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SCIENTIFIC ARTICLE

Use of Simple Clinical Predictors on Preoperative Diagnosis of Difficult Endotracheal Intubation in Obese Patients

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Risk Assessment.

Abstract

Background and objectives: Although the incidence of difficult laryngoscopy is similar in obese and non-obese patients, there are more reports of difficult intubation in obese individuals. Alternatives for the diagnosis and prediction of difficult intubation in the preoperative period may help reduce anesthetic complications in obese patients. The aim of this study was to identify predictors for the diagnosis of difficult airway in obese patients, correlating with the clinical methods of pre-anesthetic evaluation and polysomnography. We also compared the incidence of difficult facemask ventilation and difficult laryngoscopy between obese and non-obese patients, identifying the most prevalent predictors.

Methods: Observational, prospective and comparative study, with 88 adult patients undergoing general anesthesia. In the preoperative period, we evaluated a questionnaire on the clinical predictors of the obstructive sleep apnea syndrome (OSAS) and anatomical parameters. During anesthesia, we evaluated difficult facemask ventilation and laryngoscopy. Descriptive statistics and correlation test were used for analysis.

Results: Patients were allocated into two groups: obese group (n = 43) and non-obese group (n = 45). Physical status, prevalence of snoring, hypertension, diabetes mellitus, neck circumference, and Mallampati index were higher in the obese group. Obese patients had a higher incidence of difficult facemask ventilation and laryngoscopy. There was no correlation between anatomical or clinical variable and difficult facemask ventilation in both groups. In obese patients, the diagnosis of OSAS showed strong correlation with difficult laryngoscopy.

Conclusions: The clinical and polysomnographic diagnosis of OSA proved useful in the preoperative diagnosis of difficult laryngoscopy. Obese patients are more prone to difficult facemask ventilation and laryngoscopy.

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Introduction

Obesity may be defined as excess of fat in the body. A person is considered obese when excess fat affects his/her physical and mental health and decreases his/her life expectancy¹. The World Health Organization (WHO) defines an obese person as one who has a body mass index (BMI) greater than 30 kg per square meter of body surface ($BMI \geq 30 \text{ kg.m}^{-2}$).

The incidence of obesity has increased considerably almost worldwide. In Brazil, the prevalence rate is 13.3% for the female and 7% for the male population. In Europe and the U.S., the prevalence rates are 20 and 22.5%, respectively. The ascent rate varies from 0.5% to 1% per year in developed countries. Only Japan and the Netherlands have stable rates².

Improper airway management is the most frequent cause of complications related to anesthesiology and accounts for 30% of deaths, with anesthesia as the primary cause. In the last century, it became clear the importance of airway prior assessment as a means to decrease complications in anesthesia. Several devices and techniques were developed and, a few decades ago, Cormack and Lehane, and Mallampati et al. developed tables for predicting difficult intubation.

Within this context, it is important to distinguish difficult laryngoscopy from difficult tracheal intubation. Difficult laryngoscopy is an objective parameter related to the classification of larynx visualization in grades III or IV according to Cormack and Lehane. The concept of difficult intubation, a more subjective evaluation, is related to the physician's experience and the number of attempts or techniques used during the procedure. One patient with grade III or IV in the classification of Cormack and Lehane may undergo intubation without difficulty. On the other hand, one patient with Cormack's grade I may have limited access to the airways due to a subglottic tumor or tracheal deviation.

In obese individuals, the incidence of difficult laryngoscopy is similar to that of non-obese individuals (about 10%)⁶. Nevertheless, there are more reports on difficult intubation in obese patients. This is believed to be due to changes in upper airway, present in patients with BMI above 30 kg.m^{-2} ^{3,4}. Some clinical predictors are related to increased risk of difficult airway in obese patients. Mallampati's grade III or IV, large neck circumference, and previous diagnosis of obstructive sleep apnea syndrome (OSAS) are factors related to difficult intubation in obese patients³.

OSAS is a clinical condition associated with obesity and difficult intubation. It results from partial or complete airway obstruction during sleep, and its prevalence varies between 9% and 24% in the general population⁵. Non-treated OSAS may lead to cognitive dysfunction, decreased job performance, and poor quality of life. The main symptoms are associated with loud snoring, pauses in breathing during sleep, and daytime sleepiness⁶. Prevalence is higher in specific subgroups, such as obese and overweight patients and older individuals. Risk factors are smoking, alcoholism, male gender, and family history of OSAS.

Because it is a clinical condition with significant relevance to the anesthetic procedure, recent consensus of the American Society of Anesthesiologists (ASA) emphasize the need to diagnose OSAS patients in the perioperative period through clinical history, physical examination, and laboratory tests⁷. Various strategies have been proposed to

improve the diagnosis and treatment of obstructive sleep apnea. Prediction algorithms and the use of home monitoring at night, such as oximetry, have improved the access to diagnostic tests⁵. In centers having no polysomnography as preoperative routine, the investigation of some specific clinical indicators may help identify patients with a possible diagnosis of OSAS⁵.

The development of alternative ways of diagnosing obstructive sleep apnea and foreseeing difficult tracheal intubation in the preoperative period may help reduce the rates of anesthetic complications in obese patients. The objectives are to identify independent clinical predictors to predict and diagnose difficult airway in obese patients during the preoperative period, through the correlation between clinical methods of preanesthetic evaluation and polysomnography results. The secondary objective is to compare the incidence of difficult facemask ventilation and laryngoscopy between obese and non-obese patients and assess the most prevalent predictors in each group.

Method

This is an observational, prospective, and comparative study. After approval by the Human Research Ethics Committees (CEP) of the Universidade de Brasília, each patient gave previous informed consent.

The sample consisted of patients from the University Hospital of Brasília aged over 18 years undergoing general anesthesia for surgical procedures from May to November 2011. In the preoperative period, all patients completed a questionnaire of clinical predictors for preoperative diagnosis of OSAS⁷.

Sample size was determined based on the estimated mean incidence of difficult laryngoscopy in the population, with calculated minimum sample of 40 patients in each group.

Patients were allocated into two groups. The first group consisted of patients diagnosed with obesity according to WHO criteria ($BMI \geq 30 \text{ kg.m}^{-2}$) and the second group included patients with $BMI < 30 \text{ kg.m}^{-2}$.

Demographic variables evaluated were age, sex, height, weight, BMI, and ASA physical status. Clinical predictors of OSAS were self-reported snoring or family history of snoring, treated or untreated systemic arterial hypertension (AH), type 2 diabetes mellitus (DM), daytime sleepiness and apnea during sleep. The anatomical parameters assessment was based on the modified Mallampati index, measurement of neck circumference, thyromental and sternomental distances, mouth opening, mandibular protrusion capacity, mobility, and cervical morphology.

We investigated the existence of preoperative polysomnography examination on medical records. Clinical data were correlated with the results of polysomnographic studies to identify the variables related to OSAS diagnosis.

We evaluated the experience of the anesthesiologist who performed the anesthetic procedure, difficult facemask ventilation, and Cormack-Lehane classification during laryngoscopy. Difficult laryngoscopy was considered as grade III or IV, according to Cormack-Lehane classification system.

For statistical analysis, we used Excel© (Microsoft Corporation) software for descriptive statistics and correlation analysis. For comparison between obese and non-obese

patients, continuous data were analyzed using Student's t-test and unpaired nominal variables using the chi-square test. A value of $p < 0.05$ was considered significant.

Results

The sample consisted of 83 patients allocated into two groups: obese group ($n = 43$) and non-obese group ($n = 45$). Only nine patients in the obese group and one patient in the non-obese group had preoperative polysomnography results in their records.

There was no difference between both groups regarding age, sex, and height. Weight, BMI, and ASA physical status were significantly higher in the obese group (Table 1).

The higher prevalence of snoring, hypertension, and type 2 diabetes mellitus in obese patients was statistically significant ($p < 0.05$). There was no difference between groups regarding daytime sleepiness and apnea during sleep (Table 2).

The values for neck circumference and Mallampati modified index were significantly higher in obese patients ($p < 0.05$). There was no difference between groups regarding thyromental and sternomental distances, mouth opening, mandibular morphology, mobility capacity, and cervical protrusion (Table 3).

There was no statistically significant difference between groups regarding the experience of physicians performing the airway access (Table 4). The differences in difficult facemask

Table 1 Demographic Data.

	Obese	Non-obese	
n	43	45	
Parameters	Mean (\pm SD)	Mean (\pm SD)	p
Age (years)	48.8 (\pm 13.2)	49.6 (\pm 13.7)	0.80
Sex	33F/10M	36F/9M	0.19
Height (cm)	160.3 (\pm 9.7)	160.1 (\pm 8.1)	0.94
Weight (kg)	94.6 (\pm 20.6)	63.4 (\pm 9.2)	< 0.001*
BMI (kg.m ⁻²)	36.7 (\pm 6.1)	24.7 (\pm 3.1)	< 0.001*
Physical status	35 I-II/ 8 III-IV	45 I-II/ 0 III-IV	< 0.05*

BMI: Body Mass Index.

Table 2 Prevalence of the Clinical Predictors of OSAS.

Predictors	Obese	Non-obese	p
n	43	45	
Snoring	86.0%	35.6%	< 0.05*
Apnea	13.0%	6.7%	> 0.05
Sleepiness	41.9%	24.4%	> 0.05
AH	48.8%	26.7%	< 0.05*
Type-2 DM	32.6%	0%	< 0.05*

AH: Arterial Hypertension; DM: Diabetes Mellitus

Table 3 Anatomical Evaluation.

Parameters	Obese Mean (\pm SD)	Non-obese Mean (\pm SD)	p
Neck circumference (cm)	40.7 (\pm 3.4)	36.4 (\pm 4.0)	< 0.001*
Thyromental distance (cm)	8.1 (\pm 1.4)	7.6 (\pm 1.0)	0.07
Sternomental distance (cm)	15.1 (\pm 1.8)	14.4 (\pm 1.6)	0.07
Mouth opening (cm)	4.6 (\pm 0.7)	4.5 (\pm 0.6)	0.48
Mallampati classification	35 I-II/ 6 III-IV	44 I-II/ 1 III-IV	< 0.05*
Adequate mandibular protrusion (%)	86.0	90.1	> 0.05
Adequate cervical mobility (%)	90.7	95.6	> 0.05
Normal mandibular morphology (%)	93.0	95.6	> 0.05

Table 4 Anesthesiologist's Experience.

	Obese	Non-obese	p
1 year	39	34	> 0.05
> 1 year	4	11	> 0.05

Table 5 Airway Access.

Parameters	Obese	Non-obese	p
Difficult ventilation	16.3 %	0 %	< 0.05*
Difficult laryngoscopy	9.3 %	0 %	< 0.05*

ventilation and laryngoscopy were statistically significant ($p < 0.05$). No patient in the non-obese group had difficult ventilation or laryngoscopy (Table 5).

None of the anatomical or clinical variables assessed had significant correlation with difficult facemask ventilation in both groups. In obese patients, the polysomnography used to diagnose OSAS showed strong correlation with difficult laryngoscopy ($r = 0.8$). The other parameters had no good correlation with this outcome (Table 6). In obese patients undergoing polysomnography, weight, physical status, history of snoring, apnea during sleep, and mento-thyroid distance values showed good correlation with the diagnosis of OSAS (Table 7).

Table 6 Correlation with Difficult Airway Access.

Predictor	Difficult ventilation	Difficult laryngoscopy
BMI	r = 0.15	r = 0.12
Snoring	r = 0.17	r = 0.20
Neck circumference	r = 0.17	r = 0.19
Physical status	r = 0.27	r = 0.20
OSAS	r = 0.36	r = 0.80*

BMI: Body Mass Index; OSAS: Obstructive Sleep Apnea Syndrome.

Table 7 Correlation with Diagnosis of OSAS.

Predictor	Diagnosis of OSAS
N	9
Weight	r = 0.82
Snoring	r = 1.00
Physical status	r = 0.74
Nocturnal apnea	r = 0.80
Mento-thyroid distance	r = 0.73

Discussion

Difficult airway access and improper management are the main causes of complications in anesthetic practice⁸. The accurate preoperative diagnosis of difficult tracheal intubation may result in lower rates of anesthetic complications, particularly in obese patients.

It is believed that the airway access is more difficult in obese than in non-obese patients due to the anatomic changes resulting from excess weight⁸. In obese patients, there is a reversed relationship between weight and pharyngeal area due to fat deposition on cervical structures⁹. Thus, difficult intubation, sometimes defined as inadequate glottis exposure to direct laryngoscopy, is more prevalent in patients with high BMI⁸.

In the present study, consistent with literature reports, the incidence of snoring, AH, and diabetes mellitus was higher in obese patients¹⁰. These findings were already expected, as obesity is an independent risk factor for arterial hypertension, insulin resistance, and nocturnal airway obstruction¹¹.

Although obesity is a physical characteristic that is most associated with the diagnosis of obstructive sleep apnea⁹, the incidence of daytime sleepiness and apnea during sleep was similar in both groups. One possible explanation is that there are other factors associated with airway obstruction, such as septal deviation and tonsillar hypertrophy, whose incidence is similar between obese and non-obese individuals^{2,9}.

The anatomical parameters of airway evaluation showed no difference between the two groups, which was similar to the study by Kim et al.⁴ The only exception was the value of neck circumference and Mallampati index, which were higher in the obese group. This may be explained by the fact that these patients had decreased pharyngeal area due to the excess of soft tissue in this region⁹.

Studies by Juvin et al.³ and Kim et al.⁴ showed higher incidence of difficult facemask ventilation in obese patients. However, its actual incidence in patients with a BMI >30 kg/m² remains controversial because it is hard to define and given the variety of methods used⁸. In the present study, the proportion of obese patients with difficult facemask ventilation was 16.3%, which is similar to previous studies². Patients in the non-obese group had adequate facemask ventilation. The greater difficulty in obese patient's ventilation results from fat tissue deposition in the hypopharynx, uvula, tongue, and arytenoid folds, increasing the volume of these structures and reducing the free area for air passage.

According to current literature, the incidence of difficult intubation in obese and non-obese individuals is similar (about 10%)³. In our study, the incidence of difficult laryngoscopy in obese patients was 9.3%. However, among non-obese patients there was no case of difficult intubation, compared with those reported in literature, which showed incidence around 10% in this group^{3,4}. This finding may be a consequence of the limited sampling size studied. The studies reporting similar incidences had at least 100 patients in each group^{3,4}. The level of experience among the different physicians who accessed the airways in both groups could be another explanation for this finding. Nevertheless, there was no difference between groups regarding this variable.

According to studies by Kim et al. and Benumof, the incidence of difficult facemask ventilation in obese patients is superior to difficult laryngoscopy^{7,9}. However, the explanation for this evidence remains controversial, as risk factors for both entities are quite similar. In the present study sample, the percentage of patients with difficult ventilation (16.7%) was higher than that of patients with difficult laryngoscopy (9.3%), which is consistent with the literature.

To date, no clinical predictor was directly correlated with difficult facemask ventilation in obese patients, similar to this study⁹. However, large neck circumference, modified Mallampati index (grade III or IV), and a previous diagnosis of OSAS with polysomnography are among the predictors established as risk factors for difficult laryngoscopy^{3,8}. In the present study, the only factor presenting good correlation with difficult laryngoscopy in obese patients was a previous diagnosis of OSAS with polysomnography. Variables such as gender, age, BMI, history of snoring, neck circumference and Mallampati index showed no correlation with Cormack-Lehane classification III or IV in obese patients.

Evidence on literature indicates that obese patients with OSAS usually have a higher incidence of difficult laryngoscopy^{8,9}. Anatomical measurements, such as reduced mouth opening, sternomental, and thyromental distances and greater neck circumference are highly related to both diagnosis of difficult airway access and OSAS. Another essential point is that the excess fat tissue in obese patients with OSAS may occur at the hypopharyngeal level, which makes the evaluation by Mallampati classification unreliable to predict difficult intubation. The finding of a good correlation between the preoperative diagnosis of OSAS and difficult airway access in obese patients comes as no surprise⁹. Thus, assessing the presence of clinical predictors of OSAS is a valuable tool to aid in the prediction of difficult airway management in obese patients.

One limitation of our study was the poor availability of polysomnography in the preoperative period. Among obese patients, nine (20.9%) underwent polysomnography, while, among non-obese patients, only one (2.2%) underwent a sleep study. This detail hampered the correlation between the evaluated clinical predictors and the diagnosis of obstructive sleep apnea. The American Thoracic Society and the American Academy of Sleep Medicine recommend supervised polysomnography over two nights in the sleep laboratory. For a highly prevalent condition, this approach results in inevitable differences between service demand and sleep laboratories current capacity. Despite the limitation, the weight, physical status, history of snoring, apnea during sleep, and mento-thyroid distance values showed good correlation with the polysomnographic diagnosis of OSAS in the obese group.

Another limitation of this study was the sample size. The number of patients analyzed was slightly higher than the minimum required, so that the findings were not explained by chance. However, the sample was similar to that of other studies with the same focus⁸.

The assessment of some important predictors of obstructive sleep apnea may be considered as a quality in this study, as it has been poorly studied so far. Recent works, such as the one by Ramachandran et al., designed clinical questionnaires for diagnosis of OSAS in the preoperative period¹². However, the authors did not evaluate predictors, such as sleepiness, daytime fatigue, or history of apnea during sleep.

Further studies with larger samples should be conducted to determine the clinical predictors that can assist in the diagnosis of difficult laryngoscopy, as a way to decrease the incidence of complications related to inadequate airway management in obese patients.

The clinical and polysomnographic diagnosis of OSA proved useful in the preoperative diagnosis of difficult laryngoscopy. Obese patients are more prone to difficult facemask ventilation and difficult laryngoscopy than non-obese individuals.

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