

Tracheal Intubation Difficulties: Systematic Literature Review

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Abstract

Background: Tracheal intubation is a common procedure in medical practice, being performed mainly in surgical centers and emergencies in trauma patients. **Objective:** This systematic literature review aims to understand the main difficulties and complications related to tracheal intubation. **Methods:** Systematic literature review, conducted in the Virtual Health Library databases between 2016 and 2021, restricted to articles in English and Portuguese with the descriptors: Airway, Difficult intubation, and Complications. After reading the abstracts, 34 articles were found, and, after reading them, 9 articles were selected. **Results:** This review analyzed 9 scientific studies that rigorously met the previously established characteristics in the sample selection. The synthesis included the following aspects (author/year of publication, article title, objective, type of study, and database). **Discussion:** Several factors that influence the success of intubation were identified, such as technical, professional, and patient issues. In addition, measures to minimize the risks involving the procedure were highlighted. **Conclusion:** Tracheal intubation is a common procedure in surgical centers and emergencies. However, its risks, while low, should not be ignored. Unsuccessful procedures can occur and have consequences for the patient, such as trauma to the upper airway.

Keywords

Airway, Difficult Intubation, Complications

1. Introduction

Tracheal intubation is a common procedure in medical practice, being performed mainly in surgical centers and emergency units [1] [2]. The procedure is considerably simple, but it is not without complications. However, its impor-

tance should not be underestimated, since it is performed mainly on patients in vulnerable states, in which the accuracy and success of the procedure can save their lives and avoid serious and irreversible consequences [2].

The occurrence of upper airway trauma is one of the common consequences of this procedure, often related to the error or professional unpreparedness in the execution of the intubation technique, the quality of the material used, and the physiological characteristics and/or anatomical particularities of the patient [2].

Particularly, performing intubation on critically ill patients requires extensive knowledge of the pathophysiology of the disease and extensive experience in the management of airways, since these patients are more prone to complications after the procedure [3].

To this end, the literature has guidelines such as the early use of a video laryngoscope with a screen visible to all, as well as second-generation supraglottic airways for airway rescue, among others [4].

Therefore, an individualized approach should be given to each patient, including a thorough assessment of their health history, regarding the presence of comorbidities and airway changes, in order to identify the various factors that generate a difficult airway, the possible difficulties at the time of intubation, as well as preventing avoidable complications [1] [2] [5] [6] [7] [8].

Given this context, this review is justified and seeks to provide an updated perspective on the main difficulties involved in airway management.

2. Objective

The aim of the study is to understand the main difficulties and complications related to tracheal intubation.

3. Material and Methods

Data Sources and Search Strategy

This systematic literature review adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) recommendations and assesses the possible difficulties and complications in tracheal intubation.

A broad electronic search was performed using the Virtual Health Library (VHL), which included Lilacs, SciELO, Medline, PubMed, and Cochrane, using the descriptors: Airway, Difficult intubation and Complications. These search terms were used individually and in varying combinations.

To ensure the contemporary relevance of the data, the search was limited to articles written in English and Portuguese, published in peer-reviewed journals, between the years 2016 and 2021.

Eligibility Criteria

Initially, 132 articles were found, which underwent a relevance test consisting of the inclusion criteria: 1) reference to the term tracheal intubation; 2) analysis of events related to difficulty and complications of tracheal intubation; 3) description of results associated with airway management; and 4) publication in

selected languages and periods.

After a detailed analysis, 98 articles were excluded due to duplication and failure to present the proposed criteria. After reading the abstracts, 24 articles were excluded for not presenting the full text and the proposed theme; and finally, after reading the articles in full, 7 articles were excluded for not presenting the proposed criteria. Thus, this review is based on the remaining 9 articles that met the pre-established eligibility criteria for the analysis, as shown in (Figure 1).

Data Extraction and Statistical Analysis

Studies that met the inclusion criteria were divided among the authors and data were independently extracted into a standardized spreadsheet. The articles were evaluated by the researchers and any discrepancies were resolved by consensus.

In summary, a narrative synthesis was applied to approach the collected data, and a descriptive statistical analysis was performed using the Office 2021 Excel program for Mac.

4. Results

After eliminating duplicates and selecting publications, the articles were read in full, from which the parameters proposed in the analytical matrix of the present study were analyzed.

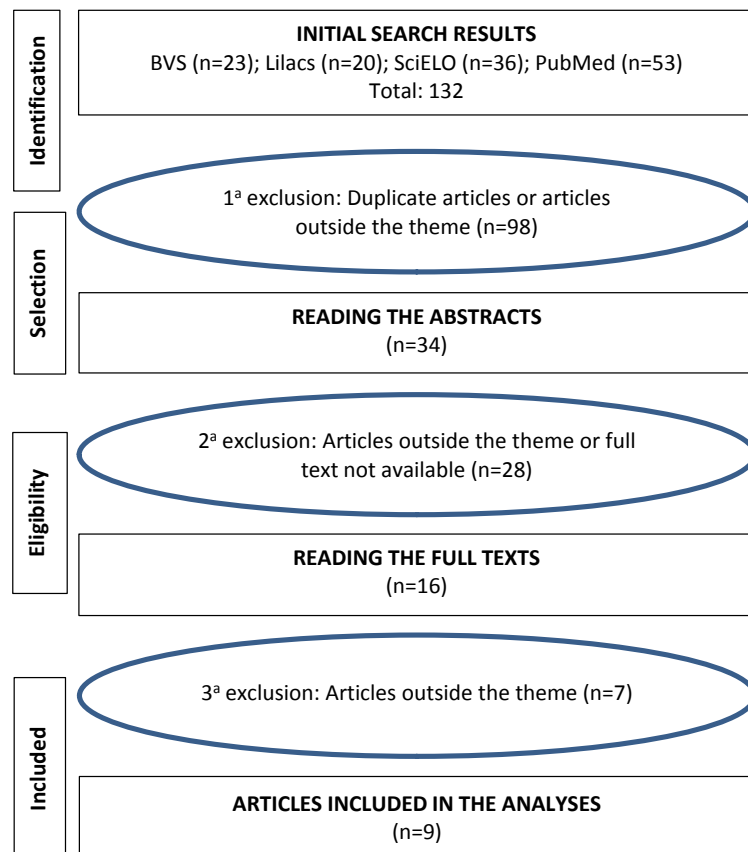


Figure 1. PRISMA flow diagram: representation of eligibility and inclusion of articles.

This systematic literature review analyzed 9 scientific studies that rigorously met the previously established characteristics in the sample selection. Of this total of articles, 4 were quantitative/qualitative studies, 1 was a quantitative study and 4 were qualitative.

The synthesis of these selected scientific articles is presented below, covering the following aspects: author/year of publication, article title, objective, type of study and database (**Table 1**).

5. Discussion

Tracheal intubation is a common procedure in medical practice, and in most

Table 1. Description of the articles selected for analysis.

Author Date	Article Title	Study Purpose	Type of Study	Data Base
Cook, F. <i>et al.</i> , 2019	Prospective validation of a new airway management algorithm and predictive features of intubation difficulty	Identify the ideal procedures for better airway management	Quantitative and Qualitative	PubMed
Ji, S.M. <i>et al.</i> , 2018	Correlation between modified LEMON score and intubation difficulty in adult trauma patients undergoing emergency surgery	Addressing the use of the LEMON scale at the time of intubation of trauma patients	Quantitative and Qualitative	PubMed
Langeron, O. <i>et al.</i> , 2018	Difficult intubation and extubation in adult anaesthesia	Analyze the difficult moments in intubation and extubation during anesthetized adults, presenting the principal measures that must be taken	Quantitative and Qualitative	PubMed
Mosier, J.M. <i>et al.</i> , 2020	Tracheal Intubation in Critically Ill. Where We Came from and Where We Should Go	Address the main challenges at the time of intubation and measures to avoid or circumvent complications	Qualitative	PubMed
Semler, M.W. <i>et al.</i> , 2017	A Multicenter, Randomized Trial of Ramped Position vs Sniffing Position During Endotracheal Intubation of Critically Ill Adults	Compare the use of olfactory and ramp positions at the time of intubation, indicating when each is most indicated	Quantitative	PubMed
Tikka, T. <i>et al.</i> , 2019	Upper airway tract complications of endotracheal intubation	To analyze the main points involved in upper respiratory tract complications in endotracheal intubation	Qualitative	PubMed
Vijayakumar, V., 2017	Intubation Difficulty Scale Score and Videolaryngoscopes	Point out the main issues at the time of intubation associated with the use of the intubation difficulty scale and the videolaryngoscope	Qualitative	PubMed
Wang, C.M.Z. <i>et al.</i> , 2019	Predictors of difficulty in intubation in patients with obstructive sleep apnoea	Identify the particularities of the patient with obstructive sleep apnea at the time of intubation	Qualitative	PubMed
White, L. <i>et al.</i> , 2020	Cricoid pressure during intubation: A systematic review and meta-analysis of randomized controlled trials	To highlight the advantages and disadvantages of using cricoid pressure during intubation	Quantitative and Qualitative	PubMed

Source: Elaborate by the authors.

cases, the results are satisfactory. However, difficult moments and complications do arise, as well as subsequent irreversible consequences since it is often performed on patients in vulnerable or critical states. Although airway management in these patients is a central aspect, especially in emergency rooms, studies suggest that this procedure can be potentially dangerous [9], and that the survival rate is significantly higher in the absence of this management [10].

The increase in the use of intervention techniques to management airways emphasizes the possibility of an increase in the risk of morbidity and mortality resulting from intubation. In this context, it is important to be aware of the existence of a “difficult airway”, as well as to rethink strategies to prevent and minimize possible injuries.

The principal factors found that determine whether an intubation can be considered difficult and risky were mouth opening, body mass index, Mallampati scale, previous history of intubation difficulty, jaw profile, thyromental distance, and mobility of the cervical column [11]. Based on the analysis of the evidence in this study, aspects that involve difficulties and complications related to intubation, as well as possible measures to achieve success in the procedure are discussed below.

A range of factors were found that influence the execution and outcome of this procedure, such as the choice of instruments and material, the technique used, degree of professional experience, and patient characteristics [12] [13] [14] [15].

With respect to the endotracheal tubes used in the management of airways, we found specific essential factors such as the material they are made from, thickness and flexibility, which are important aspects that need to be considered in the intubation procedure. Tubes that have greater flexibility have a greater propensity to be compressed, thus compromising ventilation, while tubes that are more rigid and firm, despite being more expensive, are ideal for this procedure [12].

Similarly, studies show a significant success rate for the first attempt at intubation and ease of the technique using Parker flex-tip tubes compared to conventional PVC tubes [16], as well as a higher success rate using a curved tube rather than a reinforced straight one [17].

Another essential factor found was the use of a videolaryngoscope instead of a conventional laryngoscope. The videolaryngoscope is indicated for patients that have at least two factors that can complicate intubation and is the first choice for obese patients since it facilitates the observation of the glottis [13].

The videolaryngoscope is also indicated to facilitate intubation in corrective surgeries, as an aid in stabilizing the cervical column [17]. As an example, in tracheal intubation in patients with simulated cervical immobilization, there was less movement of the cervical column using a videolaryngoscope C-MAC D-Blade than a conventional Macintosh laryngoscope [18].

Other studies have shown that the use of a videolaryngoscope promoted a significant reduction in the number of attempts and time of intubation [17] [19],

due to the necessity of employing bougies, scalpels or Magill forceps, instruments that are commonly used in conventional, direct laryngoscopy [19].

Nevertheless, it is important to emphasize that although the use of both the videolaryngoscope C-MAC D-Blade and the Macintosh laryngoscope is relatively simple, the patient is not free from possible trauma or complications in the upper airways.

With respect to the most commonly occurring complications, these are concentrated in the upper respiratory tract, including lesions to the oral cavity, oropharynx, and larynx [12]. Lesions to the oral cavity and the oropharynx are associated with direct action of the laryngoscope, of the tube, or from trauma incurred using auxiliary instruments such as bougies, among others [19]. The most common injuries are to the soft tissues of the tongue, the upper and lower lips, and the oropharynx.

However, despite the discomfort experienced by the patient, the lesions normally heal themselves, and several days after extubation there is usually no necessity of attention to these lesions from the medical team [12].

The most common lesions to the larynx were hematoma, thickening and granuloma of the vocal cords, as well as dislocation of the arytenoids, subluxation, and paralysis of the vocal cords. In post-surgical patients, the most common lesions were arytenoid erythema, inter-arytenoid edema, and edema of the vocal cords, accompanied by dysphonia, sore throat, dysphagia, hoarseness, lack of air and aspiration, symptoms that normally disappear the day after the surgical procedure [12].

In this context, a range of aspects related to prevention of lesions of the respiratory tract were also analyzed.

The size and characteristics of the tube chosen for the procedure must be compatible with patient age and sex, and other specific details of the patient must be considered as well. Tubes that are made from synthetic material and that have smooth edges are the most indicated for prolonged intubations [12].

The pressure in the interior of the endotracheal ballonnet must be controlled since there must be equilibrium between the demand for blood for the laryngeal mucous and the ballonnet pressure. When high pressure is maintained, such as it is above 28 cm H₂O, reduction and perfusion of the laryngeal mucous can occur. Therefore, diastolic blood pressure in the region of the larynx must be able to maintain this equilibrium, thus avoiding injury, especially to the posterior region of the larynx [12].

The administration of a muscle relaxer is essential, since this will reduce the movement of the laryngeal mucous, which will reduce tube movement and thus avoid lesions to the mucous, as well as improve conditions for ventilation and intubation [13].

Cricoid pressure, despite reducing the chance of regurgitation, is a complicating factor for intubation since it can also reduce the vision of the glottis and complicate the passage of the tube and therefore increase the possibility of lesions and incubation time. Furthermore, the force that must be applied is highly

variable, and depends on the state of health of the patient, and excessive force could alter the structure of the respiratory tract and cause esophageal rupture [20].

Another important aspect that merits attention is desaturation. It is essential to conduct pre-oxygenation to avoid desaturation, which has as objective the reduction of nitrogen stocks in the residual pulmonary capacity through its substitution by oxygen, which will increase the time that a patient can support apnea. The use of non-invasive ventilation with positive pressure is the method that has shown the best results. In cases where desaturation has occurred despite pre-oxygenation, a rescue oxygenation procedure using a ventilation mask is necessary; if this fails then a supraglottic ventilation must be done, which normally has a high rate of success [13] [15].

In contrast, the particular characteristics of each individual are also considered since these can negatively impact intubation. These may include pre-existing pathologies such as the presence of a laryngeal web, subglottic stenosis, reflux, and conditions associated with trauma, including fracture of the larynx, caustic lesions, and allergic or inflammatory reactions were found as factors that made intubation difficult.

Furthermore, other factors that can negatively impact intubation were found, such as the presence of comorbidities, extreme age, obesity that causes desaturation due to limited pulmonary reserves, limitations in flexing and extending the neck, and patient position, all of which can significantly increase the chances of lesion when inserting the tube [12] [14] [15].

One specific characteristic which merits special attention at the moment of intubation is patients with obstructive sleep apnea, because in this case there are anatomical alterations. Since most of these patients are obese, they have small jaws and large tongues and tonsils, and a limited range of neck movement, which consequently increases the risk of cardiovascular, hypertensive, hypoxic, and thrombotic events [21].

Another aspect that is no less important and that has a significant influence on the prevention of lesions is related to the experience of the professional who executes the intubation and extubation procedures. As more attempts are necessary to achieve the correct insertion and positioning of the tube, the greater are the chances of causing lesions in the respiratory tract [12].

Considering the aforementioned aspects associated with the intubation and extubation procedures, it is evident that there are many factors that can influence its success. In order to promote a holistic understanding of these aspects and the identification of a potentially difficult intubation, two scales were created, the intubation difficulty scale, and the LEMON scale, which have as objective the preservation of the airways of the traumatized patient. Both scales emphasize the importance of the visualization of the entry to the larynx, with the intubation difficulty scale being more focused on the duration and the difficulty of intubation. In contrast, the LEMON scale focuses on a few specific aspects of trauma such as the difficulty presented by the need to immobilize the head and neck,

and the distance between the thyroid and the hyoid bone, and in these cases the use of a videolaryngoscope is recommended [7] [8].

In the context of this discussion, it has been shown that there are diverse factors that influence tracheal intubation. When these factors are critically analyzed, in the absence of particularities of patients, all the influencing factors can be altered based on the preferences of the attending physician. For example, the attending professional should choose the most adequate equipment among those that are available and decide on which medicines to administer and at what doses.

Furthermore, the physician must be constantly updated with respect to new innovations and measures to be taken in the event of complications in an intubation procedure and the prevention of lesions. However, there are few studies that suggest the ideal methods with respect to the choices that physicians must take in these situations, and therefore the practice of medicine as it occurs in the moment will always have a preponderant role in the decisions taken in intubation procedures.

This revision discussed the most recent data from research published between 2016 and 2021 related to the difficulties in management of airways during tracheal intubation and possible prevention measures. However, this study has certain limitations since we included only articles published in English and in Portuguese, thereby excluding a large proportion of relevant studies published in other languages. Also, by selecting studies published only during the last 5 years we may be missing certain tendencies that would be evident by selecting a wider publication period.

6. Conclusion

Tracheal intubation is an extremely important procedure in medical practice, with excellent results and few complications; however, complications do occur and need attention. There are several factors that influence the prognosis of the procedure, such as the choice of equipment to be used, the experience of the professional, the use of certain medications, the particular characteristics of each patient, and the position in which the intubation will be performed.

In this sense, injuries can occur in the respiratory tract, especially in the oral cavity, oropharynx, and larynx. Therefore, more studies should be carried out to seek the best method to prevent this damage from being caused.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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