Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2023 Apr 09; 11(B):467-473.
https://doi.org/10.3889/oamjms.2023.11605
eISSN: 1857-9655
**Category:** *B - Clinical Sciences*
**Section:** *Ear, Nose and Throat*

Since 2002

OPEN ACCESS

# Prevalence of Obstructive Sleep Apnea in Patients with Difficult Intubation: Looking for Evidence?

Mohamed Shams Eldin[1]*, Ayman Yehia[1], Randa Abdallah[2], Gehan Shalaby[2], Marwa Abdelaziz[3]

*[1]Department of Otorhinolaryngology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt; [2]Department of Otorhinolaryngology, Faculty of Medicine-Girls, Al-Azhar University, Cairo, Egypt; [3]Department of Anesthesiology, Faculty of Medicine-Girls, Al-Azhar University, Cairo, Egypt*

**Edited by:** Ksenija Bogoeva-Kostovska
**Citation:** Eldin MS, Yehia A, Abdallah R, Sobhy G, Abdelaziz M. Prevalence of Obstructive Sleep Apnea in Patients with Difficult Intubation: Looking for Evidence? Open Access Maced J Med Sci. 2023 Apr 09; 11(B):467-473. https://doi.org/10.3889/oamjms.2023.11605
**Keywords***:* Obstructive sleep apnea; Difficult intubation; Polysomnography; Modified Mallampati scores; Cormack and Lehane
***Correspondence:** Mohamed Shams Eldin, Department of Otorhinolaryngology, Faculty of Medicine, Al-Azhar University, Cairo 11675, Egypt; Al Ansari Specialist Hospital, Al Jabriah Area, Industrial Yanbu, KSA-P.O 30894. E-mail: shamsent@azhar.edu.eg
**Received**: 15-Mar-2023
**Revised:** 29-Mar-2023
**Accepted:** 30-Mar-2023

**Funding:** This research did not receive any financial support
**Competing Interests:** The authors have declared that no competing interests exist


**Abstract**

**BACKGROUND:** The link between obstructive sleep apnea and difficult intubation needs to be fully investigated and made clear. If a compromised airway can be anticipated and managed; it can lessen the likelihood of adverse consequences.

**AIM:** The aim of this study was to investigate the incidence, severity, and possible association of obstructive sleep apnea in individuals with unexpected difficult endotracheal intubation and their associated clinical and polysomnographic findings.

**METHODS:** Thirty patients referred for examination after difficult endotracheal intubation were enrolled in the study group, while 30 cases from the sleep laboratory unit database with a history of surgical intervention without difficult intubation were randomly selected for the control group. Documentation was obtained for the office clinical examination and fiber-optic nasopharyngolaryngoscopy assessment by Muller maneuver. The inspected upper airway was graded clinically using the Modified Mallampati technique. A comprehensive polysomnographic assessment was done overnight. The available data from the anesthetic record, as well as those derived from clinical and polysomnographic examination, such as age, sex, Body mass index, M Mallampati score, clinical positive findings, Cormack and Lehane grade, Apnea-Hypopnea Index (AHI), desaturation index, and average O2%, were statistically analyzed.

**RESULTS:** The mean ± SD of the AHI of the study group was (29.7 ± 16.1) while in the control group, it was (13.1 ± 9.9), and the difference was of statistical significance ($p < 0.001$). The grading of the severity of obstructive sleep apnea (OSA) was significantly different between both groups, with 53.3% of the studied cases having severe OSA and the rest having moderate (26.7%) or mild OSA (13.3%). The desaturation index was significantly higher in the study group (28.9 ± 17.4) than the control group (10.2 ± 7.4), while the average O2% saturation was significantly lower among cases (91.8 ± 6.2). The mean modified Mallampati score was significantly higher among cases with grade III-CL, and the significance was also noticed in class IV.

**CONCLUSION:** OSA is a major risk factor for difficult airway management and OSA patients are more likely to have difficult intubations. Patients who underwent a difficult intubation had a higher incidence and severity of OSA compared to the control group. OSA severity and higher modified Mallampati scores were independently related.

## Introduction

It has been proposed that people with obstructive sleep apnea (OSA) may have tracheas that are difficult to intubate and that those who have tracheas that are difficult to intubate may be at a higher risk of developing OSA. Widely recognized anomalies of the upper airway may serve as the basis for such a relationship. If difficult intubation suggests a tendency to OSA, it is critical to be aware of this propensity since early detection and treatment may avoid considerable morbidity and mortality during the anesthetic period. When an anesthesiologist has difficulties mask-ventilating or intubating a patient's upper airway, the term "difficult airway" is used. Today's difficult airway prediction is not absolutely precise, which means that unexpectedly difficult intubations still continue to occur. In the pre-operative assessment, the rate of difficult endotracheal intubation has been shown to be 1–4 %, with 0.05–0.35% of anesthetics being hard to intubate in patients with adequate pre-operative assessments [1]. The Canadian Airway Focus Group defines a difficult airway as one in which an experienced practitioner anticipates or meets difficulty with any or all of facemask ventilation, direct or indirect laryngoscopy, tracheal intubation, or supraglottic airway ventilation [2]. The anesthetist should be worried about the possibility of a link between OSA and a difficult airway since both factors might result in an increased risk of perioperative threats [3]. Undiagnosed OSA patients present for surgical procedures more frequently than expected. Recognizing these individuals' risks before surgery and enhancing their perioperative care should help reduce their incidence of problems [4]. The prevalence of OSA in Western nations can range up to 13.7%. As many as, 2% of adult males and 4% of adult females are thought to need therapy [5]. OSA has several implications, including daytime drowsiness, decreased daytime performance, lack of concentration, neurocognitive impairment, uncontrolled hyperglycemia in diabetics and hemodynamic and cardiovascular comorbidities. Preventing significant consequences necessitates early diagnosis and the implementation of appropriate remedies [6]. OSA has received a lot of attention in recent years, yet it is still possible that more than 80% of cases go undetected and untreated [7]. This study seeks to answer the following question: To what extent is OSA prevalent among difficult intubation cases?

### *Aim of the work*

The objective of this study was to investigate the prevalence of obstructive sleep apnea in individuals experiencing unexpected difficult endotracheal intubation and their associated clinical and polysomnographic features.

## Patients and Methods

After obtaining approval from the hospital ethics committee, we receive 30 subjects selected from the anesthesia department-Alansari specialist hospital after recorded difficult endotracheal intubation in the period from May 2020 to December 2022 who underwent elective surgery under general anesthesia. Members of the study group were enrolled if they were recorded as being difficult to intubate by a consultant anesthetist. Cases from the control group were randomly selected from the database of the sleep laboratory unit. Thirty cases with a history of surgical intervention without difficult intubation were included as controls. Difficult intubation patients were defined and classified in relation to their findings in direct laryngoscopy, where the Cormack-Lehane grading system was employed to define the laryngeal view. For decades after its first release in 1984, this classification system has established itself as the standard for clinical practice and airway-related research. According to the original criteria of Cormack and Lehane, in Grade 1, most of the glottic aperture can be observed, whereas the arytenoid cartilages and the posterior region of the glottis are only visible in Grade 2. In Grade 3, the epiglottis is only visible, while the glottic structure was not visible on laryngoscopy in Grade 4 [8]. Anesthesiologists administered standard anesthetic and airway management, including mask ventilation and endotracheal intubation. Direct laryngoscopy and airway examination were performed with a Macintosh laryngoscope. Further airway management was evaluated using supplementary airway devices, such as a stylet introducer and video laryngoscopes. Difficult intubation was considered if Cormack and Lehane Grade III or IV was recorded or when three or more intubation attempts were necessary for intubation. Exclusion criteria include any patients with prior diagnosis of OSA, central sleep apnea, obvious craniofacial, or cervical deformity. We evaluated the upper airway for obstruction or pharyngeal airway collapse during wakefulness using a clinical office assessment and fiber-optic nasopharyngolaryngoscopy. Tongue size, palate morphology, soft palate and uvula lengths, oropharyngeal measurements, tonsil grading and size, and inspiratory airway collapse according to Muller staging had all been noted. The clinical grading of the examined upper airway was done according to the Modified Mallampati method defined by Samsoon and Young in 1987 [9]. The subject sat upright with his head in the neutral position, his mouth fully open, and the tongue maximally protruding, and was instructed not to phonate. The oropharynx was inspected from the subject's eye level, and the appearance was classified as follows: class I, soft palate, fauces, uvula, and tonsillar pillars visible; Class II, soft palate, fauces, and uvula visible; Class III, soft palate, and base of uvula visible; and class IV, soft palate not visible. To ensure optimal healing and prevent the burden of pain or pain treatment on their polysomnography values, polysomnography was performed 1–2 months following their procedure. In the sleep laboratory unit of the Al-Ansari Specialized Hospital, a complete overnight polysomnographic evaluation was performed using the Xltek® Brain Monitor with Natus® Sleep Works™ PSG software. Electroencephalography, electrooculography, chin electromyogram (EMG), electrocardiography, leg EMG, and a respiratory effort sensor were used to monitor participants. Apneas and hypopneas were identified using a nasal-cannula-pressure transducer device. The oxygen saturation level was determined using a transcutaneous finger pulse oximeter ($SpO_2$ sensor). All data were captured and evaluated by computer following the start of sleep. Apnea and hypopnea during sleep were both detected and quantified. The American Institute of Sleep Medicine's guideline2020 was used for scoring [10]. Patients were classified accordingly into three types based on their Apnea-Hypopnea Index (AHI) values: Those without OSA (<5), those with mild OSA (5–15), those with moderate OSA (15–30), and those with severe OSA (more than 30). Data available from the anesthetic records, together with that obtained from clinical and polysomnographic assessments, including age, sex, Body mass index (BMI), Mallampati score, clinical positive findings, Cormack and Lehane grade, AHI, desaturation index, and average $O_2$%, were all statistically processed. It was carried out using the SPSS computer package, version 25.0 (IBM SPSS, Armonk, NY: IBM Corp., USA). For descriptive statistics, the mean ± SD was used for quantitative variables, while frequency and percentage were used for qualitative variables. The Chi-square test or Fisher's exact test was used to assess the differences in frequency of qualitative variables, while the Mann–Whitney test or Kruskal–Wallis test was used to assess the differences in means of quantitative non-parametric variables. The Spearman correlation coefficient was used to measure the strength and direction of association between OSA severity (indicated by AHI) and other variables. The statistical methods were verified, assuming a significant level of p < 0.05 and a highly significant level of p < 0.001.

## Results

The study was carried out on 30 patients with difficult intubation who fulfilled the inclusion criteria, with a mean age of 46.9 ± 9.8 ranging from 21 to 53 years; the majority of cases (80%) were males; and the mean BMI was 28.1 ± 4.9 kg/m$^2$. The mean age of patients of control group was 37.2 ± 8.1, ranging from 21 to 55 years; just over half (53.3%) of them were male; and their average BMI was 24.2 7.1 kg/m$^2$. No significant differences were found between cases and controls regarding age and gender, though male predominance was found in the case group. Significantly, the mean BMI of cases was higher than controls (p = 0.19). About 60% of the cases in the study group were classified as Grade IV CL, while 40% were classified as Grade III. About 26.7% of the studied cases were grouped as Classes II in relation to their Modified Mallampati score, while Classes III and IV were recorded at 33.3% and 40%, respectively. The mean ± SD of the AHI of the cases in the study group was (29.7 ± 16.1) while in the control group, it was (13.1 ± 9.9), and the difference was of statistical significance (p < 0.001). The grading of the severity of OSA was seen to be significantly different between both groups, where 53.3% of the studied cases had severe OSA and the rest had moderate (26.7%) or mild OSA (13.3%). However, the grading distribution in the control group was (53.3%) for severe OSA and (13.3%) for both mild and moderate OSA. The desaturation index was significantly higher in the difficult intubation group (28.9 ± 17.4) than the control group (10.2 ± 7.4), while the average O2% saturation was significantly lower among cases (91.8 ± 6.2). Related clinical examination findings include lateral collapse and a narrow oropharyngeal inlet; inspiratory airway collapse; redundant and flappy soft palates; and tonsil grades were not statistically different between both groups (Table 1).

**Table 1: General, clinical, and laboratory characteristics of the studied sample**

| Variables | Cases n = 30 (%) | Controls n = 30 (%) | p-value |
|---|---|---|---|
| Age (years) | | | |
| Mean ± SD | 46.9 ± 9.8 | 37.2 ± 8.1 | 0.097 |
| Min-Max | (21–53) | (21–55) | |
| Gender | | | |
| Male | 24 (80.0) | 16 (53.3) | 0.054 |
| Female | 6 (20.0) | 14 (46.7) | |
| BMI (kg/m$^2$) | | | |
| Mean ± SD. | 28.1 ± 4.9 | 24.2 ± 7.1 | 0.019* |
| Min–Max | (21.4–37.6) | (12.6–37.1) | |
| Clinical findings[1] | | | |
| Lateral collapse | 6 (20.0) | 6 (20.0) | 1.000 |
| Narrow oropharynx | 6 (20.0) | 2 (6.7) | 0.254 |
| Tongue base++ | 6 (20.0) | 2 (6.7) | 0.254 |
| Inspiratory airway collapse | 12 (40.0) | 6 (20.0) | 0.158 |
| Redundant and flappy soft palate | 4 (13.3) | 2 (6.7) | 0.671 |
| Tonsil Grade 3 | 2 (6.7) | 2 (6.7) | 1.000 |
| CL grading | | | |
| Grade III | 12 (40.0) | | |
| Grade IV | 18 (60.0) | | |
| Modified Mallampati score | | | |
| Class II | 8 (26.7) | | |
| Class III | 10 (33.3) | | |
| Class IV | 12 (40.0) | | |
| AHI (event/H) | | | |
| Mean ± SD. | 29.7 ± 16.1 | 13.1 ± 9.9 | <0.001* |
| Min–Max | (3.1–55.5) | (2.7–36.2) | |
| Normal | 2 (6.7) | 6 (20.0) | <0.001* |
| Mild | 4 (13.3) | 16 (53.3) | |
| Moderate | 8 (26.7) | 4 (13.3) | |
| Severe | 16 (53.3) | 4 (13.3) | |
| Average $O_2$ saturation (%) | | | |
| Mean ± SD | 91.8 ± 6.2 | 96.2 ± 2.0 | 0.001* |
| Min-Max | (74.2–97.4) | (91.8–98.3) | |
| Desaturation index (%) | | | |
| Mean ± SD | 28.9 ± 17.4 | 10.2 ± 7.4 | <0.001* |
| Min-Max | (6.2–73.5) | (2.4–27.5) | |

BMI: Body mass index, CL: Cormack-Lehane, AHI: Apnea hypopnea index.[1]: Some participants had more than one clinical finding. Values present as number and % were analyzed by Fisher's exact test. Values present as mean ± SD were analyzed by Mann–Whitney *U* test. *: Significant.

The mean modified Mallampati score was significantly higher among cases with grade III-C (p = 0.038), and the significance was also noticed in Class IV (p = 0.024). However, the severity of AHI was not significantly different between cases with Grade III or IV CL. The same findings were also noted for the average O2% saturation and desaturation index (Table 2).

**Table 2: Relation of difficult intubation (CL grading) and different study variables among cases**

| Variables | CL Grade III n = 12 (%) | CL Grade IV n = 18 (%) | p-value |
|---|---|---|---|
| Modified Mallampati score | | | |
| Mean ± SD | 3.5 ± 0.8 | 2.9 ± 0.8 | 0.038* |
| Class II | 2 (16.7) | 6 (33.3) | 0.419 |
| Class III | 2 (16.7) | 8 (44.4) | 0.235 |
| Class IV | 8 (66.7) | 4 (22.2) | 0.024* |
| AHI (event/H) | | | |
| Mean ± SD | 30.9 ± 16.7 | 28.9 ± 16.1 | 0.865 |
| Normal | 2 (16.7) | 0 (0.0) | 0.152 |
| Mild | 0 (0.0) | 4 (22.2) | 0.130 |
| Moderate | 2 (16.7) | 6 (33.3) | 0.419 |
| Severe | 8 (66.7) | 8 (44.4) | 0.284 |
| Average $O_2$ saturation (%) | | | |
| Mean ± SD | 91.1 ± 4.6 | 92.4 ± 7.1 | 0.580 |
| Desaturation index (%) | | | |
| Mean ± SD | 29.6 ± 14.2 | 28.5 ± 19.7 | 0.734 |

AHI: Apnea hypopnea index, CL: Cormack-Lehane, Values present as number and % were analyzed by Fisher's exact test. Values present as mean ± SD were analyzed by Mann–Whitney *U* test. *: Significant.

The mean of the modified Mallampati score, the CL grading of difficult intubation, and the average $O_2$% saturation among the variable degrees of OSA patients of the studied group were not statistically different or affected by the higher AHI score except for cases with a Class III modified Mallampati score, where its incidence was found to be significantly higher among cases with moderate OSA. The desaturation index was significantly higher among cases with severe OSA (p < 0.001) (Table 3 and Figure 1).

Further analysis of the data showed a significant positive correlation between the severity of OSA and both BMI (ρ = 0.38, p = 0.037) and desaturation index (ρ = 0.84, p < 0.001), significant

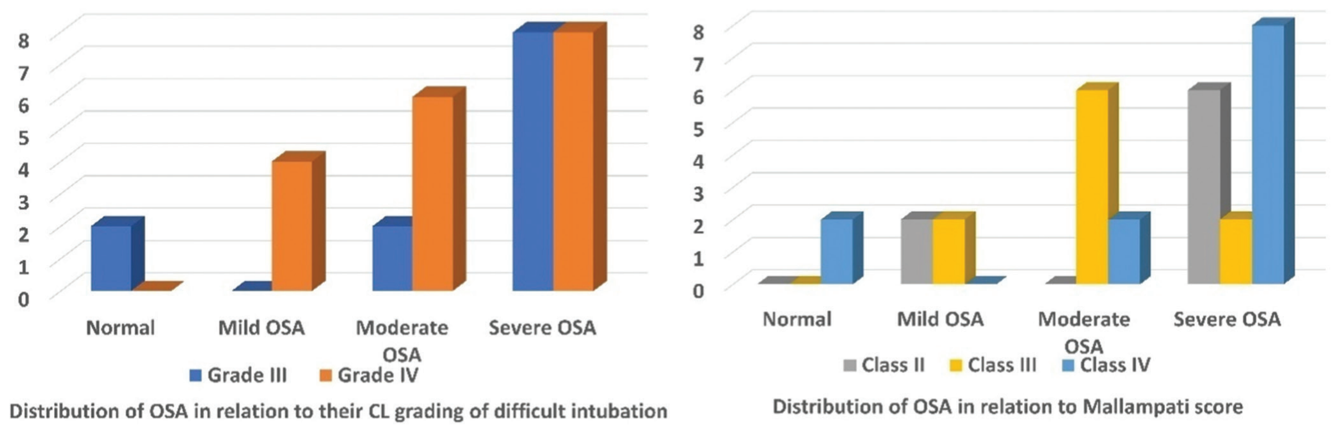


*Figure 1: Distribution of OSA in relation to their CL grading of difficult intubation and modified Mallampati score*

**Table 3: Relation between severity of obstructive sleep apnea and different study variables**

| Variables | Normal n = 2 (%) | Obstructive sleep apnea | | | p-value |
|---|---|---|---|---|---|
| | | Mild n = 4 (%) | Moderate n = 8 (%) | Severe n = 16 (%) | |
| Modified Mallampati score | | | | | |
| Mean ± SD | 4.0 ± 0.0 | 2.5 ± 0.6 | 3.3 ± 0.5 | 3.1 ± 0.9 | 0.178 |
| Class II | 0 (0.0) | 2 (50.0) | 0 (0.0) | 6 (37.5) | 0.127 |
| Class III | 0 (0.0) | 2 (50.0) | 6 (75.0) | 2 (12.5) | 0.012* |
| Class IV | 2 (100.0) | 0 (0.0) | 2 (25.0) | 8 (50.0) | 0.069 |
| CL grading | | | | | |
| Grade III | 2 (100.0) | 0 (0.0) | 2 (25.0) | 8 (50.0) | 0.069 |
| Grade IV | 0 (0.0) | 4 (100.0) | 6 (75.0) | 8 (50.0) | |
| Average $O_2$ saturation (%) | | | | | |
| Mean ± SD | 94.5 ± 0.0 | 94.8 ± 0.5 | 95.3 ± 2.0 | 91.8 ± 6.2 | 0.073 |
| Desaturation index (%) | | | | | |
| Mean ± SD | 6.2 ± 0.0 | 13.7 ± 1.7 | 18.5 ± 7.5 | 40.8 ± 14.9 | <0.001*[1] |

CL: Cormack-Lehane, Values present as number and % were analyzed by Chi-square test. Values present as mean ± SD were analyzed by Kruskal–Wallis test. *: Significant.[1]: Significance between severe and both normal, mild, and moderate.

negative correlation between the severity of OSA and average O2 saturation (ρ = −0.38, p = 0.039), and a non-significant correlation between the severity of OSA and the modified Mallampati score (ρ = −0.08, p = 0.668) (Table 4, Figures 2 and 3).

**Table 4: Correlation of the severity of OSA with BMI, the Modified Mallampati score, average $O_2$ saturation, and the desaturation index**

| Variables | BMI | Modified Mallampati score | Average $O_2$ saturation (%) | Desaturation index (%) |
|---|---|---|---|---|
| ρ | 0.38 | 0.08 | −0.38 | 0.84 |
| P-value | 0.037* | 0.668 | 0.039* | <0.001* |

ρ: Spearman correlation coefficient. *: Significant.

## Discussion

OSA is often regarded as a significant risk factor for difficult airway management. A number of studies have found that individuals with OSA are more likely to have difficult intubations, with or without difficult mask ventilation. As advised by the American Society of Anesthesiologists Task Force, individuals who have OSA or are even suspected to have it may be exposed to difficult airway hazards and should be handled according to the difficult airway management recommendations [11]. A number of researchers have conducted studies on the connection between OSA and challenging intubation in surgical patients. Findings from studies have repeatedly shown a link between OSA and a difficult airway. Significant conclusions, on the other hand, cannot be reached since the research varied in size of the sample, study design, analysis of the degree of the relations, methodology, data constraints, outcome definition, and degree of connections. In the present work, the mean age of the study group was 46.9 ± 9.8 years, ranging from 21 to 53 years, 80% of them were males, and their mean BMI was28.1 ± 4.9 kg/$m^2$. In cases of difficult intubation (CL Grades III and IV), severe obstructive sleep apnea was found in 53.3% of the patients, while moderate OSA was detected in 26.7% of the cases. In 13.3% of the difficult intubated cases, mild OSA was seen, while in 6.7% of the cases, no OSA was observed. The findings of the present study were in line with those of earlier studies that revealed a connection between OSA and difficult intubation techniques [12], [13]. The results of this analysis were close to those of a previous study that had been conducted on 33 patients who were difficult to intubate and had found that the prevalence of OSA among patients with difficult intubation was 66%. About 30% of

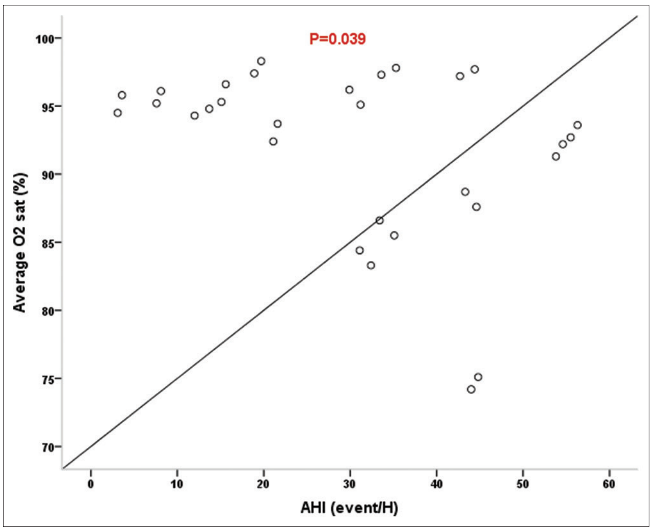


*Figure 2: Correlation of the severity of OSA with average $O_2$ saturation*

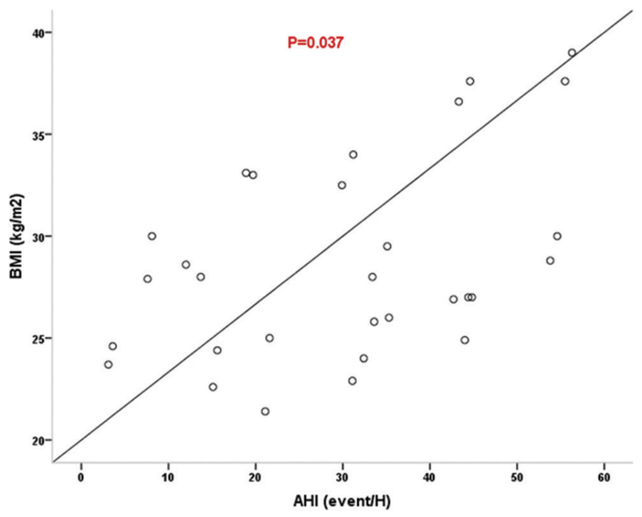


*Figure 3: Correlation of the severity of OSA with average BMI*

the patients who had difficulty being intubated had mild OSA, whereas 18% had moderate OSA, and 18% had severe OSA. Patients who had a difficult intubation had an incidence of post-operative complications that was 21% [14]. Similarly, in an earlier study, it was observed that the AHI was considerably higher in the group that had difficult intubation compared to the group that served as the control. Patients in the group with difficult intubation had a prevalence of OSA of 53.3%, with 30% of them having severe OSA (AHII ≥ 40). One patient in the control group had mild OSA with an AHI of 17.4, and the other patient in the control group had moderate OSA with an AHI of 33.4. There was a statistically significant difference between the two groups in terms of OSA severity; however, there was no significant difference, either in age or body mass index, between the groups. The main finding of this study was that patients who had a difficult intubation experienced a higher frequency and more severe form of OSA than individuals in the control group [15]. These findings were comparable to that obtained in a recent prospective multicenter observational cohort study on the association of OSA with difficult intubation where 64% of the patients were men; the mean (± SD) of the age and BMI were 66 ± 9 years and 26 ± 8 kg/$m^2$. However, OSA was diagnosed in only 10% of the studied patients. Mild and moderate OSA patients were more frequently seen accounting for 37% and 20%, respectively [1]. It is possible to explain such a high incidence by the exacerbation of collapse of the upper airway, which is made worse by supine apposition on intubation, and the state of neurological suppression that is required for maintaining the pharyngeal airway opened when anesthetics are being administered. Furthermore, limited head extension, a short, larger neck circumference, a thick neck, and a decreased thyromental space are all commonly shared between OSA and difficult intubation. These factors may contribute to the high prevalence rate. The mean modified Mallampati score was significantly higher among cases with Grade III CL and class IV (p = 0.038) and (p = 0.024), respectively. However, it was not statically different or affected by the AHI higher score among the variable degrees of OSA patients of the studied group except for cases with Class III modified Mallampati score which more significantly seen in moderate OSA cases. Our results regarding the higher modified Mallampati score (III and IV) which was significantly seen in patients with difficult intubation are consistent with similar findings in the literatures [16], [17], [18] but inconsistent with other studies which suggest that the M Mallampati score had a limited predictive value for difficult intubation [19], [20]. On the other hand, another study found that patients with Mallampati Class 3 had the highest risk of OSA which is close to our findings [21]. The obvious association between increased modified Mallampati scores and difficult intubation and also OSA severity may be explained by that length of the soft palate was longer in the difficult intubation group, which is reflected to increase the modified Mallampati score. In those with OSA, increased modified Mallampati scores could be explained by the shortening of the ramus of the mandible that would lead to shortening of the distance between the tongue and the palate. In the present study, 60 % of the DI group were found to be Grade IV CL (18 patients), where 40% of cases of DI were classified as Grade III (12 patients). OSA was seen in 10 out of 12 cases with difficult intubation scored as Grade III Cormack and Lehan and in all patients with Grade IV. In Grade III CL, moderate OSA was seen in two patients and eight patients were have severe OSA while in patients with Grade IV mild, moderate, and severe OSA was seen in 4 (22.2%), 6 (33.3%) and 8 patients (44.5%), respectively. Their mean ± SD of the AHI was (29.7 ± 16.1) while in control group, it was (13.1 ± 9.9) and the difference was of statistical significance (p < 0.001). The patients with MM score Class III was seen in 33.3% of cases with difficult intubation and moderate OSA was significantly more diagnosed (60%), (p = 0.012). Class IV MM score was seen in 40% of the cases, most of them (66.6%) were having severe OSA. However, a non-significant correlation between the severity of OSA and modified Mallampati score was recorded. It was concluded that the CL grade was found to be high with DI patients who were at high risk of OSA [22]. A highly significant difference was found in a systematic review and meta-analysis on the association between OSA and DI. The difficulty of intubation was 3.46-fold greater in individuals diagnosed as obstructive sleep apnea in a meta-analysis of 16 studies compared to those without the condition [23]. These findings were different to that obtained in a Korean study where only 8.7% of the patients of the difficult intubation group (two out of 23) were scored as Grade III while 91.3% of them (21 out of 23) were scored as Grade IV. Their mean ± SD of the AHI was 49.3 ± 19.5and while in non-difficult intubation group, it was 28.9 ± 18.0 for statistically significant difference. Sever OSA with AHI

≥ 50 was recorded in 61% of the studied cases. The patients with MMT Classes III and IV made up 73.9% of cases with difficult intubation [24].

The desaturation index was significantly higher in the difficult intubation group than the control group; while the average $O_2$% saturation was significantly lower among cases. The desaturation index was significantly higher among cases with severe OSA with a significant positive correlation and significant negative correlation between the severity of OSA and average $O_2$ saturation. These findings were also seen in another study where a direct correlation between OSA severity and SpO2 indices, including the desaturation index and $SpO_2$ nadir, was discovered [25]. OSA is characterized by the frequent collapse of the upper airway, resulting in brief interruptions in respiration or alterations in breathing pattern. In turn, significant hypoxemia and hypercapnia lead to a decrease in tissue oxygenation. The present study has a number of limitations, including the fact that the objective measurements of the polysomnographic variables were obtained from one full night of the study; as a result, night-to-night variability or first-night effects cannot be completely excluded from the study. The absence of important data from the control group, namely, the CL grading and M Mallampati scores, may also have limited the investigation. This suggests the need for a sizable, prospective, multicenter study to complement our findings.

## Conclusion

OSA was more prevalent and severe in patients who had difficult intubations compared to the control group based on this study. OSA is a major risk factor for difficult airway management, and OSA patients are more likely to have difficult intubations. Severe obstructive sleep apnea was identified in 53.3% of patients with difficult intubation, while mild OSA was identified in 26.7% of instances. The mean modified Mallampati score (III and IV) was considerably higher in individuals with Grade III CL and class IV but was not statistically distinct from or influenced by the higher AHI score among patients with varying degrees of OSA in the study group. There was no link between the severity of OSA and the modified Mallampati score. To minimize the potential hazards associated with unanticipated difficult intubation, further studies are needed to provide more precise approaches for predicting and screening OSA among patients going for elective surgery. As a recommendation, patients whose intubations were difficult should undergo screening for signs and symptoms of sleep apnea. Patients who are difficult to intubate should be referred to a sleep clinic for a full-night polysomnography, which is the basic tool for diagnosing OSA.

## References


1. Seet E, Chung F, Wang CY, Tam S, Kumar CM, Ubeynarayana CU, *et al*. Association of obstructive sleep apnea with difficult intubation: Prospective multicenter observational cohort study. Anesth Analg. 2021;133(1):196-204. https://doi.org/10.1213/ANE.0000000000005479
PMid:33720906
2. Leong SM, Tiwari A, Chung F, Wong DT. Obstructive sleep apnea as a risk factor associated with difficult airway management-A narrative review. J Clin Anesth. 2018;45:63-8. https://doi.org/10.1016/j.jclinane.2017.12.024
PMid:29291467
3. Joffe AM, Aziz MF, Posner KL, Duggan LV, Mincer SL, Domino KB. Management of difficult tracheal intubation: A closed claims analysis. Anesthesiology. 2020;131(4):818-29. https://doi.org/10.1097/ALN.0000000000002815
PMid:31584884
4. Atkins CS. Predicting the Risk of Obstructive Sleep Apnea and Difficult Endotracheal Intubation in a Surgical Population in a Rural Community Hospital Setting. DNP Projects 27; 2013. Available from: https://www.uknowledge.uky.edu/dnp_etds/27
5. Verse T, Wenzel S, Brus J. Multi-level surgery for obstructive sleep apnea. Lingual tonsillectomy vs. Hyoid suspension in combination with radiofrequency of the tongue base. Sleep Breath. 2015;19(4):1361-6. https://doi.org/10.1007/s11325-015-1241-8
PMid:26354104
6. Yilmaz A, Akcaalan M, Elsayed MM, El-Dsoky II, Ramadan MF, Abdelwahed MS, *et al*. Predicting the risk of obstructive sleep apnea and difficult endotracheal intubation in a surgical population in a rural community hospital setting. Folia Morphol. 2017;76:301-6.
7. Amra B, Pirpiran M, Soltaninejad F, Penzel T, Fietze I, Schoebel C. The prediction of obstructive sleep apnea severity based on anthropometric and Mallampati indices. J Res Med Sci. 2019;24:66. https://doi.org/10.4103/jrms.JRMS_653_18
PMid:31523252
8. Nazir I, Mehta N. A comparative correlation of pre-anaesthetic airway assessment using ultrasound with Cormack Lehane classification of direct laryngoscopy. IOSR J Dent Med Sci. 2018;17(4):43-51. https://doi.org/10.9790/0853-1704104351
9. Yemam D, Melese E, Ashebir Z. Comparison of modified mallampati classification with Cormack and Lehane grading in predicting difficult laryngoscopy among elective surgical patients who took general anesthesia in Werabie comprehensive specialized hospital-Cross sectional study. Ethiopia, 2021. Ann Med Surg (Lond). 2022;79:103912. https://doi.org/10.1016/j.amsu.2022.103912
PMid:35860078
10. Berry R, Quan SF, Abreu A. The AASM Manual for the Scoring of Sleep and Associated Events Rules, Terminology, and Technical Specifications. Version 2.6.0. Darien, IL: American Academy of Sleep Medicine; 2020. Available from: https://www.aasm.org/aasmupdated-version-sleep-scoring-manual
11. Gross JB, Apfelbaum JL, Caplan RA, Connis RT, Cote CJ, Ninkovich DG, *et al*. Practice guidelines for the perioperative management of patients with obstructive sleep apnea. An updated report by the American society of anesthesiologist's task force on perioperative management of patients with obstructive sleep apnea. Anesthesiology. 2014;120(2):268-86. https://doi.org/10.1097/ALN.0000000000000053
PMid:24346178
12. Hillman DR, Chung F. Anaesthetic management of sleep-disordered breathing in adults. Respirology. 2017;22(2):230-9.

https://doi.org/10.1111/resp.12967

PMid:27988979

13. Mathangi K, Mathews J, Mathangi CD. Assessment of perioperative difficult airway among undiagnosed obstructive sleep apnea patients undergoing elective surgery: A prospective cohort study. Indian J Anaesth. 2018;62(7):538-44. https://doi.org/10.4103/ija.IJA_158_18

PMid:30078857

14. Chung F, Yegneswaran B, Herrera F, Shenderey A, Shapiro CM. Patients with difficult intubation may need referral to sleep clinics. Anesth Analg. 2008;107(3):915-20. https://doi.org/10.1213/ane.0b013e31817bd36f

PMid:18713905

15. Hiremath AS, Hillman DR, James AL, Noffsinger WJ, Platt PR, Singer SL. Relationship between difficult tracheal intubation and obstructive sleep apnoea. Br J Anaesth. 1998;80(5):606-11. https://doi.org/10.1093/bja/80.5.606

PMid:9691863

16. Kar S, Senapati LK, Samanta P, Satapathy GC. Predictive value of modified Mallampati test and upper lip bite test concerning Cormack and Lehane's laryngoscopy grading in the anticipation of difficult intubation: A cross-sectional study at a tertiary care hospital, Bhubaneswar, India. Cureus. 2022;14(9):e28754. https://doi.org/10.7759/cureus.28754

PMid:36211112

17. Stutz EW, Rondeau B. Mallampati score. In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK585119 [Last accessed on 2023 Jan 29].

18. Vest D, Lee D, Newcome K, Stamper H. A retrospective review of difficult intubations: Is obstructive sleep apnea a predictor? Clin Nurse Spec. 2013;27(3):128-31. https://doi.org/10.1097/NUR.0b013e31828c8346

PMid:23575169

19. Wang LY, Zhang KD, Zhang ZH, Zhang DX, Wang HL, Qi F. Evaluation of the reliability of the upper lip bite test and the modified Mallampati test in predicting difficult intubation under direct laryngoscopy in apparently normal patients: A prospective observational clinical study. BMC Anesthesiol. 2022;22(1):314. https://doi.org/10.1186/s12871-022-01855-7

PMid:36217124

20. Roth D, Pace NL, Lee A, Hovhannisyan K, Warenits AM, Arrich J, *et al*. Airway physical examination tests for detection of difficult airway management in apparently normal adult patients. Cochrane Database Syst Rev. 2018;5(5):CD008874. https://doi.org/10.1002/14651858.CD008874.pub2

PMid:29761867

21. Ozen V, Ozen N. Obstructive sleep apnea in surgical patients and its relationship with difficult intubation: Two years of experience from a single center. Braz J Anesthesiol. 2021;S0104-0014(21)00338-9. https://doi.org/10.1016/j.bjane.2021.08.010

PMid:34560116

22. Acar HV, Kaya A, Yücel F, Erdem M, Günal SE, Özgen F, alidation of the STOP-bang questionnaire: An obstructive sleep apnea screening tool in Turkish population. Turk J Anesth Reanim. 2013;41(4):115-20.

23. Nagappa M, Wong DT, Cozowicz C, Ramachandran SK, Memtsoudis SG, Chung F. Is obstructive sleep apnea associated with difficult airway? Evidence from a systematic review and meta-analysis of prospective and retrospective cohort studies. PLoS One. 2018;13(10):e0204904. https://doi.org/10.1371/journal.pone.0204904

PMid:30286122

24. Lee SJ, Lee JN, Kim TS, Park YC. The relationship between the predictors of obstructive sleep apnea and difficult intubation. Korean J Anesthesiol. 2011;60(3):173-8. https://doi.org/10.4097/kjae.2011.60.3.173

PMid:21490818

25. Wali SO, Abaalkhail B, AlQassas I, Alhejaili F, Spence DW, Pandi-Perumal SR. The correlation between oxygen saturation indices and the standard obstructive sleep apnea severity. Ann Thorac Med. 2020;15(2):70-5. https://doi.org/10.4103/atm.ATM_215_19

PMid:32489441