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ORIGINAL INVESTIGATION

Obstructive sleep apnea in surgical patients and its relationship with difficult intubation: two years of experience from a single center

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Abstract
Background and objectives: In this study, we aimed to determine the risk of obstructive sleep apnea (OSA) in patients undergoing elective surgery and its relationship with difficult intubation (DI).
Methods: This prospective, descriptive, cross-sectional study was conducted between December 2018 and February 2020 in the anesthesiology and reanimation service of a training and research hospital. The study included patients who were ASA I–II, 18 years of age, and older who underwent elective surgery under general anesthesia. A form regarding the baseline characteristics of the participants as well as STOP-Bang score, Mallampati, and Cormack-Lehane classification was used to collect the data.
Results: The study included 307 patients. It was determined that 64.2% of patients had a high risk of OSA. The presence of DI (determined by repeated attempts at intubation) was 28.6% in the high-risk OSA group, while there was no DI in the low-risk OSA group. A statistically significant difference was found between the groups in terms of OSA risk according to the presence of DI according to repeated attempts, Cormack-Lehane classification, and Mallampati classification ($p < 0.001$).
Conclusion: Due to the high rate of DI in patients with a high risk of OSA, the security of the airway in these patients is endangered. Early clinical recognition of OSA can help in designing a safer care plan.

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Introduction

Obstructive sleep apnea (OSA) is a common and often undiagnosed disease that causes blood oxygen desaturation as a result of the recurrent collapse of the upper airways during sleep. OSA causes a serious increase in the risk of complications that may occur in the perioperative period, as well as poor health outcomes in the long term.[1] Due to this increased perioperative risk, recently published guidelines emphasize that the presence of OSA in patients should be identified to raise awareness among healthcare professionals, reduce the risk of complications, and improve patient outcomes.[1]

The presence of obstructive sleep apnea is an independent risk factor for difficult intubation (DI), making it difficult to ventilate the patient with a mask. Thus, the anesthesia team should take the necessary precautions to ensure that adequate airway patency is continuously maintained.[1] Patients with OSA wake up repeatedly from sleep in order to maintain airway patency, causing daytime sleepiness, fatigue, and impairment in cognitive functions.[2] The presence of OSA causes an increase in the risk of cardiovascular disease and therefore mortality, uncontrolled hyperglycemia in diabetic patients, death from traffic accidents due to impaired cognitive functions, and the development of cancer.[3] The diagnosis of OSA is often made by the apnea-hypopnea index (AHI), which is measured by taking the sum of the number of apnea and hypopnea events seen per hour in measurements performed by polysomnography overnight. An AHI is between 5–14 per hour is considered mild OSA, between 15–29 is considered moderate OSA, and 30 and above is considered severe OSA.[4]

In a systematic review evaluating 24 studies conducted in the general population, the prevalence of OSA was found to be between 6–17%, and it was established that it is more common in males, obese individuals, and elderly individuals.[5] Studies have confirmed the presence of OSA in 3.3–66% of patients who underwent surgery and were reported to have a difficult airway. In a narrative review[6] evaluating 10 studies, the incidence of DI was higher in OSA patients than in non-OSA patients [56/386 (14.5%) vs. 69/897 (7.7%); $p = 0.0002$]. It has also been revealed that more complications are seen in the perioperative and postoperative period in patients with a diagnosis of OSA who underwent intravenous sedation, general anesthesia, and postoperative opioid analgesia.[7] Additionally, the risk of cardiovascular complications from general anesthesia is 2–3 times higher in patients diagnosed with OSA.[8] Although the opioid dose consumed in the postoperative period in patients who underwent surgery with and without OSA diagnosis in a recent study was similar, the incidence of pulmonary, cardiovascular, gastrointestinal, renal, and thromboembolic complications was higher in patients diagnosed with OSA than in patients without OSA.[9]

Although it has been pointed out in the recently published updated guidelines that every patient with plans to undergo surgery should be screened with a valid and reliable OSA measurement tool,[1] it is stated that only 34.7% of anesthesiologists perform OSA screening.[10] It was observed in the study of Singh et al.[11] that although 267 patients who were to undergo surgical operation were diagnosed with moderate-severe OSA, 92% of surgeons and 60% of anesthetists did not evaluate patients for the presence of OSA.

The aim of this study was to determine the risk of OSA in patients undergoing elective surgery and its relationship with DI.

Methods

This prospective, descriptive, and relational study was conducted in the anesthesiology and reanimation service of a training and research hospital between November 2018 and February 2020. The study was conducted in accordance with the Declaration of Helsinki. Local ethics committee approval (meeting date: 11/06/2018, decision no: 1030) was obtained in addition to the necessary permissions from the hospital where the study was conducted and the consent of the patients.

Surgical operations of the ear, nose, throat, urology, general surgery, and joints were performed under general and regional anesthesia in the unit where the study was conducted. An anesthesiologist was present in the unit, which has a total of four operating theatres. After the operation, patients were taken to the recovery unit before they were sent to the clinic, and their care was provided by two nurses.

The study included patients who were ASA (American Society of Anesthesiologists) physical status I–II, 18 years of age and older who underwent elective surgery under general anesthesia, who were not pregnant, did not have any psychiatric disorder that prevented communication, and volunteered to participate in the study. Patients who were previously diagnosed with OSA and did not participate in the study were excluded from the study. Documented OSA was defined as an OSA diagnosis based on a previous laboratory or portable polysomnography or if the patient had a prescription for continuous positive airway pressure for OSA.

This study was designed based on the hypothesis that patients with high-risk OSA were at increased risk for DI compared with patients with low-risk OSA. Sampling calculations were performed using the GPower 3.1.9.4 program, and according to the Chung et al.[12] study, 23.83% of the patients had a low risk of OSA. According to these data, the sample size should be 289 with 95% power and 5% Type 1 error.

Outcomes

For the primary outcome measure, we aimed to assess the risk of OSA and its relationship with DI. The STOP-Bang score was used to detect OSA in the patients before surgery. Mallampati classification and the Cormack-Lehane test were used to evaluate the risk of DI in each patient.

Measurements

For data collection, the baseline characteristics of the participants, STOP-BANG score, Mallampati Classification, and Cormack-Lehane test were used.

The form regarding the baseline characteristics of the participants

The semi-structured questionnaire developed by researchers was used after relevant literature review.[1,2,8,11,13,14] The form includes a total of 9 questions, including 5 questions regarding the patient's age, sex, height, weight, and surgical operation, and 4 questions regarding postoperative complications with blood pressure, heart rate and oxygen saturation (SpO_2).

STOP-Bang Score

This scoring system was developed by Chung et al.,[15] and its Turkish validity and reliability are reported by Acar et al.[16] The STOP-Bang scoring system consists of eight questions in total, and the questions are answered as yes or no. 1 point is given for each yes answer and 0 point for a no answer. If the total score is less than 3, it is determined that there is a low risk of OSA; if 3 and above, there is a high risk of OSA. In this study, patients were divided into low- and high-risk OSA groups.

Definition of DI

We used three tools for detecting DI:

- Difficult intubation was defined as both a 2013-updated report on practice guidelines for management of the difficult airway by the American Society of Anesthesiologists[17] and the study of Corso et al.[14] as a maneuver performed with a correct head position and external laryngeal manipulation resulting in: a) difficult laryngoscopy, defined as being characterized by the impossibility of obtaining a view of the vocal cords even after the best external laryngeal manipulation; b) necessity of repeated attempts. Accordingly, a single repeated attempt or switch to a different blade qualifies as DI.
- **Mallampati Classification:** This classification was used to predict the risk of DI in the patient.[18] This measure has 4 classes: class 1 - soft palate, uvula, and pharyngeal pillars are visible; class 2 - soft palate, uvula are visible; class 3 - soft palate and base of uvula are visible; class 4 - soft palate is considered to be invisible.[18,19] In this study, it was established that patients in Mallampati classes 3 and 4 had a risk of DI.[18,19]
- **Cormack-Lehane Classification:** The vocal cord images were evaluated between class 1 and class 4 using a laryngoscope according to the Cormack-Lehane classification system. This system has 4 classes: class 1 - glottis is fully visible; class 2 - glottis partially visible; class 3 - only epiglottis is visible; class 4 - epiglottis expressed as invisible.[20] In this study, the presence of DI was established if a patient had a Cormack-Lehane grade of class 3 or class 4, indicating poor vocal cord imaging.[21]

Data collection

Data were collected by investigators prior to the patient undergoing surgery. The answers to the first 5 questions in the questionnaire regarding the baseline characteristics of the participants were taken from the patient's medical file. Postoperative variables were obtained from the patient's file in the recovery unit. The patient's blood pressure, pulse rate and SpO_2 values were routinely measured every 15 minutes during the first hour in the postoperative recovery unit. These values were recorded on the observation form by nurses who were working in the unit and who were unaware of the research, and these values were transferred to the questionnaire by the researchers.

A qualified anesthesiologist administered anesthesia. After the patients had been taken to the surgical table with no premedication, a noninvasive blood pressure cuff, peripheral oxygen saturation measurement and 3-lead electrocardiogram were tracked in a regular manner. In the dorsum of the hand, a 20/22G intravenous catheter was placed into a small vein. One hundred percent oxygen was derived from a mask for 2–3 minutes at 5 $L.min^{-1}$ for denitrogenization, which was administered by voluntary ventilation. A target-controlled infusion pump administered propofol (10 $mg.mL^{-1}$) and remifentanil (50 $\mu g.mL^{-1}$) (OrchestraTM, Fresenius Vial, France). The Minto model was selected for remifentanil, and the Schnider model was selected for propofol. Propofol was set at a target effect-site concentration of 4.0 $\mu g.mL^{-1}$. Remifentanil was set at a target effect-site concentration of 3.0 $ng.mL^{-1}$. After remifentanil administration, propofol was administered, and the target effect-site concentration reached 3.0 $ng.mL^{-1}$. Following loss of consciousness, 0.6 $mg.kg^{-1}$ rocuronium (a muscle relaxant) was given intravenously (IV). The head was positioned in a sniffing position to facilitate intubation after approximately 2 minutes, when paralysis was observed. The airway was then assessed and graded according to Cormack and Lehane's method, without pressing upon the thyroid cartilage, for optimum exposure of the glottis.

The Mallampati classification was evaluated by the anesthesiologist involved in the study prior the patient undergoing surgery. After the patient was placed in a sitting position, he/she was asked to open his/her mouth, stick his/her tongue out, and not to make a sound. The pharyngeal structure of the patient was illuminated with an appropriate light source and evaluated according to the Mallampati classification system.

The Cormack-Lehane classification was evaluated by the anesthesiologist who took part in the study, using a Macintosh blade suitable for gender, without applying pressure to the jack with the laryngoscope. Intubation was performed with a Portex tube, and the number of attempts at intubation was recorded.

The STOP-Bang score was evaluated by the anesthesiologist involved in the study before the operation. The neck circumference of the patient was measured with a suitable tape measure by a nurse who was unaware of the research. The STROBE checklist was used for reporting the study.

Statistical analysis

IBM SPSS Statistics for Windows, Version 22.0 (SPSS; IBM Corp., Armonk, NY, USA) was used at the end of the study for statistical analysis of the data obtained. The compat-

ibility of the obtained measurement values to a normal distribution was examined with the Shapiro-Wilk test. The median and interquartile range (IQR) were used to represent the descriptive statistics of continuous numerical variables. Number (n) and percentage (%) were used to display categorical variables. Comparisons regarding data that did not show a normal distribution were made using the Mann-Whitney U test, chi-squared test, or Fisher's exact test. In the multigroup analysis, if the *p*-value was less than 0.05, the Mann-Whitney U test with Bonferroni Correction, one of the *post hoc* tests, was used to determine which group(s) caused the difference. In statistical decisions, the $p < 0.05$ level was considered statistically significant.

Results

The study included 307 patients. There were 197 patients (64.2%) at high risk for OSAS as defined by a STOP-BANG score of 3 or higher. Five patients were awakened after three unsuccessful intubation attempts due to DI. Age ($p < 0.001$) was significantly higher in patients with high OSA risk than in those with low OSA risk. OSA risk was found to be significantly higher in males ($p < 0.001$). The risk of OSA was found to be low in obese patients ($p < 0.001$). A statistically significant difference was found between the groups in terms of OSA risk according to operation type. According to the Bonferroni corrected Mann-Whitney U test, the difference originated from the patients who underwent ENT ($p < 0.001$), general surgery ($p = 0.002$), and urology ($p < 0.001$) operations. Patients in the ENT group had a high risk of OSA (Table 1).

The presence of DI, based on the need for repeated attempts for intubation, was 28.6% in the high-risk OSA group, while there was no DI in the low-risk OSA group. A statistically significant difference was found between the groups in terms of OSA risk according to the presence of DI based on the need for repeated attempts ($p < 0.001$), Cormack-Lehane ($p < 0.001$) and Mallampati classification ($p < 0.001$) (Table 2).

Discussion

As a result of this study, 64.2% of patients had a high risk of OSA. It was found that age was higher in patients with high OSA risk, and males had a high risk of OSA. The risk of OSA was high in Mallampati class 3 patients who underwent ENT surgery. It was observed that the patients with low OSA risk were not obese, were easily intubated, and had a Cormack-Lehane grade of 1.

In this study, 64.2% of the patients had a high risk of OSA, and 35.8% had a low risk of OSA. OSA prevalence is higher in patients undergoing elective surgery than in the general population. OSA is seen in one of every 4 men and one of every 10 women who undergo surgery.[22] Finkel et al.[23] screened of 2,877 patients scheduled for surgery and observed that 24% had a high risk of OSA, and 81% of these patients did not have a prior diagnosis of OSA. Before elective surgery, patients should be checked for the risk of OSA with physical examination and screening tests. In a previous study it was observed that although a moderate risk of OSA was detected in 38% of patients, 60% of anesthetists and 92% of surgeons did not diagnose OSA prior to surgery.[11] The high prevalence of OSA in our study, similar to previously reported in the literature, demonstrates that patients were not screened for OSA risk by the anesthesiologist and/or surgeon before the operation. With this in mind, it is important to note that the American Society of Anesthesiologists also recommends preoperative screening for OSA.[2]

In this study, it was observed that patients with a low risk of OSA did not experience DI. OSA is associated with an increased incidence of DI, increased duration of postanesthesia care unit length of stay, and respiratory and cardiovascular complications during the perioperative period.[24] Both anesthesia and sleep create a predisposing factor for upper airway obstruction by causing a decrease in pharyngeal dilator muscle activity and lung volume.[25] OSA causes a delay (100–200 milliseconds) or deterioration in upper airway muscle tone. Hiremath et al.[26] were the first to find a significant relationship between the presence of OSA and DI in their studies with polysomnography. Chung et al.[15] also confirmed the presence of OSA in 66% of patients with DI. Siyam et al.[27] studied 36 surgical patients with polysomnography-confirmed OSA, matching two or three demographically controlled patients for every OSA patient. OSA patients had a higher incidence of DI than non-OSA patients [8/36 (21.9%) vs. 2/77 (2.6%)]. In the study by Kim et al.,[28] 90 patients with polysomnography-confirmed OSA were compared with non-OSA patients matched for age and sex. The incidence of DI was higher in OSA patients than in non-OSA patients [15/90 (16.7%) vs. 3/90 (3.3%)]. Liao et al.[29] found that patients with OSA had difficult intubation (OSA vs non-OSA: 20% vs. 10%). Similar to the literature, in our study, the rate of DI was higher in patients with a high risk of OSA.

Many ear, nose, and tongue disorders may lead to OSA.[30] Especially in patients undergoing ear-nose-throat surgery, difficulties are often encountered in providing effective ventilation, and these patients with a history of the difficult airway are at risk for the development of OSA.[31] The conditions that cause ENT-specific surgical operations such as retrognathic mandible, nasal obstruction, and enlarged adenoids and tonsils also increase the risk of OSA. Similar to the literature,[14] the risk of OSA was found to be high in patients who underwent ENT surgery in this study.

Although polysomnography applied in the laboratory is the gold standard in the detection of obstructive sleep apnea,[32] its usage rate is low due to its high cost, lack of availability in every hospital, and long wait times. One of the well-validated questionnaires suggested by the American Society of Anesthesiologists in the evaluation of OSA in the surgical population is the STOP-Bang score.[13] It is often preferred because of its fast application and easy use.[12] The variables of age, sex, blood pressure, and obesity in the STOP-Bang score are similar to the literature in this study[14] as the variables affecting patients with high OSA risk.

There is evidence of OSA pathogenesis due to the upper airway size and shape.[33] The Mallampati class is an easy and replicable method for determining the size and shape of the upper airways and is validated as a tool to assess the risk of DI.[34] Shah et al.[30] revealed that a one-unit increase in the Mallampati score increases the risk of OSA more than 1.5 times. In the study of Hukins,[34] although Mallampati classes

Table 1 Baseline characteristics of study patients (n = 307).

Variables	Low risk OSA 110 (35.8%)	High Risk OSA 197 (64.2%)	*p*-value
Age, years	30 [22–38]	41 [25–47]	<0.001
BMI, kg. m^{-2}			
Not obese (BMI < 30)	108 (98.2)	137 (69.5)	<0.001
Obese (BMI ≥ 30)	2 (1.8)	60 (30.5)	
Gender			
Female	36 (32.7)	–	< 0.001
Male	74 (67.3)	197 (100)	
Type of operation			
Orthopedic	10 (9.1)	32 (16.2)	<0.001
Genitourinary	26 (23.6)	8 (4.1)	
General surgery	31 (28.2)	35 (17.8)	
Otorhinolaryngologic	43 (39.1)	122 (61.9)	
Comorbidities			
Yes	2 (1.8)	11 (5.6)	0.146
No	108 (98.2)	186 (94.4)	
Diabetes mellitus			
Yes	–	47 (3.6)	0.054
No	108 (100)	190 (96.4)	
Hypertension			
Yes	2 (1.8)	9 (4.6)	0.339
No	108 (98.2)	188 (95.4)	

BMI, body mass index; OSA, Obstructive sleep apnea.

Table 2 Comparing two groups according to presence of difficult intubation (n = 307).

Variables	Low risk OSA 110 (35.8%)	High Risk OSA 197 (64.2%)	*p*-value
Mallampati class			
1	90 (81.8)	78 (39.6)	<0.001
2	20 (18.2)	77 (39.1)	
3	–	42 (21.3)	
Cormack-Lehane class			
1	61 (55.5)	65 (33.0)	<0.001
2	49 (44.5)	72 (36.5)	
3	–	47 (23.9)	
4	–	13 (6.6)	
DI according to Cormack-Lehane Classification			
Yes	–	60 (30.5)	<0.001
No	110 (100)	137 (69.5)	
DI according to Mallampati Classification			
Yes	–	42 (21.3)	<0.001
No	110 (100)	155 (78.7)	
DI according to repeated attempt			
Yes	–	55 (28.6)	<0.001
No	110	137 (71.4)	

DI, difficult intubation.

2 and 3 were high in the presence of OSA, they stated that there was no relationship between Mallampati 1 and 4 and the presence of OSA, and suggested that the use of the classification system was not beneficial. In this study, it was observed that the risk of OSA was highest in patients with Mallampati class 3.

The Cormack-Lehane classification is one of the methods used to evaluate the risk of DI.[35] In the literature,[16] the Cormack-Lehane grade was found to be high in patients at high risk of OSA. In this study, patients in the high-risk OSA group also had higher Cormack-Lehane grades. The reason for this situation can be demonstrated by the high presence of DI in patients with a high risk of OSA.

Our study has a few limitations. First, the apnea/hypopnea scores did not graduate. Second, the smoking status of the patients was not recorded. Third,

analysis of baseline predictors for DI, such as thyromental distance, interincisor distance and dentition was not reported in this study. The risk and incidence of difficult mask ventilation among patients, which is also an important factor in difficult airways, was not assessed in this study. Patients who had difficult mask ventilation after muscle relaxation had DI. Last, the results can be generalized for our country, but not another broader population.

Conclusion

In conclusion, it was observed that the risk of OSA was high in patients who underwent elective surgery under general anesthesia and that the presence OSA increases the risk of DI. Due to the high rate of DI in patients with a high risk of OSA, the security of the patient's airway is endangered. Therefore, it is necessary to use screening tools in operating rooms to diagnose OSA. Early clinical recognition of OSA can help in designing a safer care plan. More studies evaluating the risk of OSA in patients undergoing surgical operation are needed. The authors recommended that patients with DI should be screened for OSA and considered for diagnosis with polysomnography.

Conflict of interest

The authors declare no conflicts of interest.

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