European Review for Medical and Pharmacological Sciences 2014; 18: 1869-1874

Does the STOP-Bang, an obstructive sleep apnea screening tool, predict difficult intubation?

H.V. ACAR, H. YARKAN UYSAL, A. KAYA, A. CEYHAN, B. DIKMEN

Department of Anesthesiology and Intensive Care, Ankara Training and Research Hospital of Ministry of Health, Ankara, Turkey

Abstract. – OBJECTIVE: A close relationship between obstructive sleep apnea (OSA) and difficult intubation has been suggested. We hypothesized that the STOP-Bang questionnaire, a screening tool for obstructive sleep apnea (OSA), can predict difficult intubation.

PATIENTS AND METHODS: In this prospective cohort study, 200 adult surgical patients undergoing surgery under general anesthesia were studied to evaluate the usefulness of the STOP-Bang questionnaire for predicting difficult intubation. STOP-Bang questionnaire results, Mallampati score and tonsil size, as well as demographic data, were recorded preoperatively. Cormack & Lehane grading and difficulty of intubation (Cormack & Lehane grade III or IV, need of an intubation aid, or need of three or more intubation attempts) were also evaluated.

RESULTS: Eighty-three out of 200 patients had a high risk of OSA based on the STOP-Bang questionnaire. The occurrence of difficult intubation was higher in the patients at a high risk of OSA (i.e., a STOP-Bang score of ≥ 3) than in the patients at a low risk (13.3% vs. 2.6%) (p = 0.004). Higher age, greater weight, higher body mass index, greater neck circumference, male gender, presence of comorbidities, lower preoperative SpO_2, longer extubation times, higher Mallampati score, higher Cormack & Lehane grading, tonsil size and difficult intubation were significantly correlated with a high risk of OSA (p < 0.001). Fourteen out of 200 patients had difficulty in intubation. A STOP-Bang score of ≥ 3 was seen more frequently in the difficult intubation patients (78.6% vs. 38.7%) (p = 0.009). Greater weight, greater neck circumference, greater Mallampati score, a STOP-Bang score ≥ 3 and male gender were significantly correlated with difficult intubation (p < 0.05).

CONCLUSIONS: A STOP-Bang score of ≥ 3 was a predictor for difficult intubation.

Key Words:

Obstructive, Sleep apnea, Intubation, Anesthesia general, Adult.

Introduction

Difficult intubation and obstructive sleep apnea (OSA) are two major problems for anesthesiologists, which may contribute to perioperative morbidity and mortality because both are associated with upper airway abnormalities[1].

OSA, which is characterized by periodic, partial, or complete obstruction of the upper airway during sleep, has a prevalence of 2% for women and 4% for men in the general population[2]. The most prominent symptoms of OSA are loud snoring and daytime sleepiness[3]. For anesthesiologists, the most significant feature of OSA is the occurrence of perioperative respiratory adverse events, whereas one of the major consequences of OSA is the risk of difficult intubation[4]. Although the frequency of difficult intubation in the general surgical population is not extremely high, poor management of difficult airways accounts for 35% of all anesthesia-related deaths[5].

Studies have suggested that OSA patients are at a higher risk of difficult intubation than are control patients[6-9]. For that reason, the identification of OSA patients during preoperative assessment would prevent adverse events[1]. In recognition of the consequences of OSA in the perioperative period, the American Society of Anesthesiologists (ASA) recommended that anesthesiologists screen surgical patients for OSA in the preoperative period[1]. Pregnant patients also are at risk for OSA[10]. A recent study showed that 69% of the surgical patients had OSA while 60% of the patients with moderate-to-severe OSA were not diagnosed by the anesthesiologists preoperatively[11].

Although there are several other screening tools for OSA, the STOP-Bang questionnaire stands out in its ease of use and proven validity for surgical patients (Appendix 1)[12]. The STOP-Bang identifies the patients at a high risk of OSA. Society for Ambulatory Anesthesia con-

Corresponding Author: H. Volkan Acar MD; hvacar@yahoo.com

sensus statement recommends the use of the STOP-Bang in surgical patients preoperatively[13].

In this study, our objective was to assess the usefulness of the STOP-Bang questionnaire for predicting difficult intubation in adult surgical patients.

Patients and Methods

After Institutional Review Board approval, this prospective cohort study was conducted at the Ankara Training and Research Hospital of the Ministry of Health. Adult patients aged 18-65 (ASA physical status I-II) undergoing elective surgery (general, urological, orthopedic and plastic) under general anesthesia were eligible for recruitment. Patients with craniofacial abnormality who were undergoing major head-neck surgery with an OSA diagnosis were excluded from the study. Written consent was obtained from the patients. With an α of 0.05 and power of 0.80 to detect a 20% difference in difficult intubation between OSA patients and non-OSA patients, we estimated a sample size of 193 patients[9].

The STOP-Bang questionnaire[12] results, demographic data, and preoperative SpO_2 values were recorded in the preoperative waiting area. Answers of 'yes' to three or more items on the STOP-Bang indicate a high risk of OSA, whereas 'yes' to less than three items indicates low risk. History of previous surgeries and difficult intubation and the presence of comorbidities were also recorded. Assessment of the Mallampati grading[14] and tonsil size[15] was performed by an attending anesthesiologist in the operating room. Tonsil size was evaluated according to their hypertrophy, listed as follows: Grade I – tonsils inside the tonsillar fossa lateral to posterior pillars; Grade II – tonsils occupying 25% of oropharynx; Grade III – tonsils occupying 50% of oropharynx; Grade IV – tonsils occupying 75% or more of oropharynx; and Grade 0 – previous tonsillectomy. After routine monitoring (ECG, noninvasive blood pressure, and peripheral oxygen saturation), propofol 2.5 mg/kg, lidocaine 1 mg/kg and fentanyl 1 μg/kg were used for the induction of anesthesia. Rocuronium 0.5 mg/kg iv was given to facilitate endotracheal intubation. Ninety seconds after the administration of rocuronium, laryngoscopy and intubation were performed in a standard sniffing position. Difficult intubation was defined as a Cormack and Lehane grade III or IV, need for an intubation aid, or need for three or more intubation attempts[7]. Following intubation, anesthesia was maintained with 2-3% sevoflurane in a 50% oxygen/50% N_2O mixture.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) 11.5 software (SPSS Inc., Chicago, IL, USA). Continuous variables were shown as the mean ± standard deviation, whereas the number and percentage of cases were used for nominal data. Logistic Regression was applied for univariate analysis. The odds ratio and 95% confidence intervals were calculated for each risk factor. The diagnostic performance of low risk and high risk of having OSA discrimination of patients with or without difficult intubation were evaluated by calculating sensitivity, specificity, positive and negative predictive values and accuracy at the cut-off point of 3 for OSA. A p value less than 0.05 was considered statistically significant.

Results

We evaluated 200 patients, 81 (40.5%) males and 119 (59.5%) females. The mean age of the patients was 46.6 ± 15.7, and the mean body mass index (BMI) was 27.4 ± 5.1. Eighty-three of 200 patients were found to have a high risk of OSA (i.e., STOP-Bang score of ≥ 3), and difficult intubation was observed in 14 of 200 patients. The prevalence of difficult intubation was 13.3% for the high-risk patients (11/83) and 2.6% for the low-risk patients (3/117) ($p = 0.004$) (Table I). When we divided the patients into two subgroups according to STOP-Bang score, patients at a high risk of OSA were more likely to have a higher age, greater weight, higher BMI, and larger neck circumference ($p < 0.001$). High risk of OSA was also significantly correlated with male gender ($p < 0.001$), higher frequency of comorbidities, lower preoperative SpO_2 values, longer extubation time and longer duration of stay in the recovery room. Compared with the patients at a low risk of OSA, the high-risk patients had higher Mallampati scores ($p < 0.001$), tonsil size ($p = 0.021$) and Cormack and Lehane grades ($p < 0.001$). The postoperative complications were mild and did not require intervention in any patient.

Demographic and clinical data of the patients with and without difficult intubation are shown in Table II. A STOP-Bang score of ≥ 3 was seen

Table I. Demographic and clinical data of patients with low risk and high risk of having OSA.

	Low risk of having OSA (STOP-Bang <3) (n = 117)	High risk of having OSA (STOP-Bang ≥3) (n = 83)	p-value	Odds ratio (95% confidence interval)
Age (yr)	40.5 (13.9)	55.3 (14.1)	<0.001	1.075 (1.050-1.101)
Height (cm)	164.9 (8.3)	166.3 (8.7)	0.249	1.020 (0.986-1.054)
Weight (kg)	69.7 (11.6)	82.5 (14.4)	<0.001	1.084 (1.054-1.115)
BMI	25.6 (4.3)	29.9 (5.2)	<0.001	1.211 (1.128-1.300)
Male gender	36 (30.8%)	45 (54.2%)	<0.001	2.664 (1.486-4.776)
History of difficult intubation	0 (0%)	2 (2.4%)	0.171	–
Presence of comorbidities	13 (11.1%)	40 (48.2%)	<0.001	7.442 (3.624-15.283)
Neck circumference (cm)	38.0 (4.1)	42.4 (4.8)	<0.001	1.265 (1.164-1.375)
Preoperative SpO_2	96.8 (1.9)	95.8 (2.1)	<0.001	0.793 (0.687-0.917)
Extubation time (min)	5.3 (2.9)	6.6 (4.1)	0.014	1.116 (1.023-1.217)
Duration of stay in the recovery room (min)	7.8 (3.6)	8.9 (4.4)	0.059	1.073 (0.997-1.154)
Patients with postoperative complications	2 (1.7%)	4 (4.8%)	0.235	2.911 (0.521-16.281)
Patients with difficult intubation	3 (2.6%)	11 (13.3%)	0.004	5.806 (1.566-21.522)
Mallampati score	1.7 (0.6)	2.0 (0.7)	<0.001	2.480 (1.539-3.995)
Cormack&Lehane	1.3 (0.5)	1.7 (0.8)	<0.001	2.206 (1.397-3.483)
Tonsil size	1.3 (0.5)	1.4 (0.5)	0.021	1.912 (1.101-3.322)

Values for continuous variables are presented as mean (SD)

more frequently in the patients with difficult intubation (p = 0.004). BMI (p = 0.059), neck circumference (p = 0.016), and Mallampati scores (p < 0.001) were significantly higher in the patients with difficult intubation than in the patients without difficult intubation. Male gender was also more frequent in the patients with difficult intubation. Sensitivity, specifity, positive predictive value, negative predictive value, accuracy and odds ratio for STOP-Bang is listed on Table III. STOP-Bang is found to be a significant predictor for difficult intubation (p = 0.004) (Table III).

Table II. Demographic and clinical data of patients with and without difficult intubation.

	Patients without difficult intubation (n = 186)	Patients with difficult intubation (n = 14)	p-value	Odds ratio (95% confidence interval)
Age (yr)	46.5 (16.1)	47.9 (10.7)	0.745	1.006 (0.972-1.041)
Height (cm)	165.3 (8.3)	168.4 (9.8)	0.188	1.043 (0.980-1.110)
Weight (kg)	74.2 (14.2)	84.7 (12.0)	0.011	1.045 (1.010-1.081)
BMI	27.2 (5.1)	30.0 (4.4)	0.059	1.099 (0.996-1.211)
Male gender	71 (38.2%)	10 (71.4%)	0.015	4.049 (1.224-13.399)
History of difficult intubation	2 (1.1%)	0 (0%)	1.000	–
Presence of comorbidities	50 (26.9%)	3 (21.4%)	0.764	0.742 (0.199-2.769)
Neck circumference (cm)	39.6 (4.9)	43.0 (3.7)	0.016	1.130 (1.023-1.248)
Preoperative SpO_2	96.4 (2.1)	96.0 (1.8)	0.465	0.910 (0.707-1.172)
Extubation time (min)	5.8 (3.5)	5.8 (3.4)	0.987	1.001 (0.858-1.168)
Duration of stay in recovery room (min)	8.1 (4.0)	9.8 (4.0)	0.122	1.093 (0.976-1.224)
Patients with postoperative complications	5 (2.7%)	1 (7.1%)	0.357	2.785 (0.303-25.628)
STOP-Bang score ≥3	72 (38.7%)	11 (78.6%)	0.009	5.806 (1.566-21.522)
Mallampati score	1.8 (0.6)	2.6 (0.7)	<0.001	5.211 (2.259-12.024)
Cormack&Lehane	1.3 (0.5)	3.2 (0.4)	0.991	-
Tonsil size	1.3 (0.5)	1.4 (0.6)	0.927	1.050 (0.370-2.981)

Values for continuous variables are presented as mean (SD)

Table III. The diagnostic performance of low risk and high risk of having OSA patients with or without difficult intubation.

Statistics	Definitions	STOP-Bang
Cut-off point		≥3
No. of cases	N	200
Sensitivity	TP/(TP+FN)	11/14 (78.6%)
Specificity	TN/(TN+FP)	114/186 (61.3%)
PPV	TP/(TP+FP)	11/83 (13.3%)
NPV	TN/(TN+FN)	114/117 (97.4%)
Accuracy	(TP+TN)/N	125/200 (62.5%)
OR	(95%CI)	5.806 (1.566-21.522)
p-value		0.004

Discussion

There were two prominent findings of our study. The frequency of difficult intubation was higher in the patients with a STOP-Bang score of ≥ 3 than in the low-score patients, and a STOP-Bang score of ≥ 3 was seen more frequently in the patients with difficult intubation. Studies have suggested that 2% of women and 4% of men have clinically significant symptomatic OSA[2]. For anesthesiologists, it is important to have a valid and reliable screening tool for OSA patients because OSA may contribute to severe perioperative complications[4] including severe apnoea-hypopnoea[16]. The "gold standard" for OSA diagnosis is polysomnography (PSG)[3]. However, the high expenses and long wait times due to the paucity of sleep clinics restricts patient access to these centers. Therefore, a quick and reliable screening tool would facilitate the detection of OSA patients in busy clinical settings.

Different diagnostic models based on clinical and craniofacial measurements have been developed by investigators for the clinical prediction of OSA[17,18]. In contrast to these models, which may require complicated calculations, the STOP-Bang questionnaire, Mallampati score and tonsil size evaluation offer an advantageous option to clinicians in busy clinical settings for predicting OSA because these three methods are easy to use. Mallampati classification with a history of close to 30 years is a significant predictor for both OSA and difficult intubation[6,15,17-19]. Tonsil size is also a known risk factor for OSA[4,15,17].

Regarding the screening tools used for predicting high risk of OSA in patients, it has been demonstrated that STOP-Bang exhibits the highest methodological validity and reasonable accuracy[20]. The questionnaire is easy to use because of its yes/no format, which can be used to discriminate between patients with or without OSA[21]. A recent study showed that it also helped to estimate OSA severity[22]. The eight-point STOP-Bang method takes only a few minutes to finish. Answering 'yes' to three or more items indicates a high risk of OSA, whereas 'yes' to less than three items indicates a low risk[12].

Earlier studies first suggested that OSA might be a risk factor for difficult intubation[23]. Hiremath et al[6] first indicated a significant relationship between OSA and difficult intubation. In this retrospective study, the authors showed that the apnea-hypopnea index in polysomnography was higher in difficult intubation patients than in control patients. Later case reports[24] and retrospective case-controlled studies[7-9] supported this relationship. Because 66% of difficult-intubation patients have a diagnosis of OSA, Chung et al[12] suggested that difficult intubation patients should be considered for referral to a sleep clinic for PSG.

The prevalence of difficult intubation is 15-20% for OSA patients[7-9] and is higher than for general population[26]. It can be seen that our prevalence (13.3%) was similar to that observed in other studies. Although we found the prevalence of difficult intubation to be 13.3% in the patients at a high risk of OSA, the actual incidence was expected to be higher because OSA was not confirmed by PSG in our patients. Assuming that not all patients with a STOP-Bang score of ≥ 3 would have an OSA diagnosis, the actual percentage of difficult intubation should be higher. We also found a statistically significant difference in difficult intubation between the patients with a high risk and low risk of OSA (2.6% vs.13.3%). These results were similar to those of Siyam and Benhamou (2.6% vs. 21.9%)[9] and Kim and Lee (3.3 vs. 16.6%)[7].

In contrast, some studies have found that OSA was not a risk factor for difficult intubation. Neligan et al[27] studied the relationship between OSA and difficult intubation in morbidly obese patients undergoing bariatric surgery and detected that only 68% of the patients whose mean BMI was 49.4 had PSG-confirmed OSA. The appearance of difficult intubation was only 3.3% in their study. The dissimilar results between Neligan et al and the others can be attributed to several factors, including the definition of difficult intubation, patient position during intubation, etc.

Other investigations have demonstrated that a high Mallampati score and male gender are independent variables for difficult intubation[27-29]. In our study, 78.6% of the patients with difficult intubation were found to have a high risk of OSA. This result supports the finding of Chung et al [25], who found that 66% of difficult intubation patients had PSG-confirmed OSA. Because our patient cases were not PSG-confirmed, the actual percentage would be expected to be lower.

Although a positive correlation between a STOP-Bang score ≥ 3 and difficult intubation was found in our study, it is hard to compare our findings with that of the others due to differences in study designs. For a definition of difficult intubation, Hiremath et al[6] used a criteria of Cormack and Lehane grade IV, whereas Siyam and Benhamou[9] used Cormack and Lehane grade III or IV. Our study used the rating employed in Kim et al[7] (i.e., Cormack and Lehane grade III or IV and need for intubation aid or more than three attempts). However, Neligan et al. used the number of attempts as a criterion[27]. Secondly, the positioning of the patient, which may affect the laryngoscopic view, has not been not similar across studies. In our work the standard sniffing position was used during laryngoscopy, whereas Neligan et al[27] preferred the ramped position. The position of the patient was not indicated in the other retrospective studies[6-9]. Finally, a difference in study methodology has been noted. In contrast to our study, other reports suggesting that difficult intubation was encountered more frequently in OSA patients investigated PSG-proven OSA patients[6-9]. Our patients were not referred to a sleep clinic because the goal of our research was to assess whether the STOP-Bang OSA screening tool could be used to predict difficult intubation.

It should be remembered that intubation can also be difficult in patients at a low risk of OSA. Although 83/200 patients had a STOP-Bang score of ≥ 3 (i.e., high risk of OSA) in our work, only 14 patients had intubation difficulty. All these 14 patients did not have a STOP-Bang score of ≥ 3, whereas three of them had a STOP-Bang score of < 3 (i.e., low risk of OSA). This finding suggests that the STOP-Bang questionnaire is sensitive but not specific to the possibility of difficult intubation.

Conclusions

The STOP-Bang questionnaire, an OSA screening tool to identify OSA patients before surgery, predicts difficult intubation in adult surgical patients.

Appendix 1

1. **S**noring – Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?
2. **T**ired – Do you often feel tired, fatigued, or sleepy during daytime?
3. **O**bserved – Has anyone observed you stop breathing during your sleep?
4. Blood **P**ressure – Do you have or are you being treated for high blood pressure?
5. **B**MI – More than 35 kg/m^2?
6. **A**ge – Over 50 yr old?
7. **N**eck circumference – Greater than 40 cm?
8. **G**ender – Gender male?

Conflict of Interest

None of the Authors declared any conflict of interest

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