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LONG-TERM ALTERATIONS IN THE UPPER AIRWAY AS A RESULT OF A LATE TRACHEOSTOMY DUE TO COVID-19. AN APPROACH FROM PHYSIOTHERAPY

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Abstract: During the pandemic caused by COVID-19, what is the highest rate of episodes of respiratory failure requiring mechanical ventilation was recorded to date within critical areas, with prolonged periods of hospitalization. Minimize contagion as much as possible, leading to dismissing strategies that shorten the days on mechanical ventilation. Tracheostomy is valued for reducing mechanical ventilation time, favoring weaning, lowering the mortality rate, and avoiding upper airway lesions. However, few healthcare centers were able to generate strategies that promote early uncoupling between patient and ventilator. This fact could explain the appearance of pathological signs such as cord dysplasia, stenosis, granulomas, and dysphagia that alter phonation processes. swallowing and respiratory Aspects such as a brief and timely diagnosis, generation of physiotherapeutic strategies that are validated, with favorable repercussions and together with a multidisciplinary team specialized in dealing with this problem could address this population and prevent these sequelae from becoming a red flag for the health system. We present a brief description of what is documented to date on the repercussions of the airway in post-COVID-19 patients.
Keywords: Airway, mechanical ventilation, tracheostomy, COVID-19.

INTRODUCTION

The appearance of the severe acute respiratory distress syndrome (ARDS) due to the coronavirus called SARS-CoV-2, at the end of 2019 gave rise to a pandemic that affected all corners of the world.(1) Health systems were disadvantaged due to the large number of infections, it was estimated that 5% of all cases required admission to the intensive care unit (ICU)(2)where the implementation of invasive mechanical ventilation (IMV) was necessary(3)IMV is a therapeutic strategy against ARDS associated with coronavirus disease (COVID-19) where the ventilatory and oxygenation conditions of the respiratory system are restored by means of an endotracheal tube.(3)(4) They were raisedrecommendations for this procedure given by the Difficult Airway Society that refer to the use of personal protection (PPE), avoiding the exposure of pathogens to health personnel.(5)(6)

The pre-pandemic consensus estimated an average MV of 13 days,(6) however, the patient positive for COVID-19 referred to the ICU due to hypoxemia due to ARDS, the IMV reached an average of 3 to 4 weeks, due to the fact that it is a virus that spreads very quickly in the environment.In addition, the decision to perform a tracheostomy is not arbitrated by a single professional, this decision encompasses the entire healthcare team seeking to improve clinical results for the patient.(7)(8) The time given for the use of the tracheostomy becomes a controversial issue, because on the one hand, an early tracheostomy is thought to be performed between 7 or 14 days.(7) While other reports mention the use of tracheostomy between 9 and 24 days of IMV in COVID-19.(9)These MV requirements could have an impact on the appearance of MV-associated pneumonia, laryngotracheal stenosis, subglottic stenosis, cord paralysis, tracheoesophageal fistula, granulomas, and due to increased sedation, cognitive impairment and presentation of weakness acquired in the ICU, it could increase mortality.. (8)(5)

Tracheostomy is the most prevalent option to facilitate IMV removal and avoid complications from the endotracheal tube. However, under the pandemic wave, most hospitals and clinics viewed tracheostomy unfavorably due to the fact that it was a procedure that generated aerosols that endangered health personnel;(10)That is,

there was a certain variability regarding the exact moment of performing the tracheostomy, observing heterogeneous results always conditioned to the variables that the patient may present.(eleven)but to date optimal timing of tracheostomy has not been established. The evidence concerning tracheostomy in COVID-19 patients is particularly scarce. We aimed to describe the relationship between early tracheostomy (≤10 days since intubationThe physiotherapy staff together with the multidisciplinary team under this clinical premise will always have the promptest disassociation of the IMV team from the patient. (5)In addition, the sequelae that prolonged IMV could leave on the patient are largely addressed by the physical therapist, speech therapist and occupational therapist.

The result of patients ventilated for long periods of time considered within late tracheostomy processes may lead to a high rate of cases of laryngotracheal lesions in the future. The objective of this document is to detail the complications in the upper airway reported so far due to COVID-19, highlighting their importance for the physiotherapy professional.

METHODOLOGY

This work was carried out as a systematic review of the scientific literature based on alterations in the upper airway in relation to the practice of a late tracheostomy due to COVID-19. The preparation of the document was carried out following the guidelines of the PRISMA declaration, with the aim of delivering a document of a high methodological level.(12)

SYSTEMATIC SEARCH

The search for information and collection of scientific evidence was carried out in databases such as PubMed, Scielo, Google Scholar,Web of Science Core Collection; chosen for their prestige, quality and variety of information. For a correct and accurate search for information on the proposed topic, the following MESH terms were used: Airway, Pathology, Tracheostomy, Alterations, COVID-19. In addition, Boolean connectors such as "AND", "OR", "NOT" were used to guarantee the most accurate search for investigative purposes.

INCLUSION AND EXCLUSION CRITERIA

The inclusion criteria for this review were documents from the last four years, due to the fact that COVID-19 was reported to society since the last quarter of 2019, articles that are in Spanish or English, finally, clinical trials were prioritized. randomized trials, case series reports as well as epidemiological reports. On the other hand, the exclusion criteria were articles that were not freely accessible, reports with a sample of less than 10 participants, studies in the pediatric population, and studies that were carried out on animals.

According to these exposed inclusion and exclusion criteria, it was possible to consider and eliminate several investigations, initially only with the reading of the title, 48 articles were considered, later the abstract was read and 41 documents were discarded because they presented a sample of less than 10 participants (n = 20), for conducting studies in the pediatric population (n = 12), for leaving the context of post-tracheostomy disorders (n = 9). Finally, 7 articles met the inclusion and exclusion criteria, because they showed the different processes of advances and post-tracheostomy complications in samples of varied populations. Figure 1 summarizes the document search and selection process.

RESULTS

Through the first selection of documents, a total of 48 valid records were obtained to start

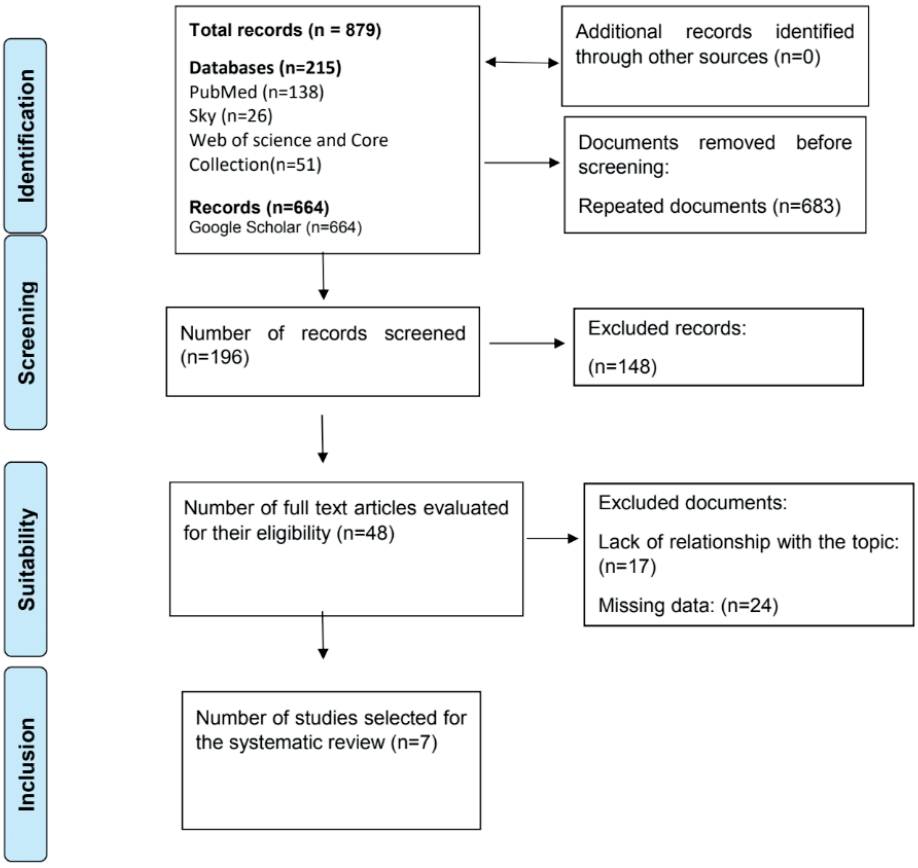

Figure 1. PRISMA flow chart at four levels.

Author (year)	Type of study	Sample	Intervention	Results	
Allisan-Arrighi et al. (2022)	retrospective review	81 patients positive for COVID 19 participated.	The medical records of patients diagnosed with COVID-19 infection were analyzed, either by polymerase chain reaction (PCR), antibody tests, or verbal confirmation. It does not refer for which tracheostomy process they were operated on.	A total of 18 patients were tracheostomized and decannulated at 70.69 days. Laryngotracheal stenosis as an important complication in 16% of cases, but in 25% of cases with the presence of granulomas.	
Piazza et al (2022)	bicentric experience	14 patients participated in this study, of which 10 were admitted to the ICU, where they underwent tracheostomy.	Six surgical and 4 percutaneous tracheostomies were performed, with a mean intubation duration of 15.8 days.	Primary results. The cannula was removed from 7 patients (70%) at the end of their hospitalization, with a mean time of tracheostomy use of 31 days, it was not possible to close the tracheostomy in 3 patients (30%).	Secondary results. It was indicated that 2 patients required a new ICU admission, one was ventilated via OTI for one day, the second received mechanical ventilation for 13 days. Presentation of laryngotracheal stenosis and major lesions of the laryngotracheal frame in 100% of cases, with the cervical trachea being mostly affected.

Chao et al., (2020)	Multicenter non-randomized prospective cohort study.	From 5 hospitals within the University of Pennsylvania Health System, 53 tracheostomized patients with COVID-19 were obtained, presenting with acute respiratory failure.	Twenty-nine percutaneous tracheostomies and 24 surgical tracheostomies were performed, with a mean intubation time of 19.7 days, where the main general indication for the tracheostomy process was acute respiratory distress syndrome (ARDS).	Primary results. It was observed that aerosolization was minimized by disconnecting the cuff from the endotracheal tube (ETT) from the ventilator.	Secondary results. Ventilator release after tracheostomy occurred in 30 patients (56.6%), 14 patients (26.4%) had their tracheostomy tube reduced, 7 patients (13.2%) were decannulated, and 2 patients, (3, 8%) presented complications. Laryngeal edema usually presented after extubation, causing stridor and the need for reintubation.
Nina et al., (2021)	retrospective study	180 patients with COVID-19 infection were identified in the Gothenburg Department of Infectious Diseases, 116 were critically ill and intubated and 55 patients were tracheostomized.	I present 40 surgical tracheostomies and 15 percutaneous tracheostomies, referring a mean time range of 5 to 28 days of intubation.	Primary results. They identified postoperative bleeding in 27% of cases, a mortality of 12.7% (7 patients)	Secondary results. They had an overall mean duration of MV of 25 days at the time of tracheostomy and the duration in the ICU is correlated ($p<0.001$). They observed postoperative bleeding in 31% of cases and laryngeal edema with respiratory tract involvement in 7% (4 patients) of all cases.
Tuna et al., (2022)	retrospective review	There were 72 patients consulted for elective tracheostomy, 10 of them died before the operation, 38 were excluded due to the absence of pneumonia due to COVID-19, 24 patients meeting the inclusion criteria.	They presented 19 surgical tracheostomies and 5 percutaneous tracheostomies, with prolonged intubation of >14 days for the tracheostomy process.	Primary results. Survival to the first postoperative week was 66.7% (63.1% surgical and 80% percutaneous).	Secondary results. 25% of patients ≤ 50 years of age were kept in the ICU for ≤ 60 days compared to 95% of patients > 50 years of age ($p=0.008$), evidencing a first-week survival of 100% in ≤ 50 years and 60% in >50 years ($p=0.262$) Presentation of generation of granulomas and aerosols, causing the health system to obtain greater biosafety measures.
Queen Elizabeth Hospital Birmingham COVID-19 Airway Team(2020)	Prospective observational cohort study	A sample of 164 patients was included, where 100 underwent tracheostomy and 64 were extubated without the need for the procedure.	Two groups were carried out, one subjected to percutaneous tracheostomy with 75 participants and 25 to surgical ones, this process was carried out with a mean intubation time >14 days.	Primary results. Survival at 30 days was 85% for the group undergoing tracheostomy.	Secondary results. MV duration was 6 days versus 27 in comparison between groups with and without tracheostomy process ($p<0.0001$). The stay in the ICU was also shorter for the group with tracheotomy versus the group that did not apply it, 23 vs. 30 days ($p<0.0001$). Late complications were vocal cord paralysis in two specific cases.

Battaglini et al (2021)	Multicenter, retrospective, observational study	153 tracheostomized patients from 11 Italian intensive care units were included.	Study in 100 patients with percutaneous tracheostomy and 53 with surgical, presenting a mean intubation time of 15 days for the process.	Primary results. 55.6% (85 patients) are gradually released from an artificial airway (1 patient died in ICU)), 32% (49 patients) were never extubated from the tracheostomy tube (all died in ICU), data missing of 19 patients.	Secondary Results. Survival did not vary significantly between surgical and percutaneous tracheostomy (p=0.66), while ICU stay, once again, did not vary significantly between tracheostomy types (p=0.070). Complications in phonation, swallowing and respiratory processes such as infections, generally determined in surgical tracheostomies, while the percutaneous process, referenced hemorrhagic processes.

Table 1. Characteristics of the selected studies.

the scientific analysis, for which the Critical Evaluation Skills Program in Spanish (CASpE) was applied, which were analyzed by two professionals corresponding to the research area of the physical therapy department of `` Universidad Técnica de Ambato``. A final result of 7 records was reached by analyzing variables such as year of publication, type of study, method applied, primary and secondary results. The characterization of each study is shown in Table 1, reporting the type of study, the intervention, and the results achieved.

DISCUSSION

The role of tracheotomy in the midst of the COVID-19 pandemic wave was uncertain, there were no guidelines to follow regarding the appropriate moment, the technique to be used (13), the expected results and the possible complications derived from it. In the analysis carried out with the 7 appropriate registries in our selection, a diversity of preponderant factors was achieved that led to tracheostomized patients presenting various alterations. Some of the alterations observed as references are laryngotracheal stenosis, cord damage associated with swallowing and phonation disorders (14).

Laryngotracheal stenosis (TLE) is mentioned by Piazza et al., in their results showing a 92.9% prevalence (15). Most of the reported evidence corresponds to case series such as the one by Onorati et al., all agreeing on a high prevalence of TLE associated with positive-pressure ventilation, over-inflation of the cuff, prone positioning, and delayed tracheostomy. (16)(17). However, the slightest change in the aerodigestive tract can trigger impaired speech, swallowing and protection of the airway, turning them into frequent complications (18).

Retrospective studies report the appearance of cord paralysis together with dysphagia diagnosed with flexible fibroscopic swallowing (FEES).(19)(twenty). Swallowing impairment categorized as dysphagia occurs in 11% to 93% of tracheostomized patients, especially when there is a prolonged time in IMV, in addition, traumatic events in the laryngeal and oral area add to the swallowing process an affectation on phonation. The total number of cases with complications regarding speech and swallowing continues to be underestimated. It is estimated that 67% of all survivors of COVID-19 had zero airway protection in the first instance and could present aspirations. (twenty-one)Studies such as the one carried out by Osbeck et al. reported that of all those evaluated, 44% showed silent aspiration, 76% poor cord mechanics, and 60% presented laryngeal edema, this in a population with IMV of 25 days on average (22).

The results of the most recent reports reveal a gloomy expectation regarding the sequelae resulting from prolonged intubation, delayed tracheostomy, and insufficient airway control, the last two due to avoiding viral aerosolization (23)(24). It could be mentioned that far from dyspnea, cough, and laryngeal stridor, there is a risk of aspiration and laryngeal penetration that accompany this population.(25). This way, it can be inferred that the number of cases could go up, as mentioned by the European Society of Laryngology, it is necessary for the otorhinolaryngologist together with the multidisciplinary team specialized in airway care to make a timely diagnosis and the respiratory physiotherapist to carry out a optimal recovery and rehabilitation process(26)(27)(28). The preventive strategy in this scenario ended up in a multidisciplinary team looking for a successful decannulation and with minimal damage to the airway, where the physiotherapist formed a fundamental pillar in this team providing a basic and advanced care service in tracheostomy, such as in stoma care, humidification, cuff management, secretion management and position changes. The need

for future investigations that support or reject the existing data is imperative.

CONCLUSIONS

During the pandemic caused by the SARS-CoV-2 virus, it unleashed an inordinate number of cases diagnosed with ARDS due to its high contagion rate, the adoption of poor biosecurity measures, and the wrong approach in the first instance by medical personnel. Resulting in collapsed ICU areas where the action of the health team was limited, limiting the action to processes and care that minimize the generation of aerosols. This way, it was recurrent to find scenarios of patients with prolonged IMV suggesting the non-application of an early tracheostomy. Overlooking the benefits that this procedure has on clinical improvement and long-term positive results. Therefore, it can be presumed that this conditioned the prevalence of laryngotracheal alterations, on swallowing,

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