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ORIGINAL STUDY

Impact of tracheostomy in patients with severe acute respiratory syndrome due to coronavirus infection

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ABSTRACT

OBJECTIVE. To estimate the effect of tracheostomy on ventilation in patients with COVID-19.

MATERIAL AND METHODS. An observational, retrospective, analytical, longitudinal study of a consecutive series of cases was carried out between April 2020 and March 2021. The study included data about different variables, such as age, sex, comorbidities, time of orotracheal intubation, place of surgery, complications and death, ventilatory parameters, blood gas and time of the weaning after tracheostomy. Descriptive statistics were used with measures of central tendency, measures of dispersion and the Wilcoxon test to see differences in the ventilatory parameters.

RESULTS. The study was performed on 130 patients admitted to the ICU with intubation to manage their critical condition. From these patients, the study group included 31 who underwent tracheostomy, 25 males (80.64%) with a mean age of 57.1±13.395 years and with 20.52±6.722 days in orotracheal intubation. Among the most frequent comorbidities, we encountered: arterial hypertension (51.6%), obesity (35.4%), diabetes mellitus (22.5%), hypothyroidism (6.4%), asthma (3.2%), pregnancy (3.2%), chronic obstructive pulmonary disease (3.2%) and obstructive sleep apnea syndrome (3.2%). The main complications were bleeding (12.9%) and decannulation (3.2%). The survival rate was 90.32%. Comparing the pre-surgical and postoperative outcomes of the ventilatory parameters and blood gas, statistically significant differences were found only in case of PEEP ($p = 0.033$), FiO2 ($p = 0.001$) and O2 saturation ($p = 0.001$). The average removal of the ventilator was 4.3±2.437 days.

CONCLUSION. There were no significant changes in the ventilatory parameters, however, they were sufficient to wean the patients from the ventilation team and discharge them to the internal medicine department to continue their management outside the intensive care unit.

KEYWORDS: tracheostomy, ventilator weaning, parameters, coronavirus.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) causes severe acute respiratory syndrome, determined by the infection with coronavirus 2 (SARS-CoV-2). It was declared by the World Health Organization as a pandemic in March 2020, due to the increasing number of cases worldwide. Approximately 17 to 35% of patients hospitalized with SARS-CoV-2 infection were admitted to an intensive care unit, primarily due to hypoxemic respiratory failure[1]. More than 75% of hospitalized COVID-19 patients required supplemental oxygen administration and 3-15% will require further mechanical ventilation[1-3]. In a study of 52 critically ill COVID-19 patients, 81% of the 37 patients who were on mechanical ventilation died at 28 days[4]. Another clinical study performed on 191 hospitalized patients notes that the survival rate was 71.72% (137 patients) and from the 32 patients (17%) who required mechanical ventilation only one survived[5]. Therefore, it becomes evident that for the patients with COVID-19 undergoing mechanical ventilation the prognosis is poor and some cases need long periods of respiratory support.

Since tracheostomy is one of the final efforts that will be offered to patients on mechanical ventilation, it should certainly be considered the possibility of performing it in patients who present favourable conditions and better

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prognosis[6-8]. Several indications for performing a tracheostomy are often mentioned, but very few are supported by convincing evidence. Disconnecting the dependence on mechanical ventilation has also been pointed out as one of the great points in favour of tracheostomy over intubation. However, there are authors who state that there is no evidence that tracheostomy is associated with advantages to remove patients from mechanical ventilation[9-12]. Some studies have shown a significant reduction in intrinsic positive end expiratory pressure (PEEP)[9,13]. There are also authors who note that after tracheostomy, respiratory work and airway resistance are reduced, compared to breathing through an endotracheal tube[13-16]. However, there are some results that showed no difference in current volume before and after the procedure[17,18]. Some authors describe that the tracheostomy changed the pulmonary mechanics very little, except for a drop in the maximum inspiratory pressure and, with it, better chances of disconnecting from mechanical ventilation[18,19].

Given this dilemma, the purpose of our study was to evaluate the effects of tracheostomy on ventilatory parameters, in a group of patients with orotracheal intubation for COVID-19 who met the criteria for the procedure.

MATERIAL AND METHODS

An observational, retrospective, analytical, longitudinal study was carried out between April 2020 and March 2021. We used a non-probabilistic sample, consisting of a consecutive series of cases of orotracheal intubation (IOT) and tracheostomy for the management of the SARS-CoV-2 infection. Patients operated on in the Intensive Care Unit (ICU) bed and the operating room with open technique were included. In all cases, we analysed the following variables: age, sex, comorbidities, IOT time, complications and death, ventilatory and gasometric parameters and post-tracheostomy weaning time. The gasometric parameters investigated in the study were the fraction of inspired oxygen (FiO_2), positive pressure at the end of expiration (PEEP), hydrogen potential (HCO_3), carbon dioxide partial blood pressure (PCO_2), oxygen partial blood pressure (PO_2), arterial blood oxygen pressure (PaO_2) and ventilator weaning.

The data were entered into a Microsoft Excel spreadsheet and the statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 26.0 for Windows, where we perform descriptive statistics with measures of central tendency and measures of dispersion. Fisher's exact test was used to evaluate factors associated with mortality in patients undergoing tracheotomy. For demographic and clinical variables, we used the Wilcoxon test to see differences in ventilatory parameters. A value of $p \leq 0.05$ was considered statistically significant.

RESULTS

From April 2020 to March 2021, a total of 493 patients were received in the COVID-19 conversion area of our hospital, of which 360 (73.02%) were confirmed with SARS-CoV-2 infection and 133 (26.98%) suspected. Of these, 130 patients (26.37%) were admitted to the ICU for the management of their critical condition and 31 of them (23.84%) underwent tracheostomy and met the criteria indicated by national and international organizations to perform a safe procedure. In the study group, there were 25 male (80.65%) and 6 female (19.35%), with a mean age of 57.1±13.395 years (range 30 - 88) and a mean period of 20.52 ±6.722 days (range 11-43) in orotracheal intubation.

The associated comorbidities identified in the study group were arterial hypertension (16, patients, 51.6%), obesity (11 patients, 35.4%), diabetes mellitus (7 patients, 22.5%) hypothyroidism (2 patients, 6.4%), asthma (1 patient, 3.2%), pregnancy (1 patient, 3.2%), chronic obstructive pulmonary disease (1 patient, 3.2%) and obstructive sleep apnea syndrome (1 patient, 3.2%) (Table 1). More than 40% of the cases presented two or more comorbidities, where hypertension and obesity were the most common.

There were 4 complications in 12.9% of the operated patients, of which 3 were haemorrhages and one accidental exit of the tracheostomy cannula (Table 1). The survival rate was 90.32% (28 patients) and a mortality of 9.68%. Fisher's exact test was performed to analyse the association between the presence of one and two or more variables with the sample, without finding significance with a value of p=0.635. Fisher's exact test was performed to analyse the association between age equal to or less than 50 years and equal to or greater than 51 years and death, without finding significance with a value of p=0.365.

The average time of ventilator withdrawal after tracheostomy was 4.3±2.437 days (range 1-10).

When comparing the presurgical versus post-surgical results using the Wilcoxon test, in ventilatory parameters and blood gases, statistically significant differences were found in PEEP (average values before surgery 7.77 vs after surgery 7.16, $p = 0.033$), FiO_2 (average values before surgery 47.3 vs after 38.4, $p = 0.001$) and O_2 saturation (average values before surgery 95.3 vs after 97.6, $p = 0.001$) (Table 2). The other evaluated geometric parameters such as pH (average values before 7.429 vs after 7.44, $p = 0.157$), PO_2 (91.43 vs 91.17, $p = 0.905$), PCO_2 (average values before 41.4 vs after 39.7, $p = 0.060$), HCO_3 (average values before 29.1 vs after 27.40, $p = 0.068$) and PaO_2/FiO_2 (average values before 221 vs after 243, $p = 0.256$), did not present statistically significant differences (Table 2).

We found no association between the number of comorbidities aged over 51 years and death.

Table 1. Demographic data of 31 patients operated on for tracheostomy for COVID-19 (Source: Otolaryngology Service of the Specialty Hospital No 2, IMSS, Ciudad Obregón, Sonora; April 2020 to March 2021).

	n	%
Male	25	80.6
Female	6	19.5
IoT Days	20.52 days ±6.722(range11-43)	
Comorbidity		
SAH	16	51.6
Obesity	11	35.4
Diabetes mellitus	7	22.5
Hypothyroidism	2	6.4
Asthma	1	3.2
Pregnancy	1	3.2
COPD	1	3.2
OSAS	1	3.2
Complications	4	12.9
Live	28	90.3
Dead	3	9.6
Fan withdrawal time	4.3 days ±2.437 (range 1-10)	

SAH= systemic arterial hypertension, COPD = chronic obstructive pulmonary disease, OSAS = obstructive sleep apnea syndrome.

DISCUSSIONS

Comparing our results with the ones found in the literature, Livneh et al.[20] reported 38 tracheostomies performed on a series of cases, similar with our study, in the same period of time, with a male gender dominance of 87% versus 80.65% in our case, while in Reis et al.[21] study, performed between 2020-2021 on 42 patients with SARS-CoV-2, 71% of the patients were males. The mean age of the patients included in these two studies was 57.1±13,395 years (range 56-72) in Livneh et al. and 68.4±11.1 years (range 47-90) in Reis et al. study[20,21]. With respect to the time of IOT, in our series it was of 20.52±6.722 days (range 11-43), higher compared to the time reported by Livneh et al. with 16 days[20], but similar to the results of Reis et al. of 22.9±6.5 days[21]. Among the factors associated with death, some comorbidities such as heart disease and age over 60 years are described. However, in our sample we did not find an association between age over 50 and death, as well as more than two comorbidities. These findings could have been influenced by the fact that heart disease was not recorded in our sample.

Regarding the associated comorbidities, the most common one found in our study group was arterial hypertension (51.61%), similar to that described by Zuazua-González et al. with 51.8%[22] and Reis et al. with 71% of patients with heart diseases[21]. As a second cause of comorbidity, it was reported obesity (35.4%) and as a third, most important, diabetes mellitus (22.58%). Our results were in accordance with the ones presented by Zuazua-González et al.[22] with 25.3% cases with diabetes mellitus. Reis et al. reported that, in their case series, 40% of the patients had diabetes and 33% were obese[21]. The discrepancy between our results and that of Reis et al. regarding obesity can be determined by the epidemic of obesity in our country.

The proportion of total postoperative complications was similar to that described by Reis et al. with 7.1%[21] against 12.9% of our series and lower than that described by Zuazua-González et al. in Spain with 60%, the most frequent being bleeding (30%), local infection (26.7%)[22]. Reis et al. present a complication rate of 7.1%, represented by haemorrhage in 2 patients and subcutaneous emphysema in 1 patient[21].

We presented a mortality after the tracheostomy of 9.68%, which is higher than that described by Livneh et al., who describes that death resulted in 31 days (SD 15)

Table 2. Ventilatory and gasometric data before and after surgery in 31 patients operated on (Source: Otolaryngology Service of the Specialty Hospital No 2, IMSS, Ciudad Obregón, Sonora; April 2020 to March 2021).

	Average prior to tracheostomy	Average after tracheostomy	*P-value*
PEEP	7.77	7.16	.033
FiO2	47.3	38.4	.001
pH	7.429	7.44	.157
PO2	91.43	91.17	.905
PCO2	41.4	39.7	.060
Saturation O2	95.3	97.6	.001
HCO3	29.1	27.40	.068
PaO2/FiO2 Kirby Index	221	243	.256

Ph: Hydrogen potential, PCO2: Carbon dioxide pressure, PO2: Oxygen blood pressure, PO2: Oxygen blood pressure, HCO3: Carbon dioxide, FiO2: Oxygen fraction, PEEP: positive pressure at the end of expiration, PaO2/FiO2 or Kirby index oxygen blood pressure / inspired fraction of oxygen is an indicator that measures gas exchange.

after the procedure, the mean time of hospitalization of these patients 30 days (SD 22 days)[20]. Our mortality rate was lower than that reported by Zuazua-González et al.[22] with 56.7% and Reis et al.[21] with 26%. Reis et al. found a relationship between comorbidities and the risk of death, reporting it in heart diseases (71%), diabetes (40%) and obesity (33%). In the same way, it was found a higher risk of death in those over 65 years of age. In our cases, we did not find differences between those over 50 years of age and those over 51 years of age and no association between one or more comorbidities and death.

The average time of ventilator withdrawal was 4.3±2.437 days. In comparison, Reis et al. reported 7.6±5.3 days[21], Livneh et al.[20] 25±19 days and Zuazua-Gonzales et al.[22] 28.14±10.19 days. Analysing the time on mechanical ventilation, the ventilation withdrawal in case of COVID-19 patients seems to be similar to the data found in cases of other pathologies such as multiple organ trauma, tumors, accidents, neurological diseases[21-24]. These findings sustain the idea that one of the supposed advantages of tracheostomy is the reduction of mechanical ventilation time.

Within the ventilatory parameters, authors such as Livneh et al.[20] found significant differences in the PEEP value ($p = 0.024$) with a decrease after the procedure, similar to what was found in our series ($p = 0.033$), as well as significant changes in FiO_2 ($p = 0.021$), similar to that of us ($p = 0.001$). Livneh[20] found differences in the Kirby index (PaO_2/FiO_2) after the procedure ($p = 0.018$), but in our cases it was not statistically significant (p=0.256). Giacomo Bellani et al.[17] in Italy, evaluated the effect of percutaneous tracheotomy in patients without COVID-19, finding a marginal decrease in $PaCO_2$ (43±9 mmHg vs 42±7 mmHg, before vs after, $p = 0.004$) and an increase in pH (7.43±0.04 vs 7.44±0.03, before vs after, $p = 0.03$) after tracheostomy. Their results were different from what we found in our series, where there were no significant differences in these parameters. On the other hand, Meng-Chih Lin et al.[19] from Taiwan, in a sample of patients without COVID-19, did find a significant difference in PEEP (pre 33.4±11.8 vs post 28.6±9.2 mmHg, $p = 0.04$), similar to our results. This author does not include other parameters similar to ours and concludes that possibly the reduction in PEEP could have better results for weaning the ventilator, as in our series.

CONCLUSIONS

The demographic aspects, comorbidities, complications and mortality after the tracheostomy are comparable to what is described by different works at the international level. Changes in the ventilatory parameters are similar to what was described by some authors, the time for the withdrawal of the ventilator after the tracheostomy was similar to what some research indicates. Considering our findings, we can sustain that the tracheostomy in case of patients with severe acute respiratory syndrome due to coronavirus infection might lead to a more effective and safe ventilation than in case of intubated patients, with improved outcomes and lower mortality rates.

However, there is still controversy about how the procedure manages to accelerate the "weaning" of the ventilator, because the changes that are generated in most of the ventilatory parameters are not significant.

Limitations: This is a study with a limited number of patients, as well as non-parametric statistics due to their non-normal distribution of the population.

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