Laryngotracheal mucosa injury and associated factors after endotracheal extubation: a pilot study

Lesão de mucosa laringotraqueal e fatores associados após extubação endotraqueal: estudo piloto

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Descritores
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Abstract

Objective: To describe the clinical signs of laryngotracheal mucosal injuries and associated factors.

Methods: This was an observational longitudinal study conducted with patients intubated due to general anesthesia. Assessment was carried out in the preoperative period, intraoperative period and at 24, 48, and 72 hours after extubation. Descriptive and exploratory statistics were used for analysis, in addition to odds ratio.

Results: 53.3% of the sample presented at least one clinical sign of laryngotracheal mucosal injury, mainly: hoarseness (43.3%), dysphagia (40%), and odynophagia (33.3%). The following factors were associated: intracuff pressure above 25 cmH_2O, intubation longer than 120 minutes, and the use of tubes larger than 7.5mm.

Conclusion: The most common clinical signs of laryngotracheal mucosal injury among the studied population were hoarseness, dysphagia, and odynophagia, associated with cuff pressure above 25 cmH_2O, followed by duration of intubation and inadequate endotracheal tube size.

Resumo

Objetivo: Descrever os sinais clínicos de lesão de mucosa laringotraqueal e seus fatores associados.

Métodos: Estudo observacional, longitudinal, em pacientes intubados por ocasião da anestesia geral. Foram realizadas avaliações no pré-operatório, transoperatório, e nas 24, 48 e 72 horas após extubação. Para análise, utilizaram-se estatísticas descritiva e exploratória, e também foi verificada a razão de chances.

Resultados: Dentre os pacientes, 53,3% apresentaram pelo menos um sinal clínico de lesão de mucosa laringotraqueal, sendo predominantes: rouquidão (43,3%), disfagia (40%) e odinofagia (33,3%). Estiveram associados aos seguintes fatores: pressão intra-*cuff* acima de 25cmH_2O, intubação por mais de 120 minutos e uso de tubos maiores que 7,5mm.

Conclusão: Os sinais clínicos de lesão de mucosa laringotraqueal mais frequentes na população deste estudo foram rouquidão, disfagia e odinofagia, associados à pressão do *cuff* acima de 25 cmH_2O, seguido do tempo de intubação e tamanho inadequado de tubos endotraqueais.

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Introduction

Laryngotracheal mucosa can be damaged by various factors. The endotracheal intubation process, for example, is one of the main responsible factors for lesions; however, such lesions can be prevented based on knowledge about the pathophysiology of injuries and the adoption of prophylactic measures by multiprofessional teams involved in the care of intubated patients.[1]

Intubation-related injury in airway mucosa is difficult to diagnose, and can be severe and difficult to treat. They are common among patients with endotracheal tubes or tracheostomies, with the latter considered less harmful.[1-4]

The pathophysiology of injuries due to intubation is mainly associated with the pressure exerted by the tube and/or cuff on the laryngotracheal mucosa. It is diagnosed through tests, such as fibrobronchoscopy, CT scans, laryngoscopy, and thoracic X-ray.[2,3] Interventions can be either surgical or conservative, with the use of appropriate drugs. However, in some cases, the effects of these injuries are irreversible.[4]

Choosing adequate tube diameter, in addition to monitoring and controlling cuff pressure are important factors associated with the emergence of laryngotracheal injury. Other risk factors include the need for emergency intubation and prolonged intubation. However, some patients develop injuries even when intubation time is short.[1-5]

Adequate aspiration technique, balloon pressure monitoring, and adequate mobilization of intubated patients, for example, are important activities that fall under the responsibility of the nursing staff. Handling accidental extubation or self-extubation, and all other actions that result from nursing care of patients with artificial airways must be conducted so as to mitigate any injury due to mechanical ventilation and the maintenance of artificial airways.[6-8]

The knowledge of clinical signs that suggest laryngotracheal injury, in addition to factors associated by the nursing team, is of crucial importance when planning safe intubated patient care. Thus, the objective of the present study was to describe the clinical signs of laryngotracheal mucosa injury and associated factors.

Methods

This was an observational longitudinal study conducted in a large-scale public teaching hospital in the Southeast region of Brazil between March and June 2014.

The population consisted of patients submitted to anesthetic-surgical procedures, under general anesthesia. Nonsystematic sampling was used due to the preliminary nature of the study.

Inclusion criteria were: hospitalized patients, in preoperative care, submitted to elective surgery; intubated because of anesthetic-surgical procedures (general anesthesia) and physical status classification I and II as per the American Society of Anesthesiologists (ASA).[9] Patients who presented clinical signs of laryngeal and tracheal alterations before the anesthetic-surgical procedure; who were submitted to surgical procedures in the orotracheal cavity; whose type of anesthesia was changed immediately before the start of the surgery; referred to an intensive care unit in the immediate postoperative period; who presented hemodynamic complications in the intraoperative period; who were discharged before 24 hours post extubation; and who dropped out of the study after extubation were excluded from the sample.

The population consisted of 72 patients who met the inclusion criteria, between May and June 2014. Of these, 42 (58%) were excluded, according to the following criteria: suspension of anesthetic-surgical procedure (n=14); alteration of type of anesthesia (n=5); referral to intensive care unit (n=9); intraoperative hemodynamic complication (n=3); hospital discharge less than 24 hours after extubation (n=4); and participant dropout after extubation (n=7). There were 30 eligible patients according to the inclusion criteria.

Data collection was conducted by four researchers, who received specific training for two weeks by the research coordinator. The data collection instrument was created by the authors exclusively for this study, based on the scientific literature,[1-5] and submitted to face validation by three expert judges. The instrument is divided into five parts: pre-

operative assessment; intraoperative monitoring; assessment 24 hours after extubation; assessment 48 hours after extubation; and assessment 72 hours after extubation.

The clinical variables obtained in the preoperative period were: ASA classification;[9] body mass index, according to World Health Organization (WHO) recommendations;[10] type of surgery; and anesthesia. The following variables were collected pre- and postoperatively: dysphagia verified through patient anamnesis and saliva swallowing test; odynophagia, verified through anamnesis; dysphonia or hoarseness, verified through a simple voice test in which patients were asked to make long "a" and "e" sounds and through anamnesis; laryngeal stridor, verified through auscultation of tracheal region, pain on palpation, verified by palpating the tracheal region, in addition to observing patient expression and self-referred pain; presence of bleeding, verified by direct observation and self-referred by patients.

Predictor variables observed in the intraoperative period in the operating room were: surgical positioning; size of endotracheal tube; number of intubation attempts; use of muscle relaxants; intracuff pressure of the endotracheal tube, measured with a cuff pressure gauge (analog gauge of endotracheal tube, with pressure range of zero to 120 cmH_2O, color-coded for ideal pressure, with a bulb for inflation and pressure control, with a pressure relief valve); angle of endotracheal tube to labial commissure; number of airway aspirations; and size of airway aspiration probes.

The outcome variable was laryngotracheal mucosa injury, observed according to the occurrence of the following clinical signs following extubation: dysphagia, odynophagia, dysphonia/hoarseness, dysarthria, presence of stridor, pain to touch in tracheal region and bleeding. All were verified through physical exam and anamnesis after extubation.

The data were inserted into an electronic spreadsheet in Excel® for Windows XP®, using double entry validation (typing) and transferred to the Statistical Package for the Social Sciences (SPSS), version 18.0, for processing and analysis. Univariate, descriptive and exploratory analyses were conducted to describe the investigated variables and subjects. Next, the odds ratio of predictor variables was verified.

This study was conducted according to resolution 466/12 of the Brazilian National Health Council. The protocol was submitted for appraisal and was approved by a research ethics committee, resolution no. 2.617.

Results

Mean patient age was 43.8 years, with a standard deviation of 20.6 years. Most patients were women, with 16 (53.3%) participants.

Of the 27 assessed patients, three (10%) presented BMI lower than 18.5, nine (33.3%) were within the normal range, eight (26.7%) were overweight, and seven (23.3%) presented a BMI greater than 30. Three patients included in the study could not be mobilized to measure height and weight, and therefore, BMI could not be obtained.

Regarding type of surgery, of the 30 patients who participated in the study, 20 (66.7%) were submitted to surgery of the digestive system, three (10%) were submitted to plastic surgery, two (6.7%) to neurosurgery, two (6.7%) underwent urological surgery, two (6.7%), proctological surgery, and one (3.3%), ear, nose and mouth surgery.

Twenty-four (80%) patients were placed in supine position during the surgical procedure. Tubes smaller than 7.5 mm were the most used among the studied population. Number of intubation attempts varied from one to three attempts, and most of the sample was intubated on the first try, as shown in table 1.

Twenty-seven (90%) patients maintained mean intracuff pressure above 25 cmH_2O. The angle of the endotracheal tube remained at 90° in five (16.7%) patients. Most (86.7 %) were intubated for over 120 minutes and, in this time, all patients underwent endotracheal aspiration procedures.

Table 1. Distribution of patients regarding variables observed in the intraoperative period

Variables	n(%)
Surgical positioning	
Supine	24(80.0)
Other	6(20.0)
Size of endotracheal tube, mm	
Up to 7.5	23(76.7)
>7.5	7(23.3)
Intubation attempts	
1	26(86.7)
>1	4(13.3)
Use of muscle relaxant	
Yes	14(48.3)
No	15(51.7)
Intracuff pressure (mean of initial and final pressure), cmH_2O	
Up to 25	3(10.0)
> 25	27(90.0)
Angle of tube to labial commissure	
90°	5(16.7)
Other	25(83.3)
Duration of intubation, minutes	
Up to 120	4(13.3)
>120	26(86.7)
Number of aspirations	
Up to 3	24(80.0)
> 3	6(20.0)

Regarding the emergence of clinical signs of laryngotracheal mucosa injury, 16 (53.3%) presented at least one sign.

Dysarthria and bleeding were not observed among the patients. The main clinical sign in the studied population after 24 hours of extubation was dysphonia/hoarseness, presented by 13 (43.3%) of patients. Clinical signs after 24, 48, and 72 hours of extubation are presented in table 2.

Table 2. Distribution of clinical signs 24, 48, and 72 hours after extubation

Clinical signs*	n(%)
24 hours after extubation	
Dysphonia/hoarseness	13(43.3)
Dysphagia	12(40.0)
Odynophagia	10(33.3)
Stridor	4(13.3)
Pain to touch in anterior cervical region	4(13.3)
48 hours after extubation	
Odynophagia	6(20.0)
Dysphonia/hoarseness	4(13.3)
Dysphagia	4(13.3)
Stridor	1(3.3)
Pain to touch in anterior cervical region	1(3.3)
72 hours after extubation	
Dysphagia	1(3.3)
Dysphonia/hoarseness	1(3.3)

*Categories are not mutually exclusive, i.e., more than one clinical sign could be present in the same patient

Men presented greater chances (odds ratio 2.31) of presenting clinical signs of laryngotracheal mucosa injury than women, in addition to a single intubation attempt.

Of the 16 (53.3%) patients who developed clinical signs of laryngotracheal mucosa injury, 14 (87.5%) presented intracuff pressure greater than 25 cmH_2O; 13 (81.25%) were intubated for over 120 minutes; 12 (75%) were intubated with tubes greater than 7.5 mm and with the tube angle in relation to the labial commissure different than 90°.

Regarding intracuff pressure, three (18.75%) patients presented pressure ≤25 cmH_2O, of which two presented clinical signs. Of the 27 (90%) patients with intracuff pressure >25 cmH_2O, 14 (87.5%) presented at least one clinical sign.

The odds ratio of the occurrence of clinical signs for each associated factor is displayed in table 3.

Table 3. Odds ratio of predisposing factors and clinical signs

Variables	Clinical signs		OR (95%CI)	p-value
	Yes n(%)	No n(%)		
Gender			2.31(0.53-0.69)	0.26
Male	9(30.0)	5(16.7)		
Female	7(23.0)	9(30)		
Surgical positioning			0.0	-
Dorsal decubitus	16(53.3)	8(26.7)		
Other position	0(0)	6(20)		
Size of endotracheal tube, mm			0.82(0.14-4.51)	0.81
Up to 7.5	12(40.0)	11(36.7)		
>7.5	4(13.3)	3(10)		
Intubation attempts			4.09(0.37-44.7)	0.22
1	15(50.0)	11(36)		
>1	1(3.3)	3(10)		
Use of muscle relaxant			0.88(0.20-3.8)	0.85
Yes	7(24.1)	7(24.1)		
No	8(26.6)	7(24.1)		
Intracuff pressure, cmH_2O			1.85(0.15-22.9)	0.62
Up to 25	2(6.7)	1(3.3)		
>25	14(46.7)	13(43.3)		
Angle of tube to labial commissure			4.33(0.42-44.4)	0.19
90°	4(13.3)	1(3.3)		
Other	12(40)	13(43.3)		
Duration of intubation, minutes			3.00(0.27-32.7)	0.35
Up to 120	3(10.0)	1(3.3)		
>120	13(43.3)	13(43.3)		
Number of aspirations			0.0	-
Up to 3 times	10(33.3)	14(46.7)		
>3 times	6(20.0)	0(0)		

OR - Odds ratio; 95%CI - 95% confidence interval

Discussion

Limitations of this study include its number of participants, not allowing for representativeness of other groups, as it is a preliminary assessment which can surely guide and foster future studies about laryngotracheal injury related to endotracheal intubation. However, statistical tests were conducted with methodological rigor, ensuring the reliability of the findings.

Endotracheal intubation is conducted daily in emergency rooms, pre-hospital environments and operating rooms. It is a necessary life-saving procedure, however, it can cause laryngotracheal injury, which can range from light to severe, temporary or permanent, and can even cause death.[11] Nurses must understand the clinical signs and associated factors of the occurrence of laryngotracheal mucosa injury to adopt due preventive measures.

The studied men developed more clinical signs of laryngotracheal mucosa injury than the women. This result was not corroborated by the results in the literature.[12] Other factors, both intrinsic and extrinsic, such as obesity and size of endotracheal tube, respectively, could have influenced results related to patient gender and must be controlled in future studies.

The population of this pilot study consisted mainly by adult patients submitted to elective surgery of the digestive system, and the predominant clinical sign was hoarseness, a type of dysphonia and important indication of temporary or permanent vocal cord lesion.[3,13]

Over half of patients submitted to anesthetic-surgical procedures present hoarseness.[3] However, if after a week of extubation it has not subsided, professionals must suspect vocal cord paralysis.[3] A study conducted in Brazil with patients submitted to endotracheal intubation for over 24 hours and up to 14 days showed a moderate to intense level of vocal alteration in most participants, measured through patient self-perception.[13]

The occurrence of dysphagia after extubation is defined as the difficulty or inability to transfer food from the mouth to the stomach and is identified through a liquid swallowing test, or with the patient's own saliva. This is a frequent and important clinical sign in patients following endotracheal extubation.[14,15]

Odynophagia is a common postoperative clinical sign[1] and can predispose to temporary postoperative dysphagia. Further studies are needed to improve understanding of this clinical sign related to laryngotracheal injury after intubation.

Intracuff pressure over 25 cmH_2O stood out in this study and this finding corroborates the trend found in the literature.[16] Ongoing monitoring of intracuff pressure and maintaining it at parameters lower than tissue perfusion pressure reduces incidence of dysphonia in patients submitted to endotracheal intubation.[3] Training health teams, especially nursing professionals, is considered a good strategy to raise awareness of the harmful effects of excessive cuff pressure and contribute to safer patient care. Specific material is also necessary, such as cuff pressure gauges, to provide more precise readings.

In a clinical study conducted with dogs, 25 cmH_2O was established as the optimal pressure, sealing the tube to air leaks and preventing decreased air flow volume provided by the mechanical ventilator, thus determining minimal injury to mucosa in contact with the cuff.[17]

Tests have been conducted with a device that automatically modulates intracuff pressure, according to tidal volume, synchronized with either inspiration or expiration, i.e., during inspiration, intracuff pressure remains at 25 cmH_2O and, during expiration, at 7 cmH_2O. The device was tested with pigs and the automatic modulation of intracuff pressure was shown to be more efficient than maintaining constant pressure at 25 cmH_2O, in terms of the occurrence of injury.[18] This device has not yet been tested in humans.

Intubation time was also related to the emergence of clinical signs suggesting laryngotracheal mucosa injury. Of the 16 (53.3%) patients who developed injury, 13 (43.3%) had been intubated for over 120 minutes. The risk and incidence of laryngotracheal injury increase over time.[1] However, short-term intubations can also cause lesions.[5] The presence of the endotracheal tube triggers all the

histological phenomena of aggression and defense of the laryngotracheal mucosa, which do not depend on the duration of intubation. Duration of intubation seems to favor only the predominance of destructive injury.[5]

The position of the endotracheal tube in relation to the labial commissure was associated with laryngotracheal injury. Of the 16 (53.3%) patients with clinical signs of laryngotracheal mucosa injury, in 12 (40%), the tube was angled different than 90° during the entire postoperative period. It is believed that the greater the inclination of the tube in relation to the labial commissure, the greater the risk of developing laryngotracheal injury.

The chance of developing injury in patients who used endotracheal tubes ≤7.5 mm was lower than those who were given tubes >7.5 mm. The results described here are in accordance with the pattern described in the literature, which has indicated that larger tubes present greater risk for the development of laryngotracheal injury.[1,11] Choosing an adequate tube size is an important factor to mitigate the risk of damaging mucosa in the laryngeal and tracheal region.

Concerning surgical positioning, it has already been shown that the position of Trendelenburg in patients undergoing laparoscopic gynecological surgery increases the pressure exerted by the cuff on laryngeal and tracheal mucosa, resulting in greater discomfort after extubation, and may constitute a factor associated with the occurrence of lesions Laryngotracheals.[19]

Regarding surgical positioning, patients placed in the Trendelenburg position for laparoscopic gynecological surgery showed increased cuff pressure on laryngeal and tracheal mucosa, resulting in greater discomfort after extubation, considered an associated factor in the occurrence of laryngotracheal injury.[12,20,21]

Even though the aspiration of tracheobronchial secretions can be a necessary procedure, it can be harmful to tracheal mucosa.[7]

Studies about patient safety involving laryngotracheal injury are still incipient.[22] To minimize the occurrence of such lesions generated by the intubation process, healthcare teams must adopt preventive measures, such as rigorous and constant monitoring of intracuff pressure, adequate patient position and immobilization, adequate tube size, and carrying out tracheal aspiration.

Nurses can identify risk of laryngotracheal mucosa injury based on the knowledge of its associated factors. This type of injury can be prevented through technical and legal nursing actions. However, nursing must intensify its studies about the diagnoses, interventions, and outcomes that involve injuries to the laryngotracheal mucosa.

This pilot study can help raise awareness of nurses about the risks of implementing and maintaining artificial airways in patients, in addition to inciting further studies on the phenomenon of laryngotracheal mucosa injury.

Conclusion

The most common clinical signs of laryngotracheal mucosa were hoarseness, dysphagia, and odynophagia. Associated factors were cuff pressure above 25 cmH_2O, duration of intubation and inadequate size of endotracheal tube.

Collaborations

Cordeiro ALPC and Barbosa MH contributed to the conception of the study; data interpretation; drafting of the manuscript; and final approval of the version to be published. Silva R, Prado CBC and Oliveira KF participated in the critical review of the article for important intellectual content.

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