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ORIGINAL RESEARCH

Combination of STOP-BANG score and mandibulohyoid distance in the prediction of difficult airway among obstructive sleep apnea patients

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ABSTRACT

Objective: This study was designed to evaluate the diagnostic performance of STOP-BANG score and mandibulohyoid distance (MHD) towards difficult laryngoscopy among obstructive sleep apnea patients.

Cross-Sectional Study

Methodology: Forty-one patients who had STOP-BANG scores of ≥3 and required tracheal intubation for general anesthesia were recruited in this cross-sectional study. MHD was measured through lateral cephalometry. After induction of anesthesia, an anesthesiologist who was blinded to patient's profile performed a laryngoscopy and evaluated the Cormack-Lehane grading. Sensitivity, specificity, positive and negative predictive values were determined for STOP-BANG and MHD. Binary logistic regression, receiver operating characteristics (ROC) and correlation analyses were employed.

Results: Body mass index, neck circumference, and Mallampati scores were higher in the difficult laryngoscopy group. MHD was longer in difficult laryngoscopy group (25.40 ± 5.67 mm) than easy laryngoscopy group (20.17 ± 4.28 mm; $p = 0.002$). STOP-BANG score was higher in difficult laryngoscopy group (5.86 ± 0.96 vs. 4.30 ± 0.98; $p < 0.001$). The combination of MHD and STOP-BANG score improved the quality of diagnostic test in predicting the laryngoscopy status with area under ROC of 87.6%, compared to each isolated parameter (i.e., MHD = 75.7%, STOP-BANG = 85.5%). Both MHD and STOP-BANG scores were significantly positive correlated ($r = 0.42$, $p = 0.006$).

Conclusions: STOP-BANG score and MHD were useful in predicting difficult intubation. The diagnostic performance improved further when combining both parameters.

Key words: Airway assessment; Difficult airway; STOP-BANG; Lateral cephalometry; Mandibulohyoid distance; Obstructive sleep apnea

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INTRODUCTION

Obstructive Sleep Apnea (OSA) is a disorder in which breathing tend to be obstructed briefly during sleep and repeatedly "stop temporarily". It has a prevalence of 9% to 38% in the general population.[1] For anesthetist, the significance of OSA is the association with perioperative respiratory adverse events. One of the major concerns is the risk of difficult intubation.[2] Studies has shown that OSA patients are associated with higher incidence of difficult intubation.[3,4] Unanticipated difficult intubation was most frequently encountered primary airway problem, accounting for 39% of all complications of airway events[5] and 11% of anesthesia related situational awareness errors contributing to mortality and morbidity.[6]

The identification of OSA during preoperative assessment may help to prevent adverse events.[7] Singh et al[8] reported that 69% of the surgical patients had OSA, and up to 60% of the moderate to severe OSA were undiagnosed preoperatively. Thus, the American Society of Anesthesiologist (ASA) has recommended a routine screening of OSA preoperatively.

There are several screening tools for OSA. The STOP-BANG questionnaire is the simplest to use and has a proven validity.[9] A score of ≥ 3 predicts OSA,[10,11] while a higher score may be associated with increased risk of difficult airway.[7,10,12] To date, there is no single airway test that can reliably predict a difficult airway,[13] comparing to a combination of multiple tests.[14,15] Radiological methods of using mandibulohyoid distance (MHD) (Figure 1) may increase the sensitivity and specificity in this matter.[16-18] This study was designed to evaluate the diagnostic performance of STOP-BANG questionnaire, MHD and the combination of both parameters in the evaluation of difficult laryngoscopy.

METHODOLOGY

Prior to this prospective, cross-sectional trial, ethical approval was obtained from Human Research and Ethical Committee of Universiti Sains Malaysia (Reference: USM/JEPeM/ 15010010) It was registered and conducted from May 2015 to February 2016 in Hospital Universiti Sains Malaysia (ClinicalTrials.gov identifier: NCT03105388). Forty-one patients with ASA class I or II, aged between 18 to 75 years old, who were posted for surgery requiring tracheal intubation under general anesthesia, and fulfilled the STOP-BANG score of $\geq$ 3 were recruited. A STOP-BANG score of $\geq$ 3 was chosen because it has a very high sensitivity and high negative predictive value for moderate to severe OSA. Patients who were pregnant, fasted for less than six hours, or those with gastroesophageal reflux disease were excluded.

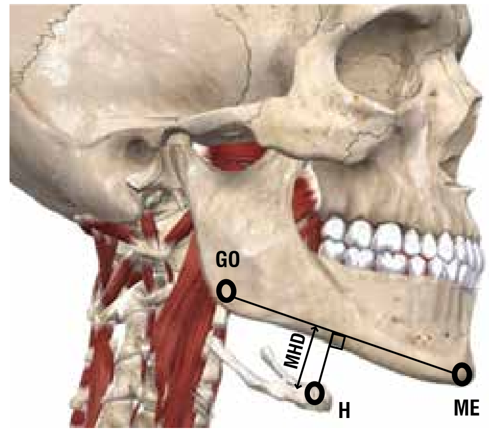

Figure 1: Lateral cephalometry. GO, Gonion; H, Hyoid bone; ME, menton; MHD, mandibular plane-hyoid bone distance

Written consent was obtained from each patient.

Data recorded include age, gender, ASA classification of physical status, height, weight, thyromental distance, neck circumference, and modified Mallampati scores (Samsoon and Young) (19) were recorded. Lateral Cephalometry was taken in a neutral head position. Mandibular-hyoid distance was measured.

Standard monitoring was applied before induction of anesthesia i.e. electrocardiography, non-invasive blood pressure monitoring and pulse oximeter. Anesthesia was performed by a skilled anesthesiologist who was blinded towards the cephalometric measurements as well as the STOP-BANG scores of the patient. After preoxygenation, intravenous (IV) fentanyl 1.5-2 μg/kg and IV propofol 1-2 mg/kg, were administrated in titration. After loss of consciousness, 0.9 mg/kg IV rocuronium was given. When the state of paralysis was achieved guided by train-of-four (TOF) monitoring, patient's head was placed in sniffing position to facilitate intubation. Without pressing the thyroid cartilage, the airway was evaluated and graded following Cormack-Lehane grading system using direct laryngoscopy. The patient was subsequently intubated with appropriate-sized endotracheal tube using a video laryngoscope.

After intubation, mechanical ventilation was conducted with volume control ventilation, at tidal volume of 8 ml/kg ideal body weight, rate of 12 breaths per minute. Anesthesia was maintained with inhalational agent Sevoflurane with the minimum alveolar concentration (MAC) of 1.0. After operation, all patients were reversed using Sugammadex.

Airway management Parameters

Cormack-Lehane (CL) grading system was used as the standard outcome, comparing with MHD and STOP-BANG score. Patients with a CL grade I and II were grouped into Group A (easy laryngoscopy), while patients with CL grade III and IV were grouped into Group B (difficult laryngoscopy).

Statistical Analysis:

The STATA 14 was used for data entry and analysis. All numerical variables were described using mean ± SDs and categorical variables were described using frequency and percentages. Independent sample t-test was used to compare the MHD and STOP-BANG score between Group A and B. MHD and STOP-BANG were recoded into two categories based on recommended cut-off point of 20mm (16) and 5 (20) respectively. The association between laryngoscopy status with categorized MHD (>20 mm) and STOP-BANG (≥5) were tested using Pearson Chi-square test. The sensitivity, specificity, positive and negative predictive values for categorized MHD and STOP-BANG in predicting easy and difficult laryngoscopy was determined.

A comprehensive evaluation was done by using binary logistic regression analysis to examine the predictability of MHD and STOP-BANG on laryngoscopy status. The optimal cutoff point for sensitivity and specificity of MHD and STOP-BANG based on present data were determined through receiver operating characteristic (ROC) analysis. A list of cutoff point for diagnostic tools, sensitivity, specificity, negative and positive predictive value and accuracy were described in a table. Pearson correlation analysis was used to determine the correlation between MHD and STOP-BANG score.

Table 1: Comparison between easy laryngoscopy and difficult laryngoscopy among participant's age, bmi, neck circumference, modified mallampati score, weight, height.

Variables	Easy laryngoscopy	Difficult laryngoscopy	t-value (df = 39)	p-value
	Mean (SD)	Mean (SD)		
Age years)	51.25 (12.48)	48.00 (14.20)	0.777	0.442
Gender:				
Female	11 (55.0%)	11 (52.4%)	0.028 (1)*	0.867
Male	9 (45%)	10 (47.6%)		
BMI (kg/m^2)	29.36 (5.15)	36.54 (5.10)	-4.481	< 0.001
Neck circumference (cm)	41.60 (1.70)	47.00 (5.16)	-4.456	< 0.001
Mallampati	2.00 (< 0.01)	2.48 (0.68)	-3.132	0.003
Weight (kg)	74.59 (12.99)	92.31 (14.44)	-4.125	< 0.001
Height (cm)	159.50 (8.22)	158.71 (7.80)	0.314	0.755

*Note: * Chi-square (df)*

Table 2: Comparison between easy laryngoscopy and difficult laryngoscopy among STOP–BANG score and mandibulohyoid distance

Variables	Easy Laryngoscopy		Difficult laryngoscopy		t-value	df	p value
	Mean (SD)	n (%)	Mean (SD)	n (%)			
MHD (mm)	20.17 (4.28)		25.40 (5.67)		-3.322	39	0.002
≤ 20 mm > 20 mm		13 (65.0) 7 (35.0)		5 (23.8) 16 (76.2)	7.057*	1*	0.008*
STOPBANG score	4.30 (0.98)		5.86 (0.96)		-5.133	39	< 0.001
< 5 ≥ 5		11 (55.0) 9 (45.0)		1 (4.8) 20 (95.2)	12.489*	1*	< 0.001*

*Note. *Chi-square test. MHD, Mandibulohyoid distance*

Table 3: Detailed report of diagnostics parameters for mandibulohyoid distance and STOP-BANG in predicting laryngoscopy status

Cutoff point for diagnostic tools	Sensitivity / Specificity in %	PPV / NPV in %	Accuracy
Mandibulohyoid distance:			
>18mm	85.7/ 35.0	58.1/ 70.0	61.0
>20mm	76.2/ 65.0	69.6/ 72.2	70.7
>22mm	66.7/ 70.0	70.0/ 66.7	68.3
>24mm	61.9/ 85.0	81.3/ 68.0	73.2
STOP-BANG:			
≥ 4	100.0/ 25.0	58.3/ 100.0	63.4
≥ 5	95.2/ 55.0	69.0/ 91.7	75.6
≥ 6	57.1/ 90.0	85.7/ 66.7	73.2
≥ 7	33.3/ 100.0	100.0/ 58.8	65.8

PPV = positive predictive value, NPV = negative predictive value

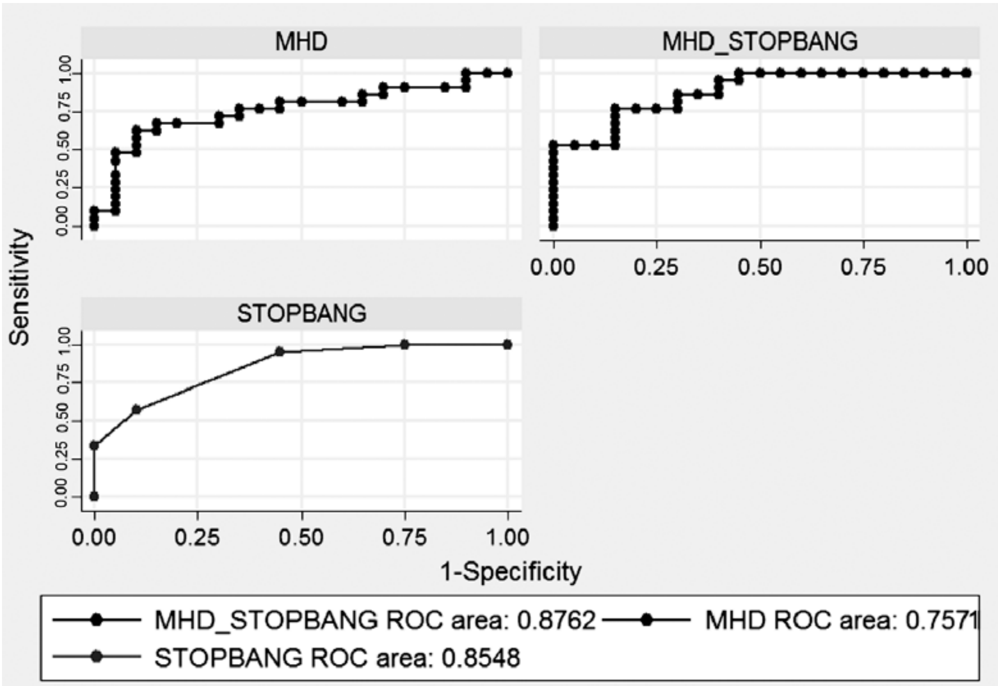

Figure 2: Receiver operating characteristic curve of STOP-BANG score and mandibulohyoid distance. (n = 41)

RESULTS

A total of 41 patients with mean age of 49.59 ± 13.32 years old participated in the study. There were no statistically differences between two groups with respect to their age and gender (Table 1). The mean Mallampati score was 2.24 ± 0.54, the mean of neck circumference was 44.37 ± 4.71 cm.

For MHD, the mean ± SD was 22.85 ± 5.64 mm. Difficult laryngoscopy were observed in 21 (51.2%) of the 41 patients. Based on CL grading system, 31.7% of the participants were in grade I, 17.1% were grade II, 39.0% were in grade III and 12.2% were in grade IV.

MHD was found to be larger in difficult laryngoscopy group (25.40 ± 5.67 mm) as compared to easy laryngoscopy group (20.17 ± 4.28 mm; p-value = 0.002) (Table 2). STOP-BANG score was higher in difficult laryngoscopy group (5.86 ± 0.96) compared to easy laryngoscopy group (4.30 ± 0.98; p-value < 0.001). The categorized mandibular distance and STOP-BANG were also significantly associated with difficulty in laryngoscopy.

By using MHD alone (MHD > 20mm), 23 out of 41 participants (56.1%) were predicted to be difficult. The sensitivity of this parameter was 76.2%, positive predictive value was 69.6%, negative predictive value was 72.2% and the accuracy was 70.7%. By using STOP-BANG score model alone (STOP-BANG $\geq$ 5), 29 (70.7%) participants were predicted to be difficult and 12 (29.3%) participants were deemed easy. Based on this score, the sensitivity for predicting difficult laryngoscopy was 95.2%, positive predictive value was 69.0%, negative predictive value was 91.7%, and the accuracy was 75.6%.

Binary logistic regression showed that MHD was a significant predictor of laryngoscopy status (OR = 1.23, p = 0.006). Those with one unit (in mm) higher in MHD had 1.23 higher odd of having difficult laryngoscopy. The receiver operating characteristic (ROC) curve and its corresponding area under the curve of MHD was 75.7%, indicated that the diagnostic performance was characteristically good (Figure 2). The detailed report of sensitivity and specificity based on several cut-off points for MHD in predicting laryngoscopy status was listed in Table 3. Based on the present data in binary regression model, the optimal cut-off point for MHD was 20 mm.

From the binary logistic regression, STOP-BANG score was a significant predictor of laryngoscopy status (OR = 5.40, p = 0.002). Those who score one unit higher in STOP-BANG score had 5.40 higher odd of having difficult laryngoscopy. The ROC curve and its corresponding area under the curve of STOP-BANG was 85.5%, indicating a good diagnostic performance (Figure 2). Based on the present data in binary regression model, the optimal cut-off point for STOP-BANG was five (Table 3).

When combining STOP-BANG score and MHD in the binary logistic regression model, the corresponding area under the ROC increased marginally to 87.6% (Figure 2). This indicated that the quality of diagnostic test improved when combining STOP-BANG score and MHD in predicting the outcome. Besides, correlation between STOP-BANG score and MHD was statistically significant (r = 0.421 with p value = 0.006), indicating that the correlation was positive.

DISCUSSION

The aim of the study was to assess the predictive model for difficult intubation in patient at risk of OSA using STOP-BANG and MHD. Many assessment criteria had been incorporated, but do not consistently produce accurate evaluation of the risk of failed intubation.[21]

The major finding of this study was that a combined STOP-BANG score and MHD yield a better prediction of difficult airway. It was shown that the specificity and sensitivity of each test was not perfect, but when the tests were used in combination, the specificity and sensitivity increased.

Mallampati classification which has used widely for difficult airway assessment has been reported to be of limited value by some researchers.[22-24] A major pitfall in achieving a reliable score for Mallampati classification is the failure to ensure that the patient opens the mouth and protrudes the tongue maximally. This study found that modified Mallampati score has significant value in predicting difficult laryngoscopy, consistent with findings by Mahmoodpoor et al. and Patel et al. [25,26] However, modified Mallampati score was inadequate as a standalone test to reliably predict difficult laryngoscopy or tracheal intubation.[27,28] The same goes to neck circumference which has been shown to have a strong correlation with STOP-BANG score.[29] The greater the neck circumference, the higher the score by Cormack Lehane classification.[30] This finding was comparable to our result.

The STOP-BANG score appears to promise a good diagnostic performance in predicting difficult laryngoscopy. In this study, it showed high sensitivity, high accuracy and a reasonable specificity. STOP-BANG questionnaire is easy to use and very cost effective. The severity of OSA increases linearly as the score increases from 3 to 8.[20] Findings of this study were consistent with this. A STOP-BANG score of >3 has been suggested by Toshniwal et al.[10] to be associated with difficult airway. However, the authors found that using a cut-off point of $\geq$5 might yields the highest accuracy, and a relatively more balanced sensitivity, specificity, positive- and negative predictive values (Table 3).

Cephalometry has provided us substantial insight into the pathophysiology of OSA, identifying the most significant craniofacial characteristics associated with this disease. The increased in MHD was found to be significantly associated with large neck circumference and receding chin. Studies have shown that an increased in MHD in OSA patient is associated with an increased risk of difficult laryngoscopy.[16] A combination of STOP-BANG score and MHD had led to a marginally improvement in the area under ROC of predicting the outcome by 87.6%.

The measurement of MHD can be done electronically with radiography, and does not depend on the skill of assessor, thus preventing inter assessor variability. Results were accurate and could be easily retrieved for re-examination. In addition, a single cephalometry has the benefits of revealing other radiographic parameters such as submandibular angle[31] and facial angle.[25]

The MHD technique may be limited by the concern of additional ionizing radiation from lateral cephalometry. However, according to the Biological Effects of Ionizing Radiation Committee VII (BEIR VII) reports, the risk of developing a fatal cancer from a single exposure from lateral cephalometry is very minimal. Clearly the benefits of a single exposure of cephalometry with the aim of assessing ease of laryngoscopy outweighed the risk, given the risk of death from difficult airway management was as high as 40%.

There are a few limitations in this study. First, the CL grading system which was used as the outcome of this study, may not be as accurate as other classification system such as ASA Intubation Difficult score or Cook's grading system. The grading system may also depend on operator experience, patient characteristics and clinical settings. Besides, this study may also miss out the association of limited head and neck mobility and difficult laryngoscopy, which may be significant in OSA population.[32] This aspect is not able to be detected using both STOP-BANG score and MHD. Besides, the risk and incidence of difficult mask ventilation among OSA patients which is also an important issue in difficult airway, was not assessed in this study. Patient who had difficult mask ventilation after muscle relaxation had been associated with difficult intubation.[10]

Another limitation was the exclusion of obstetric patients, due to the risk of radiation exposure during lateral cephalometry. Similarly, the study did not include extreme age groups, which are known to have higher incidence of difficult airway. Nevertheless, sleep studies were not performed for all the participants prior to laryngoscopy due to long waiting list for this test in our institution, and the concern of cost-effectiveness.

CONCLUSION

The incidence of difficult laryngoscopy in OSA patients is not negligible. The combined STOP-BANG score and mandibulohyoid distance can improved the overall accuracy of the model to predict difficult laryngoscopy. This technique provides relatively easy, reproducible and objective way of assessment among OSA patients.

Conflict of interest: None declared.

Authors' contribution:

KTL + CN: Literature review, collected data and drafted the manuscript

RHMZ: Designed the study, discussion, edited and finalizing the manuscript

WMNWH: Concept, analyzing data and edited the manuscript

YCK: Analyzing data, discussion and edited the manuscript

LMF + MII: Collected data, drafted and proofread the manuscript

SEC: Literature review, interpretation of data, discussion and finalizing the manuscript

REFERENCES

1. Senaratna CV, Perret JL, Lodge CJ, Lowe AJ, Campbell BE, Matheson MC, et al. Prevalence of obstructive sleep apnea in the general population: A systematic review. Sleep Med Rev. 2017;34:70-81. [PubMed] DOI: 10.1016/j.smrv.2016.07.002
2. Benumof JL. The new ASA OSA guideline. ASA Refresher Courses in Anesthesiology. 2007;35(1):1-13.
3. 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 Mar;45:63-8. [PubMed] DOI: 10.1016/j.jclinane.2017.12.024
4. Opperer M, Cozowicz C, Bugada D, Mokhlesi B, Kaw R, Auckley D, et al. Does obstructive sleep apnea influence perioperative outcome? a qualitative systematic review for the society of anesthesia and sleep medicine task force on preoperative preparation of patients with sleep-disordered breathing. Anesth Analg. 2016;122(5):1321-34. [PubMed] DOI: 10.1213/ANE.0000000000001178
5. Cook TM, Woodall N, Frerk C. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: Anaesthesia. Br J Anaesth. 2011;106(5):617-31. [PubMed] DOI: 10.1093/bja/aer058
6. Schulz CM, Burden A, Posner KL, Mincer SL, Steadman R, Wagner KJ, et al. Frequency and type of situational awareness errors contributing to death and brain damage. Anesthesiology. 2017;127(2):326-37. [PubMed] DOI: 10.1097/ALN.0000000000001661
7. Corso RM, Petrini F, Buccioli M, Nanni O, Carretta E, Trolio A, et al. Clinical utility of preoperative screening with STOP-Bang questionnaire in elective surgery. Minerva Anestesiol. 2014;80(8):877-84. [PubMed]
8. Singh M, Liao P, Kobah S, Wijeysundera D, Shapiro C, Chung F. Proportion of surgical patients with undiagnosed obstructive sleep apnoea. Br J Anaesth. 2012:aes465. [PubMed] DOI: 10.1093/bja/aes465
9. Arias-Carrion O, Nagappa M, Liao P, Wong J, Auckley D, Ramachandran SK, et al. Validation of the STOP-Bang Questionnaire as a screening tool for obstructive sleep apnea among different populations: a systematic review and meta-analysis. PloS One. 2015;10(12):e0143697. [PubMed] DOI: 10.1371/journal.pone.0143697
10. Toshniwal G, McKelvey GM, Wang H. STOP-Bang and prediction of difficult airway in obese patients. J Clin Anesth. 2014;26(5):360-7. [PubMed] DOI: 10.1016/j.jclinane.2014.01.010
11. Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, Islam S, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. Anesthesiology. 2008;108(5):812-21. [PubMed] DOI: 10.1097/ALN.0b013e31816d83e4
12. Acar H, Uysal HY, CeyhanKaya 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(13):1869-74. [PubMed]
13. Crawley SM, Dalton AJ. Predicting the difficult airway. BJA Education. 2015;15(5):253-7. DOI: 10.1093/bjaceaccp/mku047
14. Wajekar AS, Chellam S, Toal PV. Prediction of ease of laryngoscopy and intubation-role of upper lip bite test, modified mallampati classification, and thyromental distance in various combination. J Family Med Prim Care. 2015;4(1):101-5. [PubMed] DOI: 10.4103/2249-4863.152264
15. Badhe VK, Deogaonkar SG, Tambe MV, Singla A, Shidhaye RV. Clinical comparison of five different predictor tests for difficult intubation. Anaesth Pain Intensive Care. 2014;18(1). [Free full text]
16. Chou HC, Wu TL. Mandibulohyoid distance in difficult laryngoscopy. Br J Anaesth. 1993;71(3):335-9. [PubMed] DOI: 10.1093/bja/71.3.335
17. Barrera JE, Pau CY, Forest VI, Holbrook AB, Popelka GR. Anatomic measures of upper airway structures in obstructive sleep apnea. World J Otorhinolaryngol Head Neck Surg. 2017;3(2):85-91. [PubMed] DOI: 10.1016/j.wjorl.2017.05.002
18. Dejan S. Difficult endotracheal intubation—scales and causes. J Pharma Pharmacol. 2017;5(10)775-86. [Free full text]
19. Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. Anaesthesia. 1987;42(5):487-90. [PubMed]
20. Chung F, Subramanyam R, Liao P, Sasaki E, Shapiro C, Sun Y. High STOP-Bang score indicates a high probability of obstructive sleep apnoea. Br J Anaesth. 2012;108(5):768-75. [PubMed] DOI: 10.1093/bja/aes022
21. Vannucci A, Cavallone LF. Bedside predictors of difficult intubation: a systematic review. Minerva Anestesiol. 2016;82(1):69-83. [PubMed]
22. Eiamcharoenwit J, Itthisompaiboon N, Limpawattana P, Suwanpratheep

A, Siriussawakul A. The performance of neck circumference and other airway assessment tests for the prediction of difficult intubation in obese parturients undergoing cesarean delivery. Int J Obstet Anesth. 2017;31:45-50. [PubMed] DOI: 10.1016/j.ijoa.2017.01.011
23. Huang YG, Ma LL, Yu XR, Zhu B, Shen JX, Zhang JG. Difficult airway for patients undergoing spine surgeries. Chin Med J. 2016;129 (6):749-50. [PubMed] DOI: 10.4103/0366-6999.178033
24. Aktas S, Atalay YO, Tugrul M. Predictive value of bedside tests for difficult intubations. Eur Rev Med Pharmacol Sci. 2015;19(9):1595-9. [PubMed]
25. Mahmoodpoor A, Soleimanpour H, Golzari SEJ, Nejabatian A, Pourlak T, Amani M, et al. Determination of the diagnostic value of the Modified Mallampati Score, Upper Lip Bite Test and Facial Angle in predicting difficult intubation: A prospective descriptive study. J Clin Anesth. 2017;37:99-102. [PubMed] DOI: 10.1016/j.jclinane.2016.12.010
26. Patel B, Khandekar R, Diwan R, Shah A. Validation of modified Mallampati test with addition of thyromental distance and sternomental distance to predict difficult endotracheal intubation in adults. Indian J Anaesth. 2014;58(2):171-5. [PubMed] DOI: 10.4103/0019-5049.130821
27. Lundstrom LH, Vester-Andersen M, Moller AM, Charuluxananan S, L'Hermite J, Wetterslev J, et al. Poor prognostic value of the modified Mallampati score: a meta-analysis involving 177 088 patients. Br J Anaesth. 2011;107(5):659-67. [PubMed] DOI: 10.1093/bja/aer292
28. Shiga T, Wajima Z, Inoue T, Sakamoto A. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. Anesthesiology. 2005;103(2):429-37. [PubMed]
29. Hannallah M, Exeter Y, Scher L, Habib G, Hwang G, Cai L. Comparison of "the STOP-Bang" and "the Modified Neck Circumference" obstructive sleep apnea screening questionnaires. Anaesth Pain & Intensive Care. 2015;18(2):153-5. [Free full text]
30. Riad W, Vaez MN, Raveendran R, Tam AD, Quereshy FA, Chung F, et al. Neck circumference as a predictor of difficult intubation and difficult mask ventilation in morbidly obese patients. Eur J Anaesthesiol. 2016;33(4):244-9. [PubMed] DOI: 10.1097/EJA.0000000000000324
31. Greenland KB, Irwin MG. Airway management - 'spinning silk from cocoons' (Chinese idiom). Anaesthesia. 2014;69(4):296-300. [PubMed] DOI: 10.1111/anae.12621
32. Shailaja S, Nichelle SM, Shetty AK, Hegde BR. Comparing ease of intubation in obese and lean patients using intubation difficulty scale. Anesth Essays Res. 2014;8(2):168-74. [PubMed] DOI: 10.4103/0259-1162.134493

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