Original Article

Sternomental distance and sternomental displacement as predictors of difficult laryngoscopy and intubation in adult patients

ABSTRACT

Background: Several morphometric airway measurements have been used to predict difficult laryngoscopy (DL). This study evaluated sternomental distance (SMD) and sternomental displacement (SMDD, difference between SMD measured in neutral and extended head position), as predictors of DL and difficult intubation (DI).

Materials and Methods: We studied 610 adult patients scheduled to receive general anesthesia with tracheal intubation. SMD, SMDD, physical, and airway characteristics were measured. DL (Cormack-Lehane grade 3/4) and DI (assessed by Intubation Difficulty Scale) were evaluated. The optimal cut-off points for SMD and SMDD were identified by using receiver operating characteristic (ROC) analysis. Multivariate logistic regression was used to predict DL and ROC curve was used to assess accuracy on developed regression model.

Results: The incidence of DL and DI was 15.4% and 8.3%, respectively. The cut-off values for SMD and SMDD were ≤14.75 cm (sensitivity 66%, specificity 60%) and ≤5.25 cm (sensitivity 70%, specificity 53%), respectively, for predicting DL. The area under the curve (AUC) with 95% confidence interval (CI) for SMD was 0.66 (0.60–0.72) and that for SMDD was 0.687 (0.63–0.74). Multivariate analysis with logistic regression identified inter-incisor distance, neck movement <80°, SMD, SMDD, short neck and history of snoring as predictors and the predictive model so obtained exhibited a higher diagnostic accuracy (AUC: 0.82; 95% CI 0.77–0.86). SMDD, but not SMD, correlated with DI.

Conclusions: Both SMD and SMDD provide a rapid, simple, objective test that may help identifying patients at risk of DL. Their predictive value improves considerably when combined with the other predictors identified by logistic regression.

Key words: Anesthetic techniques; anthropometry; difficult; intubation tracheal; laryngoscopy

Introduction

Sternomental distance (SMD) is an indicator of head and neck mobility.[1] It has been suggested as the best single test for ruling out difficult intubation among forced protrusion of the mandible, inter-incisor gap, modified Mallampati grade, and thyromental distance (TMD).[2] Previous studies have addressed the correlation between SMD and difficult laryngoscopy (DL).[1-6] However, in these studies, other factors that can contribute to DL and whether or not intubation was difficult have not been assessed.

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SMD is conventionally measured with the head extended on the neck (SMD extension). A modification of measurement of SMD is the measurement obtained with the head in neutral position (SMD neutral). We planned to study whether a difference between SMD extension and SMD neutral (henceforth referred to as sternomental displacement, SMDD) can be used as a predictor for DL. The study hypothesis was that, similar to SMD, sternomental displacement can be a useful parameter for airway assessment to detect DL. The primary aim of the study was to determine whether SMD displacement correlates with DL and secondary aims were to determine the optimum threshold value of SMD for DL in the Indian population and to assess whether SMD and SMDD correlate with difficult intubation.

Materials and Methods

The study was approved by the Hospital Ethics Committee. After obtaining written informed consent, 610 consecutive American Society of Anesthesiologists Physical Status I-III adult patients scheduled for elective surgery under general anesthesia requiring tracheal intubation were included in this prospective study. Exclusion criteria comprised patients with obvious malformation of the neck or face (candidates for awake tracheal intubation), interincisor distance <2.5 cm, unstable cervical spine, and patients requiring rapid sequence induction.

Preoperative upper airway assessment was performed by one investigator to avoid inter-observer variability. All distance measurements were obtained using a rigid ruler and approximated to the nearest 0.5 cm. The following data were recorded: (1) abnormal dentition: loose, protruding, or missing upper incisors or canines; (2) modified Mallampati classification as described by Samsoon and Young;[7] Class I = soft palate, fauces, uvula, and pillars seen; Class II = soft palate, fauces, and uvula seen; Class III = soft palate and base of uvula seen; Class IV = soft palate not visible; (3) interincisor gap <or >3.5 cm; (4) TMD measured as the straight distance from the thyroid notch to the inner mentum, with the head in full extension and the mouth closed; (5) SMD extension measured as the straight distance from the upper border of the manubrium sterni to the mentum, with the head in full extension and the mouth closed; (6) SMD neutral measured as the straight distance from the upper border of the manubrium sterni to the mentum, with the head in neutral position and the mouth closed; and (7) sternomental displacement (SMDD) was calculated by subtracting SMD neutral from SMD extension; (8) forward protrusion of the mandible (ability to move the lower teeth in front of the upper teeth; (9) mandibular length measured as the straight distance from the angle of the mandible to the mentum; (10) the maximum range of neck and head movement <80° or >80° measured as described by Wilson *et al*.,[8] wherein a pencil is placed vertically on the forehead of the patient with the head and neck in full extension. The patient is asked to fully flex the head while the change in angle is gauged by the anesthesiologist and classified as <or >80°; (10) body mass index, calculated as the weight (kg) divided by the square of the height (m); and (11) other features such as the presence of a short neck, beard or history of snoring were noted.

All patients fasted overnight and received oral alprazolam 0.25 mg/0.5 mg (< or >50 kg body weight, respectively) the night before and on the morning of surgery. In the operating room, standard monitoring (electrocardiogram, pulse oximetry, capnography, and noninvasive blood pressure) was instituted. The height of the operating table was adjusted such that the plane of the patient's face was at the level of xiphisternum of the anesthesiologist performing laryngoscopy and intubation.

The anesthetic protocol was standard. Anesthesia was induced with fentanyl (2 μg/kg) and propofol (2–2.5 mg/kg) till the loss of verbal contact. Intubation was facilitated by vecuronium 0.1 mg/kg. The patient's lungs were ventilated with oxygen and nitrous oxide (50:50) and isoflurane 0.6% for 3 min. Laryngoscopy was performed using Macintosh size 3 blade by an anesthesiologist having more than 5 years experience. The laryngoscopic view was graded by Cormack and Lehane grading scale;[9] Grade 1: Complete visualization of the vocal cords; Grade 2: Visualization of the inferior portion of the glottis; Grade 3: Visualization of only the epiglottis; and Grade 4: Nonvisualized epiglottis. No external laryngeal pressure was applied for grading the laryngoscopic view. DL was defined as Cormack and Lehane Grade 3 or 4. External laryngeal manipulation (ELM) was permitted, if necessary, after evaluation of laryngoscopy grade to facilitate the insertion of the tracheal tube. The laryngoscopic view obtained following ELM was also noted.

Cuffed tracheal tube size 7 was used in women and size 8 in men. Intubation difficulty was assessed by the Intubation Difficulty Scale (IDS) score described by Adnet *et al*.[10] The seven variables included number of tracheal intubation attempts; number of operators attempting intubation; number of alternative techniques used; glottis exposure as defined by Cormack and Lehane grade; subjective assessment of intensity of lifting force applied during laryngoscopy; need for ELM; and position of the vocal cords. Alternative techniques included repositioning of the patient, change of blade or tube, addition of a stylet, change to nasotracheal intubation, or use of fiberscopy or intubating laryngeal mask airway.[10] The IDS score was calculated in each case. A score of 0 represents an ideal intubation with minimum difficulty, an IDS score between 1 and 5 represents slight difficulty, and an IDS score >5 represents moderate to major difficulty.[10]

Duration of laryngoscopy (the time from the instant the laryngoscope blade was inserted in the mouth until tracheal intubation and removal of the laryngoscope blade from the mouth) was noted. Laryngoscopy was considered prolonged if its duration exceeded 15 s. Successful tracheal intubation was confirmed by assessment of chest movement, auscultation, and capnography. Anesthesia was maintained as per standard anesthesia protocol.

Sample size determination: The incidence of DL varies from 1% to 18%.[11] Assuming an incidence of DL to be 10%, and specificity 80% and sensitivity 80%, then 610 patients needed to be enrolled in the study, with10% precision and 95% confidence interval (CI).

Statistical methods

Descriptive statistics in the form mean and standard deviations for interval variables and counts and percentages for categorical variables were performed. Student's *t*-test (unpaired) were used to see significant mean differences of interval variables between easy and DL; Chi-square tests was used for categorical variables. Multivariate logistic regression analysis was performed on significant variables at univariate analysis. Collinearity was assessed using correlation coefficient. Adjusted odds ratios, 95% CI with *P* value are presented. Receiver operative characteristic (ROC) curve was used to see the accuracy of the regression model for predicting DL presenting c-statistics (area under the curve [AUC]), 95% CI and *P* value. $P = 0.05$ (two-tailed) was considered for statistical analysis. IBM SPSS Statistics for Windows, version (21.0), Armonk, NY was used for the analysis.

Results

Laryngoscopy was difficult in 94 of 610 (15.4%) patients. Ninety-three patients had Cormack Grade 3 and one patient had Grade 4. Duration of laryngoscopy was 30.9 ± 27 s in patients with DL and 14 ± 7.6 s in easy laryngoscopy ($P = 0.001$).

Overall patient demographic data and airway characteristics are presented in Table 1.

Age ($P = 0.001$), male gender ($P = 0.004$) and weight ($P = 0.01$) were associated with DL. Airway characteristics that were associated with DL included Mallampati class, TMD, SMD, SMDD, interincisor distance, range of neck movement <80°, limited mandibular protrusion, short neck, and history of snoring [Table 2].

The distribution of patients with regard to Cormack Grade 1, 2, 3, and 4 was 320, 196, 93, and 1 patient, respectively ($P = 0.001$). ELM decreased the incidence of DL from 94 (100%) to 16 (17.0%) patients. Moderate to major difficulty in tracheal intubation was evident in 42 of 94 (44.7%) patients in whom laryngoscopy was difficult, compared to 9 of 516 (1.7%) patients in whom laryngoscopy was easy [Table 3].

Table 1: Overall patient data (*n*=610)

Patient characteristics	Value
Age (years)	37.73±13.44
Gender (male/female)	256/354
Weight (kg)	60.17±12.88
Height (cm)	159.46±9.37
Body mass index (kg/m^2)	23.68±4.87
Inter-incisor distance ≤3.5 cm	56 (9.2)
Mallampati Class 3/4 (sitting)	99 (16.3)
Thyromental distance (cm)	6.21±0.99
SMD (cm)	15.41±2.12
SMD neutral (cm)	9.50±1.85
Sternomental displacement (cm)	5.90±1.57
Mandibular length (cm)	9.15±0.96
Limited mandibular protrusion	32 (5.2)
Range of neck movement <80°	17 (2.8)
Short muscular neck	70 (11.5)

Values are mean±SD or *n* (%). SD: Standard deviation; SMD: Sternomental distance

Table 2: Airway characteristics in the easy and difficult laryngoscopy groups

	Laryngoscopy		
	Easy (*n*=516)	Difficult (*n*=94)	*P*
Mallampati class (sitting)			
0	4 (0.7)	0	0.001
1	249 (48.3)	19 (20.2)	
2	202 (39.1)	37 (39.4)	
3	43 (8.3)	30 (31.9)	
4	18 (3.5)	8 (8.5)	
Thyromental distance (cm)	6.3±0.98	5.98±0.98	0.02
SMD (cm)	15.2±2	14.4±2	0.001
Sternomental displacement (cm)	6.07±1.5	5±1.4	0.001
SMDD/SMD %	39±9	35±8	0.001
Mandibular length (cm)	9.16±0.90	9.05±1.25	0.28
Inter-incisor distance ≤3.5 cm	41 (7.9)	15 (16.0)	0.001
Neck movement <80°	6 (1.2)	11 (11.7)	0.001
Limited mandibular protrusion	22 (4.3)	10 (10.6)	0.01
Short neck	43 (8.3)	27 (28.7)	0.001
Beard	9 (1.7)	2 (2.1)	0.98
History of snoring	83 (16.1)	46 (48.9)	0.001

Values are mean±SD and *n* (%). SD: Standard deviation; SMDD: Sternomental displacement SMD: Sternomental distance

Patients with DL had significantly greater number of intubation attempts and number of operators, increased lifting force, external laryngeal pressure application and increased use of alternative techniques [all $P = 0.001$, Table 3]. The incidence of difficult intubation was 8.3%. There was no failed intubation.

Multivariate analysis with logistic regression revealed the following parameters to be significantly associated with DL: age, male gender, SMD, sternomental displacement, inter-incisor distance, range of neck movement <80°, short neck and history of snoring [Table 4].

The cutoff value for SMDD for predicting DL was ≤5.25 cm, with 70% sensitivity and 53% specificity. AUC of ROC curve for SMDD was 0.687 with 95% CI 0.63–0.74) [Figure 1]. The multivariate analysis odds ratio (95% CI) of SMDD was 0.79; (0.71–0.88). SMDD, when expressed as a percentage of SMD was statistically significant in predicting DL [$P = 0.001$, Table 2].

Table 3: Intubation difficulty scale score and variables of intubation difficulty scale

Variables	Laryngoscopy		*P*
	Easy (*n*=516)	Difficult (*n*=94)	
IDS break score			
0	284 (55.0)	1 (1.1)	0.001
1-5	223 (43.3)	51 (54.3)	
>5	9 (1.7)	42 (44.7)	
Variables of IDS			
Attempts >1	45 (8.7)	35 (37.2)	0.001
Operators >1	16 (3.1)	26 (27.7)	0.001
Cormack Grade 3 and 4	0	94 (15.4)	-
Increased lifting force	18 (3.5)	42 (44.7)	0.001
External laryngeal manipulation	199 (38.6)	94 (100)	0.001
Alternative techniques	79 (15.3)	55 (58.5)	0.001
Vocal cords adducted	0	0	-

Values are *n* (%). IDS: Intubation difficulty scale

Table 4: Predictors of difficult laryngoscopy through multivariate logistic regression

Variable	Adjusted OR	95% CI	*P*
Age (years)	1.03	1.01-1.05	0.001
Gender male	3.0	1.74-5.24	0.001
Body mass index	0.96	0.90-1.02	0.18
Sternomental displacement	0.79	0.65-0.95	0.01
Thyromental distance	1.05	0.73-1.51	0.80
Inter-incisor distance	0.44	0.21-0.94	0.03
Neck movement <80°	0.26	0.08-0.84	0.02
Limited mandibular protrusion	1.63	0.64-4.16	0.31
Short neck	2.43	1.15-5.10	0.02
History of snoring	3.32	1.88-5.86	0.001

Hosmer–Lemshow for goodness of fit of the model χ^2=7.17, df=8, P=0.51. Sternomental displacement and SMD were found collinear to each other; only SMD has been taken for multivariate analysis. OR: Odds ratio; CI: Confidence interval; SMD: Sternomental distance

Cut off value for predicting DL for SMD was ≤14.75 cm with sensitivity 66%, specificity 60%; AUC of ROC curve for SMD with 95% CI was 0.66 (0.60–0.72).

The AUC from the ROC curve to predict DL from the multivariate regression model was 0.82 95% CI 0.77–0.86 [Figure 2].

With regard to difficult intubation, a significant negative correlation was seen between SMDD and IDS score ($r = -0.29$, $P = 0.001$). In contrast, the correlation between SMD and IDS score was not significant ($r = -0.07$, $P = 0.7$).

Gender differences were evident in SMD (16.28 ± 2.22 cm vs. 14.74 ± 1.91 cm; $P < 0.001$) and SMDD (6.24 ± 1.69 cm vs. 5.66 ± 1.49 cm; $P < 0.001$) in males and females, respectively. There was a negative correlation for SMD with age ($P = 0.01$) and BMI ($P = 0.01$), and a positive correlation with height ($P = 0.01$). There was no association between SMDD and age ($P = 0.056$). Similar to SMD, there was a positive association between SMDD and height ($P < 0.001$) and a negative correlation with BMI ($P = 0.003$).

Discussion

Our results show that both SMD and SMDD correlate with laryngoscopic view. However, only SMDD, and not SMD, correlated with difficult intubation. Using discriminant analysis, the best cut-off point for predicting DL for SMD and SMDD was ≤14.75 cm and ≤5.25 cm, respectively. This study confirms the results of previous investigators by identifying age, male gender, SMD, inter-incisor distance,

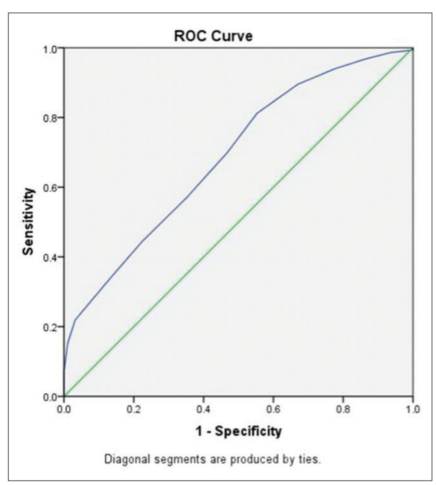

Figure 1: Receiver operating characteristic curve for sternomental displacement

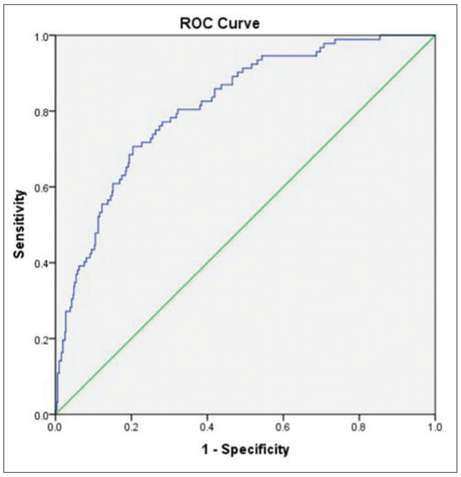

Figure 2: Receiver operating characteristic curve to predict difficult laryngoscopy from the multivariate regression model

range of neck movement <80°, short neck and a history of snoring as predictors of DL.

We found a significant difference between SMDD in patients with a Grade 3 or 4 laryngoscopic view compared with those with a Grade 1 or 2 view (5 ± 1.4 vs. cm 6.07 ± 1.5 cm, respectively). It has been suggested that a difference of <5 cm between SMD extension and SMD neutral, (sternomental displacement), is associated with a DL;[12] conversely, a sternomental displacement of more than 5 cm is indicative of easy laryngoscopy.[12] The cut-off value of ≤5.25 cm for SMDD identified in our study for prediction of DL validates this statement. An interesting finding of our study is that a significant negative correlation was seen between SMDD and IDS score. In contrast, the correlation between SMD and IDS score was not significant. The head extension is an important factor in determining the ease or difficulty of tracheal intubation.[13] Whether SMDD can be used as an indirect measure of atlantooccipital extension needs further investigation.

We found a significant difference between SMD in patients with a Grade 3 or 4 laryngoscopic view compared with those with a Grade 1 or 2 view (14.4 ± 2.0 cm vs. 15.2 ± 2.0 cm, respectively). Savva[2] found an SMD of ≤12.5 cm to be the best predictor of DL and suggested that SMD should be used as the sole routine test.[2] Ramadhani *et al*.[1] assessed the value of SMD as a sole predictor of DL in an obstetric population. They found a significant difference between SMD in those patients with a Grade 3 or 4 laryngoscopic view compared with those with a Grade 1 or 2 view (13.17 ± 1.54 cm vs. 14.3 ± 1.49 cm, respectively). An SMD of 13.5 cm or less provided the best cut-off point for predicting subsequent DL in parturients.[1] Liaskou *et al.*[3] reported a cut-off value for SMD of ≤15 cm (AUC 0.64) for predicting DL in Grecian patients. They found TMD, SMD, RHTMD and neck circumference to be poor single predictors of DL. A predictive model that included TMD, SMD, RHTMD and neck circumference exhibited a higher and statistically significant diagnostic accuracy for DL (AUC: 0.68, $P < 0.001$).[3] Allahyary *et al*.[4] determined the predictive value of several airway parameters in an obstetric population. The larynx was difficult to visualize in 18.2% parturients. There was a statistically significant difference in SMD between easy and difficult visualization of larynx (15.1 ± 1.1 and 14.1 ± 0.8 cm, respectively; $P < 0.001$). The sensitivity, specificity, and positive predictive value for SMD were 13.5%, 86.7%, 18.5%, respectively. Using the cut-off point of 13.5 cm, the authors found that SMD had a low sensitivity (13.5%) and positive predictive value (18.5%) but a relatively high specificity (86.7%).[4] In contrast, Merah *et al*.[5] found that the SMD could not predict DL in Nigerian obstetric patients. This is because the authors used a cut-off point of 13.5 cm (as described by Al Ramadhani *et al*.[1]) while the mean SMD in their study was 17.8 ± 1.7 cm. The authors attribute this to possible anthropometric differences between people from the Middle East and West Africa. They also reported no significant difference in SMD in easy and DL groups. This could be related to the small sample size (80 patients) in their study.

There is a wide range of SMD cut-off values such as 12.5 cm,[2] 13.5 cm[1] and 15 cm[3] to predict DL in the literature. This could be due to anthropometric differences in various ethnic population groups. In our study, both SMD and SMDD showed a positive correlation with patient height; perhaps the ratio of height to SMD may have a better predictive value than SMD alone, as patient size would be taken into account. We found that both SMD and SMDD showed statistically significant differences with gender. Türkan *et al*.[6] reported gender differences in SMD, with the male sex having increased morphometric distances. Identical SMD measurements in a patient with a small body frame (woman with a height of 150 cm) and a larger body frame (a 170 cm man) would be expected to be associated with different neck and jaw proportions in relation to the surrounding structures. The length of the neck and mandible, as well as the volume of the tongue and soft tissue, may vary with the size and proportion of the body.[14] This suggests that gender differences will also affect the cut-off points for determining DL. Differences in airway assessment parameters with regard to gender and race are areas for future research. Expression of SMDD as a percentage of SMD was found to be a useful indicator of DL in our study. The SMDD/SMD percent may allow for the individual's proportions which are not taken into account with the use of SMD. Therefore, using the SMDD/SMD percent may have a better predictor value than SMD alone, as the figure will be adjusted for patient size.

Our results confirm that both SMD and SMDD correlate with laryngoscopic view. However, SMD and SMDD do not take into consideration the relative tongue and pharyngeal size, mandibular space, overriding maxilla, enlarged incisors, decreased temporomandibular joint mobility, or a narrow high arched palate.[1] Therefore, neither SMD nor SMDD can be used alone to predict DL. Nevertheless, measurement of SMD and SMDD can be usefully added to other preoperative airway assessment tests such as IIG, MMT, and TMD.

In a meta-analysis of bedside screening tests, a poor to moderate discriminative power was reported when any test was used alone.[15] Our results support that a combination of individual tests or risk factors add incremental diagnostic value in comparison with the value of each test alone. The AUC of ROC curve to predict DL from the multivariate regression model is 0.82. This implies that all the significant risk factors identified in multivariate analysis are important to predict DL (age, male gender, SMD, sternomental displacement, inter-incisor distance, range of neck movement $<80°$, short neck, history of snoring).

Our study has limitations. Since SMD and SMDD were tested only in the Indian population, these results may not apply to other ethnic groups. Their validity remains to be determined in another sample population.

Conclusion

A key feature of any predictive test is its ease of implementation so that it can be adopted into routine clinical practice. Both SMD and SMDD provide a rapid, simple, easy to perform, reproducible and low cost objective test of identifying patients of DL. Their predictive value improves considerably when combined with the other predictors identified by logistic regression in this study, namely, inter-incisor distance, range of neck movement $<80°$, short neck, and a history of snoring.

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Conflicts of interest

There are no conflicts of interest.

References

1. Al Ramadhani S, Mohamed LA, Rocke DA, Gouws E. Sternomental distance as the sole predictor of difficult laryngoscopy in obstetric anaesthesia. Br J Anaesth 1996;77:312-6.
2. Savva D. Prediction of difficult tracheal intubation. Br J Anaesth 1994;73:149-53.
3. Liaskou C, Vouzounerakis E, Moirasgenti M, Trikoupi A, Staikou C. Anatomic features of the neck as predictive markers of difficult direct laryngoscopy in men and women: A prospective study. Indian J Anaesth 2014;58:176-82.
4. Allahyary E, Ghaemei SR, Azemati S. Comparison of six methods for predicting difficult intubation in obstetric patients. Iran Red Crescent Med J 2008;10:194-201.
5. Merah NA, Foulkes-Crabbe DJ, Kushimo OT, Ajayi PA. Prediction of difficult laryngoscopy in a population of Nigerian obstetric patients. West Afr J Med 2004;23:38-41.
6. Türkan S, Ates Y, Cuhruk H, Tekdemir I. Should we reevaluate the variables for predicting the difficult airway in anesthesiology? Anesth Analg 2002;94:1340-4.
7. Samsoon GL, Young JR. Difficult tracheal intubation: A retrospective study. Anaesthesia 1987;42:487-90.
8. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. Br J Anaesth 1988;61:211-6.
9. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984;39:1105-11.
10. 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.
11. Naguib M, Scamman FL, O'Sullivan C, Aker J, Ross AF, Kosmach S, *et al.* Predictive performance of three multivariate difficult tracheal intubation models: A double-blind, case-controlled study. Anesth Analg 2006;102:818-24.
12. Khan RM. Airway assessment. In: Khan RM, Maroof M, editors. Airway Management. 3rd ed. Hyderabad, India: Paras Medical Publisher; 2009. p. 14-35.
13. Nichol HC, Zuck D. Difficult laryngoscopy – The "anterior" larynx and the atlanto-occipital gap. Br J Anaesth 1983;55:141-4.
14. Butler PJ, Dhara SS. Prediction of difficult laryngoscopy: An assessment of the thyromental distance and Mallampati predictive tests. Anaesth Intensive Care 1992;20:139-42.
15. 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;103:429-37.