least in this series, we did not have this type of complications, nor bleeding, even though the patients were anticoagulation, anticoagulation was suspended 12 hours before; and other groups with critically ill COVID-19 patients report few complications as well [31], but the tracheal stenosis is still latent; the incidence of and risk factors associated with tracheal stenosis in critically ill patients with COVID-19, who required the tracheostomy, are currently unknow [32]. these authors treated 13 patients with post-COVID-19 tracheal stenosis in a period of a twenty-three months [32]; and these reports are likely to increase [33, 34], may become a relevant pathology within the next few years: [35]. So far, in this study, no one has presented tracheal stenosis.

Obesity has been identified as a risk factor for developing complications after a tracheostomy [36]; the relationship between obesity and tracheal stenosis is also mentioned [37]. In this study did not present complications inherent to tracheostomy; the type of tracheostomy, surgical or percutaneous, appears to be unrelated to an increased tendency to stenosis [37].

Some reports good results by performing "moderately early" tracheostomies in patients with COVID-19, this is what they call the tracheostomy that is performed on the fourteenth day of the onset of the disease, our patients do not seem to have benefited from this modality.

5. Conclusion

In this group of patients critically ill with COVID-19, who were admitted to the intensive care unit, diabetes, systemic arterial hypertension, obesity, blood group A and age over 65 years were associated with higher mortality, as well Likewise, our results do not support performing an early tracheostomy in this group of patients.

Declare

All authors declare that they have not received any type of funding for the preparation of this work.

Conflicts of Interest

All authors declare that they have no conflict of interest.

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