Original Article

Assessment of perioperative difficult airway among undiagnosed obstructive sleep apnoea patients undergoing elective surgery: A prospective cohort study

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ABSTRACT

Background and Aims: Obstructive sleep apnoea (OSA) is largely undiagnosed in surgical population. Airway-related complication account for 35% of anaesthesia-related deaths and OSA patients have higher occurrence of difficult intubation (DIT). The aim of the study is to estimate the occurrence and compare utility of OSA screening parameters in predicting difficult mask ventilation (DMV) and DIT in patients with undiagnosed OSA. **Methods:** A prospective observational study was conducted in a tertiary care centre in patients undergoing elective surgery. STOP-BANG questionnaire was administered preoperatively along with collection of demographic data and airway assessment. Population was divided in to OSA and non-OSA groups based on STOP-BANG score >3. Occurrence of DMV, laryngoscopy (DL), and DIT were compared between both groups using DMV score, Cormack–Lehane grading, and intubation difficulty scale score, respectively. **Results:** A total of 54 patients in OSA and 46 patients in non-OSA group were studied. A total of 49 cases of DMV, 14 cases of DIT, and 25 cases of DL were encountered. In the OSA group, there was 77.7% DMV, 22.2% DIT, and 33.3% DL. History of snoring had the highest sensitivity and negative predictive value while history of apnea, body mass index >35, sleep apnoea clinical score had the highest specificity in determining occurrence of difficult airway. Multivariate logistic regression analysis demonstrated STOP-BANG score as the single most important predictor of DMV (odds ratio 3.15, 95% confidence interval, 2.06–4.8). **Conclusion:** Positive screening test for OSA is associated with difficult airway management.

Key words: Difficult intubation, difficult mask ventilation, obstructive sleep apnea, screening, STOPBANG, surgical patients

INTRODUCTION

Obstructive sleep apnoea (OSA) is a condition where there is collapse of the pharyngeal airway during sleep, causing temporary cessation of airflow (apnoea) or shallow breathing (hypopneoa).[1] The collapse can be partial or complete and keeps recurring during sleep. Common signs of OSA include snoring, unrefreshing sleep, and daytime sleepiness. The prevalence of OSA in India has been shown to be 13–19% depending on the type of study population.[2,3] Prevalence of OSA in surgical population is higher than in the general population and it can vary widely according to the underlying medical condition and type of surgery.[4] A recent study in India showed a prevalence of undiagnosed OSA to be as high as 24.5% among surgical patients.[5]

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OSA can pose a significant challenge in the perioperative period as there are concerns of difficult intubation (DIT), upper airway collapse, and obstruction in the postoperative period.[6] Literature shows disastrous respiratory complications in perioperative period in patients with OSA mainly due to failure to secure airway during induction, respiratory obstruction following extubation and respiratory arrest due to sedation and opioid use in postoperative period. In the present scenario, 82% males and 93% females with OSA remain undiagnosed.[7] Hence it is certain that numerous patients undergo surgery with undiagnosed OSA. A recent consensus of the American Society of Anesthesiologists (ASA) issued practice guidelines including assessment of patients before surgery and careful postoperative monitoring emphasizing the need to diagnose OSA in high-risk patients in the perioperative period.[8]

There is dearth of data regarding the management of patients with undiagnosed OSA and there is not a defined protocol to determine who requires closer monitoring. Hence, the need is to develop cost-effective tools and investigate some clinical indicators that can be used to identify patients with a possible diagnosis of OSA and predict perioperative complications.

The aim of the study is to estimate the occurrence and compare utility of OSA screening parameters in predicting difficult mask ventilation (DMV) and DIT in patients with undiagnosed OSA.

METHODS

The study was initiated after obtaining clearance from institutional ethical committee. A written informed consent was taken from all patients before enrollment in to the study. This was a prospective cohort study conducted between November 2014 and January 2016.

Study population consisted of all consecutive patients of either sex, age >18 years belonging to ASA I, II, or III posted for elective surgery under general anaesthesia with endotracheal intubation during the study period. Patient undergoing cardiothoracic surgery, head and neck surgery, neurosurgery, and emergency surgery were excluded from the study. Obstetric patients, patients with neuromuscular disease, facial abnormalities, diagnosed lung disease on treatment, diagnosed OSA, on CPAP (Continuous positive airway pressure) therapy were also excluded from the study.

An informed written consent was taken after explaining the study protocol. Only those patients who gave consent were included to the study group. Patients were identified from the daily scheduled operation theater list that satisfied the inclusion criteria.

A subject data sheet was used to collect demographic data and brief medical history pertinent to the study and surgery. For all patients, STOP-BANG questionnaire was used to determine the risk of OSA. The STOP-BANG questionnaire contains eight yes or no patterns of questions. STOP-BANG stands for S – history of snoring, T – history of tiredness, O – observed apnoeas during sleep, P – blood pressure (hypertension), B – body mass index (BMI) >35 kg/m^2, A – age >50 years, N – neck circumference >40 cm, G – gender is male. Every positive response was given a point of one and the sum of each score was taken as the total score. Anthropometric data like height, weight, BMI, neck circumference, thyromental, and sternomental distance were measured.[9,10]

Patients scoring >3 in STOP-BANG and were taken as patients having OSA and patients having <3 on STOP-BANG were taken as patients not having OSA.

The anaesthesiologist in charge of each case was blinded to the study group. All the data pertaining to DMV and DIT were recorded by the anaesthesiologist in charge of the case. In the operating theater, an 18G intravenous line was secured and standard ASA monitors like pulse oximeter, Non-invasive blood pressure device, 5 lead electrocardiogram (ECG) and temperature probe were placed on all patients. A pillow of adequate thickness was used to support head of patient. It was ensured that the external auditory meatus and sternal notch were aligned in a horizontal position. Inj fentanyl 2 mcg/kg was given as premedication and patients were induced with inj thiopentone 3–6 mg/kg after preoxygenation. The adequacy of mask ventilation was confirmed and ease of mask ventilation including use of airway adjuncts and any respiratory compromise during this phase was recorded. Neuromuscular blocker inj atracurium 0.5 mg/kg was used, after a period of 5 min of ventilation, laryngoscopy was done using macintosh blade 3 or 4 and Cormack–Lehane grading was recorded. Use of additional maneuvers, bougie, stylet, external pressure, need of additional or change of operator, and ease of intubation were also noted. A maximum of three attempts of intubation was allowed; in event of failure, a senior anesthesiologist took over and airway was managed in accordance to guidelines by difficult airway society.[11]

Occurrence of DMV, difficult laryngoscopy (DL), and DIT was compared between both groups using DMV score,[12] Cormack–Lehane grading,[13], and intubation difficulty scale (IDS) score, respectively.[14]

Based on previous studies, the prevalence of difficulty airway in surgical patients with OSA was 21.9% in comparison with 2.6% in normal population.[9] A sample size of minimum 44 in each group was calculated, taking power of study as 80% and level of significance as 5% using OpenEpi, Version 3 software. A total 100 patients were studied [Figure 1].

Statistical analysis was done using SPSS version 21. Continuous data were expressed as mean ± SD or median, categorical variables as frequencies, number or percentage. Chi-square or Fischer exact test was used to compare nominal data between the OSA and non-OSA group. Student *t*-test or Mann–Whitney U test were used to compare continuous variables. Univariate analysis was used to identify individual risk factors for DMV and DIT. Binary logistic regression was done to identify predictors of difficult airway. All variables that attained significant difference ($P < 0.05$) in univariate analysis was entered to the final model. A step-wise forward conditional method was used to determine the individual risk factors, odds ratio and 95% confidence interval (CI) was obtained for the identified predictors.

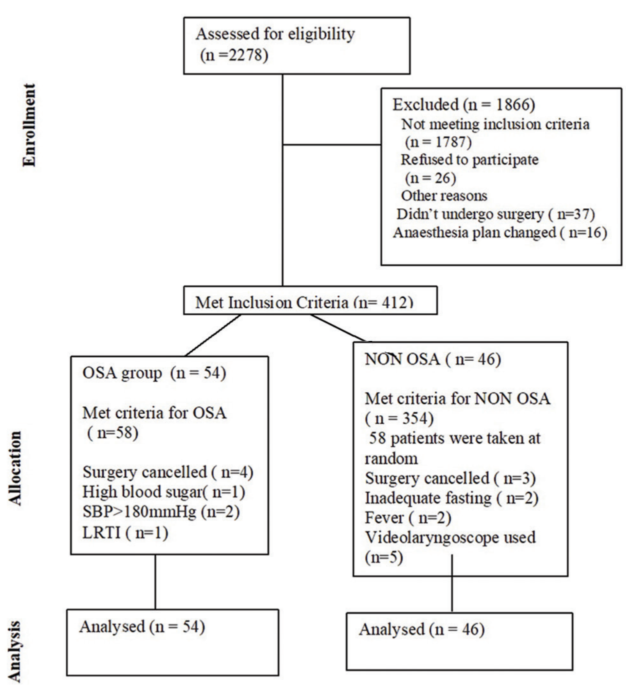

Figure 1: Consort diagram for group allocation

Hosmer–Lemeshow test was used to assess model fitness. *P* value less than 0.05 was taken as significant. Sensitivity, specificity and Area under curve was obtained for all the components of STOPBANG score.

RESULTS

A total of 2278 patients underwent general anesthesia with endotracheal intubation during the study period. A total of 412 patients who met the inclusion criteria were screened to get 58 OSA patients. Surgery was cancelled in 4 patients and thus a total of 54 patients formed the OSA group. It was proposed to study 100 patients in total; hence 46 patients in the non-OSA group were taken for comparison in to the final analysis [Figure 1]. The population consisted of 53 female and 47 male equally distributed in either group. There was equal distribution of both the sexes in either group [Table 1]. The mean age of patients in OSA [57.80 ± 11.30] group was significantly higher as compared with the non-OSA [40.90 ± 14.4] group. There was no significant difference between the numbers of laparoscopic surgeries between the groups [Table 1]. There were increased number of comorbidities in OSA group when compared with non-OSA group and hence ASA grades were higher [Table 1].

There was significant difference between weight–height and BMI in both the groups [Table 2]. OSA group had higher BMI and weight compared with the non-OSA group. Parameters that were used to assess adequacy of airway was significantly different between the groups [Table 2]. However, there was no

Table 1: Demographic data of study population

Demographics	Non-OSA	OSA	Odds ratio (95% CI)	P
Sex				
Male	22	25	1.033 (0.68-1.57)	0.88
Female	24	29	0.972 (0.67-1.408)	
Type of surgery				
Open	25	26	1.13 (0.77-1.66)	0.54
Laparoscopy	21	28	0.88 (0.59-1.32)	
History of HTN	4	36	21 (2.01-67.75)	0*
History of DM	2	10	5 (1.03-24.14)	0.038*
ASA status				
I	34	10	0.289 (0.165-0.507)	0*
II	12	44	3.606 (2.13-6.10)	

**P*<0.05 Pearson's Chi-square test. ASA – American Society of Anesthesiologists; CI – Confidence interval; DM – Diabetes mellitus; HTN – Hypertension; OSA – Obstructive sleep apnoea difference in amount of mouth opening and degree of neck extension between the groups. Sternomental distance and thyromental distance were significantly lower in the OSA patients. OSA patients also had increased neck circumference when compared with non-OSA patients. Modified Mallampati class was significantly higher in OSA group as compared with non-OSA group with odds ratio of 9.69, 95% confidence intervals (CI) [3.51–26.77].

The incidence of DMV was 51% in the total population, 77.8% in OSA group when compared with 15.2% incidence in non-OSA group. The relative risk for DMV was 5.11[95% CI 2.55–10.260]. Presence of at least one comorbidity was significantly associated with DMV but not with DL (P = 0.356) or DIT (P = 0.148). DMV showed significant positive correlation with hypertension (P = 0.001).

There was one case of impossible mask ventilation in OSA group and supraglottic device was used for ventilation. The DMV score was significantly higher in OSA group when compared with non-OSA group [Figure 2]. In case of DMV, two hand mask ventilation and two hand with use of adjunct airway were the commonly used maneuvers.

Table 2: Anthropometric data of study population

Measurements	Non-OSA (Mean±SD)	OSA (Mean±SD)	*P*
Weight (kg)	64.61±11.60	71.19±11.81	0.01*
Height (cm)	160.24±9.25	157.85±8.7	0.19
BMI (kg/m^2)	24.93±4.11	28.60±4.56	0.00*
Mouth opening (cm)	4.91±0.072	5.13±5.55	0.79
SMD (cm)	15.70±2.01	14.04±1.65	0.00*
TMD (cm)	7.61±0.98	6.87±0.95	0.00*
NC (cm)	34.72±2.49	38.33±3.83	0.00*

*P<0.05 Pearson's Student *t*-test. SMD – Sternomental distance; TMD – Thyromental distance; NC – Neck circumference; BMI – Body mass index; OSA – Obstructive sleep apnoea

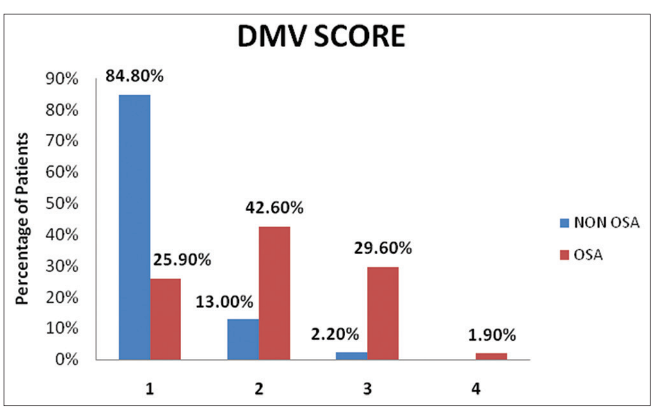

Figure 2: Difficult Mask Ventilation Score of study subjects in OSA and NON OSA groups *P < 0.05 Pearson's chi square test

The incidence of DL was 25% in total population, 18% in OSA, and 7% in non-OSA. Laryngoscopic grade was significantly higher in OSA group as compared with non-OSA group. Grade 2 was the most common view in OSA group [Figure 3]. There was increased requirement of bougie in OSA group as there was an increase in grade 3 view. The relative risk for DL was 2.190 [95% CI 1.005–4.776].

Incidence of DIT based on IDS score >5 was 14% in the total population. OSA group had an incidence of 22.2% when compared with 4.3% in non-OSA group. Relative risk of 1.75[95% CI 1.295–2.379] was found for DIT in patients with OSA.

STOP-BANG score more than 3 was a good predictor of DMV and DIT with area under curve 0.81 and 0.68, respectively [Figure 4]. Individual components of the STOP-BANG were analyzed and showed significant correlation with difficult airway [Table 3]. History of snoring had highest sensitivity (95.91% for DMV and 88% for DL) while history of apnoea (98.3% for DMV, 95.34% for DIT, and 96% for DL), BMI >35 (96.07% for DMV, 95.34% for DIT, and 96% for DL) and SACS score (96.07% for DMV, 89.5% DIT, and 92% for DL) had highest specificity in determining occurrence of difficult airway.

Multivariate logistic regression model which included all the parameters which were significant on univariate analysis demonstrated STOP-BANG score as the single most important predictor of DMV (odds ratio 3.15 (95% CI 2.06–4.8), R value 0.52) and sternomental distance (odds ratio 0.514 (95% CI 0.3–0.9), R value 0.46) as predictor of DIT.

DISCUSSION

The prevalence of OSA in the present study was found to be 14.07%. Previous studies have demonstrated a

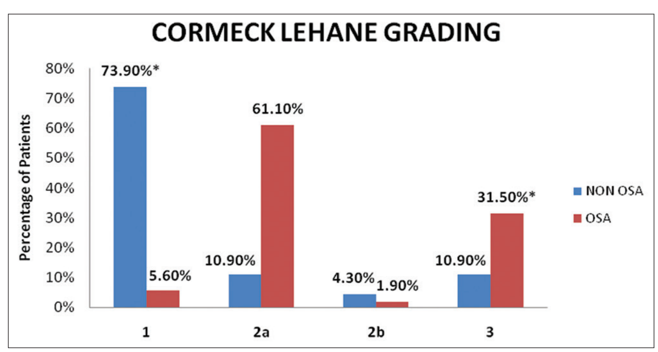

Figure 3: Cormeck Lehane Grading of study subjects in OSA and NON OSA groups *P < 0.05 Pearson's chi square test

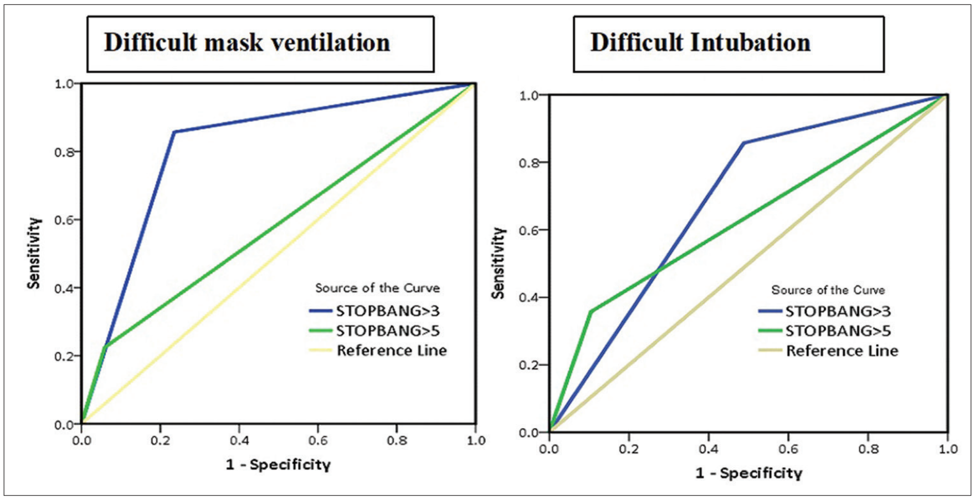

Figure 4: AUC for difficult mask ventilation and intubation

Table 3: AUC for individual components

	Sensitivity	Specificity	PPV	NPV	AUC	*P*	95% CI
For DMV							
Snoring	95.91	68.62	74.60	94.59	0.68	0.002#	0.57-0.78
Age >50	75.50	64.70	67.20	73.30	0.74	0*	0.64-0.84
NC >40 cm	40.80	90.19	80.00	61.30	0.70	0.001*	0.60-0.80
BMI >35 kg/m^2	8.16	96.07	66.66	52.17	0.73	0.004*	0.63-0.83
For DIT							
NC >40 cm	42.85	77.90	24.00	89.33	0.68	0.03*	0.54-0.81
For DL							
BMI >35 kg/m^2	20.00	98.60	83.30	78.72	0.68	0.007*	0.56-0.80
NC >40 cm	44.00	81.30	44.00	81.30	0.64	0.04*	0.50-0.77

#*P*<0.05 Chi-square test; **P*<0.05 Student's *t*-test. AUC – Area under curve; NPV – Negative predictive value; PPV – Positive predictive value; NC – Neck circumference; BMI – Body mass index; DL – Difficult laryngoscopy; DIT – Difficult intubation; DMV – Difficult mask ventilation; CI – Confidence interval

prevalence of 9–24% in general population to as high as 71% in patients undergoing bariatric surgery.[4,15] Majority of the studies on prevalence of OSA in surgical patients were conducted in specific population, such as cardiac surgery and bariatric surgery. The present study was conducted on patients undergoing routine surgeries, such as general, gynaecology, orthopaedics, and urology. In daily general anaesthesia practice for routine preoperative and postoperative care, these types of patients are more likely to be encountered. OSA patients are more likely to be male and older. In the present study, there was an equal distribution of male and female in both the groups. Previous studies in surgical patient have shown predominance of male in patients diagnosed with OSA.[4,15] Smaller population size in the present study might have contributed to absence of gender difference. The average age was higher in OSA group and this finding is similar to previous studies.[4,5,15] Patients with high risk for OSA had increased prevalence of diabetes mellitus and hypertension, which was statistically significant. Studies have demonstrated OSA as an individual risk factor for cardiovascular morbidities and diabetes mellitus.[16] A common pathophysiological mechanism has been proposed for the development of metabolic syndrome and OSA. There has been improvement in glycaemic and blood pressure control after initiation of treatment for OSA.[17] Hence patients with hypertension and diabetes presenting in clinic for preoperative evaluation should be screened for OSA and vice versa for holistic management of patients. Patients in high OSA group had higher ASA grades. This can be explained by the prevalence of increased number of comorbidities in OSA group, which translates to higher ASA grades. BMI, weight, and neck circumference was significantly higher in OSA patients when compared with non-OSA patients. Obesity is considered a predictor of OSA.[17] The severity of OSA was not found to correlate with BMI in few population studies done on obese patients.[18] Thus the distribution of fat might be important in development of OSA. Various anthropometric measurements like BMI, waist circumference, and neck circumference have been used as surrogate for central obesity. The depositions of fat around neck, pharyngeal structure contribute to narrowing of airway and collapsibility of upper airway.[18,19] Patients in OSA group had statistically significant lower sternomental distance, thyromental distance, and higher Mallampati grade. These measurements are representative of a short neck, crowded upper airway, and larger tongue, which are indicators of difficult airway. The anatomic balance theory states that imbalance between excessive soft tissues or small bony cavity is casual of airway collapse and development of OSA. OSA patients have been shown to have larger tongue and increased pharyngeal fat deposition.[20] Higher Mallampati class, shorter sternomental was found to have a significant association with OSA in the present study.

STOP-BANG questionnaire was used to identify patients at high risk of OSA in the present study. A cut-off of STOP-BANG score >3 was used to delineate between OSA and non-OSA. STOP-BANG questionnaire has been validated in surgical patients and was shown to have high sensitivity and negative predictive value in diagnosing moderate-to-severe OSA. A score of 3 had sensitivity of 82.2%, 93%, and 100% at the cut offs of AHI >5, AHI >15, and AHI >30, respectively.[21] The decision as to the questionnaire and cut off to be used for categorizing patients as high risk for OSA is important and use of a uniform diagnostic criteria is vital. All the screening tools have substantial false negative rates. Hence caution should be excised when selecting a screening tools to increase the overall sensitivity and specificity in identifying high-risk OSA patients.

An important aspect of anaesthesia is airway management. Various studies have demonstrated the increased incidence of DMV and DIT in patients with OSA. Studies have demonstrated the utility of STOP-BANG score in predicting difficult airway.[22]

The incidence of DMV was significantly higher in OSA group compared with non-OSA group. Previous studies have shown an incidence of 5–20% for DMV based on different cut offs and definitions used.[12] Our study showed a incidence of 51%. This study was designed to compare the incidence between OSA and non-OSA patients and not to find the actual prevalence and the more number of patients in OSA group and criteria used could have reflected as much higher incidence compared to previous studies. DMV has been shown to be predictive of undiagnosed OSA.[23] A definite association between DMV and OSA is yet to be ascertained. But risk factors of DMV, such as old age, obesity, airway abnormalities, increased tongue size, history of snoring, and male gender are similar to that for OSA. Inability to mask ventilate under general anaesthesia might demonstrate increased upper airway relaxation and collapse, which can happen during sleep in OSA patients.[23] This puts anaesthesia provider in a favorable position to identify patients with OSA and refer patients with DMV for evaluation of OSA.

Patients in OSA group had higher Cormack–Lehane grade and DITs (22.2%) when compared with non-OSA patients. These findings are similar to that of previous studies that showed incidence between 15% and 20% in OSA patients.[9,24] The actual prevalence might be higher, assuming all patients with STOP-BANG >3 might not have OSA. Earlier studies have hinted on the possibility of DIT to be a surrogate for OSA.[25] A relationship between DIT and polysomnography (PSG) confirmed that OSA showed prevalence as high as 66%.[26] The incidence of DMV was much higher when compared with DIT. This was also in accordance to previous studies that showed no correlation between DMV and DIT, proposing different mechanisms for the occurrence of both.[23]

Patients in OSA group had higher grading of DIT. Studies have correlated age, BMI, neck circumference, Mallampati grade, sternomental distance, and thyromental distance with DIT. All these risk factors were present more frequently in the OSA group when compared with non-OSA group. STOP-BANG score was identified as the single most important predictor of difficult airway. Individual components of the STOP-BANG score individually were also good predictors of difficult airway. This emphasis the importance of good history and screening for OSA in preanesthetic check-up in prediction of difficult airway. Stigmata of OSA include obesity, narrow oropharynx, and crowded oral cavity, which are individual risk factors for DIT.[26] Hence a common pathway between occurrence of OSA and difficult airway is plausible.

This study was limited by the sample size, PSG was not done to confirm the diagnosis of OSA and the patients were not assessed for overall outcome. Further studies with PSG, follow-up, and larger sample size will help determine the actual complications in the perioperative period.

CONCLUSION

The occurrence of difficult airway is significantly more in patients with positive screening test on STOPBANG.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Shafazand S. Perioperative management of obstructive sleep apnea: Ready for prime time? Cleve Clin J Med 2009;76(Suppl 4):S98-103.
2. Udwadia ZF, Doshi AV, Lonkar SG, Singh CI. Prevalence of sleep-disordered breathing and sleep apnea in middle-aged urban Indian men. Am J Respir Crit Care Med 2004;169:168-73.
3. Sharma SK, Kumpawat S, Banga A, Goel A. Prevalence and risk factors of obstructive sleep apnea syndrome in a population of Delhi, India. Chest 2006;130:149-56.
4. Singh M, Liao P, Kobah S, Wijeysundera DN, Shapiro C, Chung F. Proportion of surgical patients with undiagnosed obstructive sleep apnoea. Br J Anaesth 2013;110:629-36.
5. Agrawal S, Gupta R, Lahan V, Mustafa G, Kaur U. Prevalence of obstructive sleep apnea in surgical patients presenting to a tertiary care teaching hospital in India: A preliminary study. Saudi J Anaesth 2013;7:155-9.
6. Kaw R, Chung F, Pasupuleti V, Mehta J, Gay PC, Hernandez AV. Meta-analysis of the association between obstructive sleep apnoea and postoperative outcome. Br J Anaesth 2012;109:897-906.
7. Young T, Evans L, Finn L, Palta M. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. Sleep 1997;20:705-6.
8. Practice guidelines for the perioperative management of patients with obstructive sleep apnea: An updated report by the American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea. Anesthesiology 2014;120:268-86.
9. Siyam MA, Benhamou D. Difficult endotracheal intubation in patients with sleep apnea syndrome. Anesth Analg 2002;95:1098-102.
10. Reed AP. Chapter 9 - Evaluation and Recognition of the Difficult Airway A 2 - Hagberg, Carin A. Benumof and Hagberg's Airway Management. 3rd ed. Philadelphia: W.B. Saunders; 2013. p. 209-21.e3.
11. Frerk C, Mitchell VS, McNarry AF, Mendonca C, Bhagrath R, Patel A, *et al*. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth 2015;115:827-48.
12. Langeron O, Masso E, Huraux C, Guggiari M, Bianchi A, Coriat P, *et al*. Prediction of difficult mask ventilation. Anesthesiology 2000;92:1229-36.
13. Yentis SM, Lee DJ. Evaluation of an improved scoring system for the grading of direct laryngoscopy. Anaesthesia 1998;53:1041-4.
14. Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P, *et al*. The intubation difficulty scale (IDS): Proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology 1997;87:1290-7.
15. Finkel KJ, Searleman AC, Tymkew H, Tanaka CY, Saager L, Safer-Zadeh E, *et al*. Prevalence of undiagnosed obstructive sleep apnea among adult surgical patients in an academic medical center. Sleep Med 2009;10:753-8.
16. Chung SA, Yuan H, Chung F. A systemic review of obstructive sleep apnea and its implications for anesthesiologists. Anesth Analg 2008;107:1543-63.
17. Candiotti K, Sharma S, Shankar R. Obesity, obstructive sleep apnoea, and diabetes mellitus: Anaesthetic implications. Br J Anaesth 2009;103(Suppl 1):i23-30.
18. Kang HH, Kang JY, Ha JH, Lee J, Kim SK, Moon HS, *et al*. The Associations between Anthropometric Indices and Obstructive Sleep Apnea in a Korean Population. PLoS One 2014;9:e114463.
19. Borges PdTM, Filho ESF, Araujo TMEd, Neto JMM, Borges NEdS, Neto BM, *et al*. Correlation of cephalometric and anthropometric measures with obstructive sleep apnea severity. Int Arch Otorhinolaryngol 2013;17:321-8.
20. Tsuiki S IS, Ishikawa T, Ishikawa T, Yamashiro Y, Tatsumi K, Nishino T. Anatomical balance of the upper airway and obstructive sleep apnea. Anesthesiology 2008;108:1009-15.
21. Yang Y, Chung F. A Screening Tool of Obstructive Sleep Apnea: STOP-Bang Questionnaire. Sleep Med Clin 2013;8:65-72.
22. Toshniwal G, McKelvey GM, Wang H. STOP-Bang and prediction of difficult airway in obese patients. J Clin Anesth 2014;26:360-7.
23. Plunkett AR, McLean BC, Brooks D, Plunkett MT, Mikita JA. Does difficult mask ventilation predict obstructive sleep apnea? A prospective pilot study to identify the prevalence of osa in patients with difficult mask ventilation under general anesthesia. J Clin Sleep Med 2011;7:473-7.
24. Kim JA, Lee JJ. Preoperative predictors of difficult intubation in patients with obstructive sleep apnea syndrome. Can J Anaesth 2006;53:393-7.
25. Acar HV, Yarkan Uysal H, Kaya A, Ceyhan A, Dikmen B. Does the STOP-Bang, an obstructive sleep apnea screening tool, predict difficult intubation? Eur Rev Med Pharmacol Sci 2014;18:1869-74.
26. Kurtipek O, Isik B, Arslan M, Unal Y, Kizil Y, Kemaloglu Y. A study to investigate the relationship between difficult intubation and prediction criterion of difficult intubation in patients with obstructive sleep apnea syndrome. J Res Med Sci 2012;17:615-20.