

A PROSPECTIVE STUDY OF AIR WAY ASSESSMENT BY SIMPLE BED SIDE TEST IN INDIAN PATIENTS

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ABSTRACT: Simple bedside tests for airway assessment were performed in 500 randomly selected Indian adult patients posted for surgery. The parameters studied were Thyromental distance (TMD), Inter incisor distance (IID) Sternomental distance (STMD), Ratio of height to thyromental distance (RHTMD), Laryngeal mobility (LM) and Mallampati classification. The TMD, STMD, IID, RHTMD and LM measurements were consolidated into three groups namely normal, moderate and low scores. The airway parameters were finally co-related with the Mallampati classification. The normal range of values observed in Indian patients were TMD - 6-7cms, IID - 4.5-5.5 cms, STMD-14-15cms, RHTMD-18-22 and LM was good in 90% of patients assessed. The airway parameters of TMD, STMD, RHTMD, IID and LM in conjunction with Mallampati classification may be a useful routine preoperative screening test for predicting intubation difficulties in Indian population. **BACKGROUND AND AIMS:** Difficult airway assessment is based on various anatomic parameters of upper airway, much of it being concentrated on oral cavity and the pharyngeal structures. The diagnostic value of tests based on neck anatomy in predicting difficult laryngoscopy was assessed in this prospective, open cohort study. **METHODS:** We studied 500 adult patients scheduled to receive general anaesthesia. Thyromental distance (TMD), Sternomental Distance (STMD), Interincisor Distance (IID), Ratio of Height to Thyromental Distance (RHTMD), Mallampatti Classification (MPC), Laryngeal Mobility (LM) was calculated. The laryngoscopic view was classified according to the Cormack-Lehane Grade (1-4). Difficult laryngoscopy was defined as Cormack-Lehane Grade 3 or 4. The optimal cut-off points for each variable were identified by using receiver operating characteristic analysis. Sensitivity, specificity and positive predictive value and negative predictive value (NPV) were calculated for each test. Multivariate analysis with logistic regression, including all variables, was used to create a predictive model. **RESULTS:** Laryngoscopy was difficult in 11% of the patients. The cut-off values were: TMD ≤ 6.5 cm, STMD ≤ 15 cm, IID ≤ 3.5 cm, MPC grade 3 & 4, and laryngeal motility judged as good, restricted and nil. The laryngeal motility had highest specificity (90%), while TMD had highest specificity (85.4%). The area under curve (AUC) for the TMD, STMD, IID, LM, MPC was 0.64, 0.63, 0.61 and 0.54, respectively. The predictive model exhibited a higher and statistically significant diagnostic accuracy (AUC: 0.68, P <0.001). **CONCLUSIONS:** The TMD, STMD, RHTMD and IID were found to be poor single predictors of difficult laryngoscopy, while a model including all four variables had a significant predictive accuracy **KEYWORDS:** Thyromental distance, Sternomental distance, Inter incisor distance, Laryngeal mobility, Height to thyromental distance ratio.

INTRODUCTION: A patent airway is an essential prerequisite of safe anaesthesia. The upper airway behaves as a magical gateway for anesthetists and endoscopists. The maintenance of a patent airway is of prime concern while caring for an anaesthetized patient, especially under general anesthesia. A thorough preoperative airway assessment is crucial for effective management of patient's airway and avoiding any life threatening complications. An adequate history, thorough physical examination of the patient, clinical tests for assessments and prediction of possible airway difficulties are essential. Difficult airway is potentially catastrophic incident.^[1]

Many airway the scores have been introduced and practiced so far like Patil's score mallampati classification, Wilson's score, Cormack and Lehane score. several bedside screening tests with the most popular being the mallampati classification, mouth opening, thyromental distance, upperlip bite test and head and neck mobility are used for predicting difficult laryngoscopy/intubation.^[2,3,4,5] simple measurements namely thyromental distance (TMD), inter incisor distance (IID), sternomental distance (SMD), Ratio of height to thyromental distance (RHTMD) and the degree of laryngeal mobility (LM) were performed in 500 Indian patients. We also assessed each patient for Mallampati classification. Finally we studied each patient at tracheal intubation particularly paying close attention on glottic view, use of extra intubation aids required, laryngeal pressures.

In large retrospective study of more than 15,000 cases, incidence of failed intubation was 1/2230 surgical patients and 1/283 in the obstetric population.^[6] The difficulty of tracheal intubation has been strongly related with the direct laryngoscopic view, as classified by cormack and lehane (grade1-4).^[7] In most studies difficult laryngoscopy ranges between 1.5% and 8.5% receiving general anesthesia,^[8] in most of studies, laryngoscopy and subsequent intubation are considered difficult in patients with Cormack lehane grade 3-4, In metaanalysis ing of shiga et al, including 35 studies with total of 50,760 patients without pathologic airway anatomy, the incidence of difficult defined as cormack lehan grade >3 was 5.8% for over all patient population.^[9]

The aim of the present was to evaluate certain anatomic of neck that can be measured pre-operatively with minimal patient co-operation and to assess their diagnostic value in predicting difficult direct laryngoscopy.

MATERIALS & METHOD: 500 patients of both sexes belonging to age group 20 to 70 years posted for surgery were randomly selected. Each patient was assessed for TMD, SMD, RHTMD, IID and LM and Mallampati classification. The earlier parameters were consolidated into three categories, namely normal, moderate & low scores. The study was approved by institutional ethical board and was conducted. Patients were included in study after obtaining their written consent to participate.

1. The Thyromental distance (TMD) was measured in sitting position with full extension of neck from posterior and inferior aspect of the mentum to the thyroid notch.^[10,11]
2. Sterno mental distance (STMD) was measured from bony point of mentum to upper border of manubrium sterni with head extended and mouth closed.^[12]
3. Ratio of height to thyromental distance (RHTMD) -It was measured as ratio of TMD to height of patient.^[13]

4. Interincisor distance (IID) Inter incisor distance (IID) was measured with patient's mouth fully opened and head in full extension Measurements were taken between upper and lower incisors.
5. The Laryngeal mobility (LM) was assessed by locating the thyroid and cricoid cartilage and moving the same upwards and sideways. This will determine the mobility and ability to displace larynx posteriorly and cephalad for a good glottic view.
6. Mallampatti grading (MPC) was done in sitting position and mouth fully open.

Class 1: Visualization of the soft palate, fauces; uvula, anterior and the posterior pillars.

Class 2: Visualization of the soft palate, fauces and uvula.

Class 3: Visualization of soft palate and base of uvula.

Class 4: Visualization of only hard palate. Soft palate is not visible at all.

Preoperative measurements of thyromental distance (TMD), Sternomental distance (STMD), ratio of height to thyromental distance (RHTMD), Interincisors distance (IID), were performed in all patients by same investigator using measuring tape.

In operating room standard monitor was applied to every patient (E. C. G., pulseoximeter, and noninvasive blood pressure monitor) and vein catheter was inserted for fluid and drug administration. After preoxygenation with 100% oxygen for 3 min, anaesthesia was induced with propofol (2mg/kg) and fentanyl 2microgm/kg. Inj. Succinyl choline was given to facilitate intubation with patient in morning sniffing position. Direct laryngoscopy was done with macintosh blade (Size3/4) and laryngoscopic view was classified cormack- lehane grade. Difficult laryngoscopy was defined as inadequate exposure of glottis under direct laryngoscopy with a blade of appropriate length, without any external pressure or other manoeuvre.

The predictive value of the tests (TMD, STMD, RHTMD and IID, LM, MPC) for difficult laryngoscopy was assessed: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated for each variable. Sensitivity reflects the proportion of difficult tracheal intubations correctly predicted to be difficult, specificity shows the proportion of easy tracheal intubations correctly predicted to be easy, PPV is the proportion of predicted difficult intubations that actually proved to be difficult and NPV is the proportion of predicted easy intubations that actually proved to be easy. In addition, receiver operating characteristic (ROC) curves were used to identify the optimal cut-off point of each variable and the area under curve (AUC) was calculated to assess the prognostic accuracy of each test. Finally, multivariate analysis with logistic regression, including TMD, STMD, RHTMD and LM, IID and MPC was used to create a model predicting difficult laryngoscopy. The Hosmer-Lemeshow test was used to assess the goodness of fit in the risk prediction model.

Our hypothesis was that the anatomic features of the neck may be useful predictive markers of difficult laryngoscopy. The primary end-point of the study was the diagnostic value of TMD, STMD, RHTMD, IID, LM, MPC and of a model including all six variables in predicting a Cormack-Lehane grade ≥ 3 . The sample size of our study was based on meta-analysis of shiga et al; who reported a 5.8% (4.7-7.5%) incidence of Cormack lehane grade 3 or 4 in 50,760 patients without airway deformity.^[9] The necessary sample size was estimated for 95% confidence

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interval (CI) by use of Epi info statistical version. Statistical analysis was performed using the SPSS software and med calc. variables were tested for normality of distribution with the Kolmogorov-smirnov test. The Mann-whitney test was used for comparisons of Cormack-lehane grades.

RESULT: Data from 500 patients were analysed. Demographic features and Cormack lehane laryngoscopic view of studied population are presented in Table 1. laryngoscopic view was assessed as difficult Cormack-lehane grade 3 and 4 in 55(11%) of studied patients.

Consolidated scores of TMD were 6-7cm (83%), 5-5.5cm (13%) and less than 5cm as (1.6%) Table 2.

- Sensitivity was 35.8% and specificity was 85.4%.
- SMD cut off values were 14cm. The range of 14-16cm was found in majority of patients.
- 81.5% was the individual range. Less than 14 cm was observed in 13.5% of patients.
- Sensitivity was 36.8% and specificity was 84.4%.
- RHTMD cutoff value was >18cm. sensitivity was 88.4% and specificity 33.2%.
- IID cut off value was <3.5cm. Patients in range of 3. 5-5cm were (90%) Table 3.
- Sensitivity was 19.4% and specificity was 80%.
- LM showed good mobility in 450 patients, restricted mobility in 45 patients and nil in 5 patient. Sensitivity was 10% and specificity was 90% Table 4, Graph 1.
- MPC classification was grade 1 in 76% patients, 19.2% had grade 2, 4 and. 8% patients had grade 3 and 4. Table 5, Graph 2.
- Sensitivity was 22% while specificity was 76%.

Patient Characteristics	Value (mean+_sd) n%
Gender: male/female	235 / 265
Age (years)	50±18
Height (cm)	169±9
Body weight	75±15
BMI	26±4
Cormack-lehane (CL) grade 1	345(69%)
Cormack-lehane (CL) grade 2	100(20%)
Cormack-lehane (CL) grade 3	45(9%)
Cormack-lehane (CL) grade 4	10(2%)

Table 1

Thyro Mental Distance (T. M. D.)									
Group	4 cm	4.5 cm	5 cm	5.5 cm	6 cm	6.5 cm	7 cm	7.5 cm	Total %
No. of Patients	1	7	23	42	96	213	106	12	
%	0.20%	1.40%	4.60%	8.40%	19.20%	42.60%	21.20%	2.40%	100%

Table 2

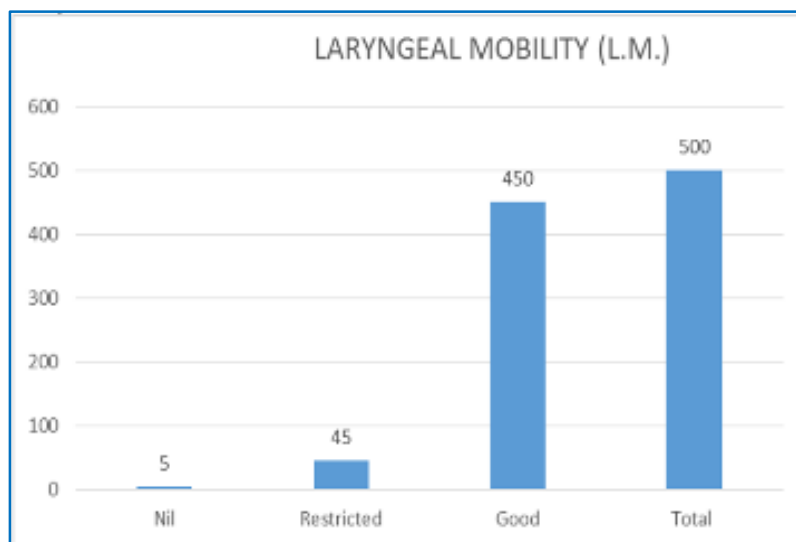
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INTER INCISSIOR DISTANCE (I. I. D.)									
Group	2.5cm	3 cm	3.5cm	4 cm	4.5cm	5 cm	5.5cm	6 cm	Total %
No. of Patients	5	5	22	65	139	250	9	6	
%	1.00%	1.00%	4.40%	13.00%	27.80%	50.00%	1.80%	1.20%	100%

Table 3

LARYNGEAL MOBILITY (L. M.)				
Group	Nil	Restricted	Good	Total
No. of Patients	5	45	450	500
%	1%	9%	90%	100%

Table 4

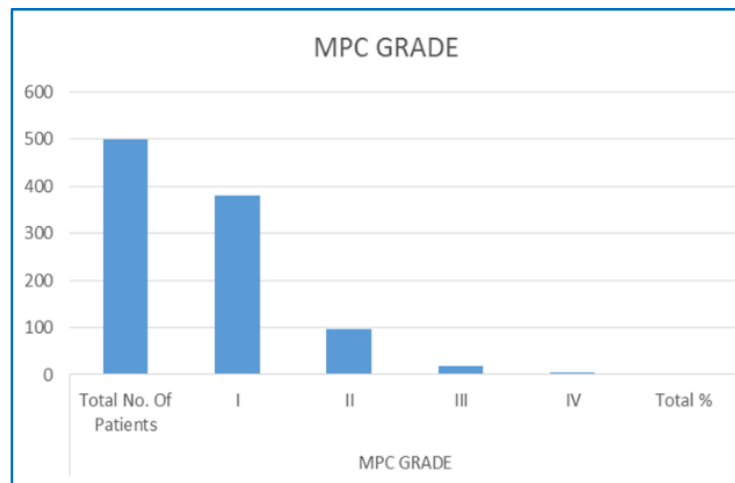


Graph 1

MPC GRADE					
Total No. Of Patients	I	II	III	IV	Total %
500	380	96	19	5	
%	76.00%	19.20%	3.80%	1.00%	100%

Mallampatti classification was performed in all cases (n= 500)

Table 5



Graph 2

Normal thyromental distance (TMD) observed was 6–7 cms in 83% cases, 5–5.5 cms in 13% cases and 4-4.5 cms in 1.6 % cases. The inter incissor distance was 4.5-5.5 cms in 79.6% cases, 3.5-4.5 cms in 17.4 % cases, 2.5-3 cms in 2% cases. Majority of cases were in the range of 4.5-5.5 cms. The Laryngeal mobility was graded as good meaning completely free, restricted and nil meaning no mobility. LM was good in 90% cases, restricted in 9% cases and nil in 1% cases. Table 6.

CO-RELATION OF MPC WITH AIRWAY PARAMETERS				
Score	TMD (%)	IID (%)	LM (%)	MPC
Normal	6-7 cms	4.5-5.5 cms	90%	I
	83%	79.60%	Normal	
Moderate	5-5.5 cms	3.5-4.5 cms	9%	II
	13%	17.40%	Restricted	
Low	4-4.5 cms	2.5-3 cms	1%	II, III, IV
	4.00%	3%	Nil	

Table 6

Specificity and sensitivity are given in Table 7 for all above parameters, Optimal cut-off points of TMD, SMD, RHTMD, IID, LM, MPC are mentioned in Table 7. Sensitivity, specificity, NPV, PPV values are mentioned in this Table 7.

RHTMD shows highest sensitivity and NPVvalue. Statistical significance ($p < 0.05$) was found in this study.

All tests had low PPV value and high NPV. Astatistical significance (< 0.05) was found for diagnostic accuracy of TMD, STMD and RHTMD. The inclusion of TMD, STMD, RHTMD improved the prognostic value of model, although none of the variables was significant as an independent prognostic factor.

Predictive Test	Cut-off value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUC mean (95% CI)	p-Value
TMD	<6.5cm	35.80%	85.40%	23.9	89.4	0.64	0.0038 (*)
STMD	<15cm	36.80%	84.40%	21.4	89.2	0.63	0.0024 (*)
RHTMD	>18cm	88.40%	33.20%	16	94.2	0.61	0.0094 (*)
IID	<3.5cm	60.00%	45.00%	12.4	86	0.54	0.3846
(*) Statistical significance for $p < 0.05$, TMD - Thyromental distance, STMD - Sternomental distance, RHTMD - Ratio of height to Thyromental distance, IID - Interincisor distance, PPV - Positive predictive value, NPV - Negative predictive value, AUC - Area under curve indicating diagnostic accuracy of each test.							
Table 7							

DISCUSSION: Several scores and classifications have been introduced for airway assessment so that the anesthetist can predict a difficult airway so as to reduce the morbidity and mortality associated with a difficult airway. Savva D in his study of 352 patients undergoing surgery used Mallampati classification and other parameters like thyromental distance and sterno mental distance, forward protrusion of mandible and inter incisor gap with the mouth fully open.^[14] Also Frerk et al proposed that combined thyromental distance and modified Mallampati classification would predict majority of difficult intubations. They showed that patients with MPC grade 3 or 4 with Thyro mental distance of less than 7cm were likely to present difficulty at intubation.^[15]

Ayoub et al have studied TMD with Cormack lehane grades and MPC score with a cut off value of ≤ 4 cm and MPC grade III/IV as difficult glottic view. They found that cutoff value of 4cm discriminates best between the easy and difficult glottic visualizations.^[16] In our study we found that thyromental distance of ≤ 4 cm correlated with MPC grades 3 and 4.

Tse JC et al,^[17] in prospective blind study in a relatively large patient group concluded that Mallampati classification, neck extension and Thyro-mental distance were not reliable in predicting difficult intubation. The study however does not include laryngeal mobility and fails to evaluate the effect of age and sex on the airway parameters.

In a double blinded study by Iohom G et al, involving 212 adult patients of both sexes, the thyromental and sterno mental distances (SMD) along with Mallampati score were assessed and laryngoscopic view were graded according to Cormack, Lehane grading. They concluded that the TMD and SMD in conjunction with Mallampati class may be a useful routine screening test in predicting difficult intubation.^[18]

Patil et al study shows the normal TMD as ≥ 6.5 cms or greater. In our study group of 500 randomly selected patients undergoing tracheal intubation it was found that 83% of the total had a TMD of 6-7 cm and all had an MPC class I.13% of patients had a TMD of 5.0-5.5 CM and their MPC class was II and fewer as low as 1.6% had a TMD between 4.0-4.5 cm with an MPC of III and or IV. In patients with TMD <6cms laryngoscopy and intubation was difficult but possible.

TMD 6.0-6.5 with MPC I, however did not have any difficulties at laryngoscopy and intubation. These patients also did not happen to possess any other anatomical abnormalities.

Our low score TMD <4cms posed significant difficulty at laryngoscopy and required stylet and MAC 3 laryngoscopy blade for intubation, assisted with excessive laryngeal pressure in backward and cephalad direction.

The inter incisor distance (IID) was measured with the patient's mouth fully open and with head in full extension. Measurements were taken between upper and lower incisors in central position, however in cases of protrusion of incisor it was measured vertical to lower incisor.

The inter incisor distance shows whether the mouth opening is adequate or not and the function of temporomandibular joint which is essential for laryngoscopy. In our study normal IID was 4.5–5.5 cms and moderate 3.5-4.5 cms and low score was at 2.5-3.5. In moderate group mouth opening was restricted most of the patient's were gutka, mava, tobacco chewers which results in submucous fibrosis causing restriction of mouth opening In low score group most of them had arthritis, fracture mandible, short mandibular ramus, burn scar in and around mandible tumors, muscular spasms and lock jaw.

THE Laryngeal mobility (LM): It was assessed by locating the thyroid and cricoid cartilages and move the structures sideways and cephalad to determine whether the structures are mobile and able to displace larynx posteriorly and cephalad to improve the glottic view. LM was normal in 90% of patients, restricted in 9% and nil mobility in 1%. This will indicate movement of larynx during intubation for proper view of the glottis. This shows an ability to use BURP (Backward, upward, right & posterior movement of larynx).

We found that model including TMD, STMD, RHTMD, had significant predictive accuracy for difficult laryngoscopy. Among the studied tests, the RHTMD had the highest sensitivity and the highest NPV, while TMD had the highest specificity and PPV. Except for RHTMD, the rest of the tests had a low sensitivity, while all of them had a low PPV and a high NPV, in agreement with existing literature.^[19] Theoretically, a perfect predictor is characterized by high sensitivity and high specificity; thus, a high diagnostic accuracy, in order to identify almost every patient at risk with minimal false positive predictions. In clinical practice, anesthesiologists are mostly concerned for the unanticipated difficult airway (False negative prediction), which may find that unprepared. On the other hand, false positive prediction, although disturbing, distressing and inconvenient, have no life threatening sequelae. Consequently, the most significant clinical problem is the false negative predictions, thus intubations predicted to be easy, proved to be difficult later. Sensitivity and NPV are statistical measures of a test performance incorporating the false negative predictions in their calculation formula. Among the tests studied, the above mentioned characteristics apply best to RHTMD as a single predictor of difficult laryngoscopy.

The incidence of difficult laryngoscopy did not differ between men and women; but, it was relatively high,^[4] possibly because the laryngoscopic view was assessed without application of any external manoeuvres. Nevertheless, similarly high frequencies of difficult laryngoscopy - exceeding 10% - have been reported by other investigators as well.^[19,20,21]

The optimal cut-off point we found for TMD in the whole sample is similar to that reported in previous studies.^[22] Nonetheless, such morphometric measurements may be affected by racial characteristics, and small differences in cut-off points are found among studies conducted in different populations.^[23] TMD has been found to be both sex and age dependent,^[24] while some investigators have used different cut-off points in males and females.^[25] In line with these, we also found that TMD values and cut-off points differed significantly between the genders. We also found that TMD is a poor predictor of difficult laryngoscopy. Our results confirm the suggestion of other investigators,^[24,25] that TMD is not accurate enough to be used as a sole predictive test of difficult laryngoscopy.

The mean value and optimal cut-off point of STMD in our studied sample are similar to those reported by Kim et al. in Korean patients.^[12] On the other hand, lower cut-off points (13-13.5 c) were calculated or used in other studies.^[3,4] As with TMD, the different racial characteristics may-at least partly-account for the different results. Notably, we also found significant differences in STMD values and cut-off points between the genders. The use of the gender-specific cut-off points resulted in a higher-but still poor-predictive accuracy of STMD in men. Despite population- and gender-related differences, our findings indicate that the STMD is a test of limited predictive accuracy when used alone, as reported by other investigators well.^[3,4,12]

The best cut-off point for RHTMD in the whole sample and also in male patients was lower than the previously reported values (21-25).^[26,27] On the other hand, the optimal cut-off value in women was in the aforementioned range.^[27] Because RHTMD is height dependent, the significant differences in height among races probably account for the different values reported in the literature with regard to diagnostic accuracy; RHTMD was not found to be superior to the other studied parameters according to the AUC. Also, the use of different cut-off points in males and females did not improve the predictive accuracy of the test in either gender and thus offered no benefit. Compared with the other tests, we found that RHTMD was the most sensitive in predicting difficult laryngoscopy, but had a low specificity and PPV. Similar findings regarding the predictive value of the test have been reported by other investigators too.^[19,20,27] The RHTMD has been found to be comparable with the upper lip bite test,^[27] in predicting difficult intubation, and superior to the modified Mallampati test,^[19,27] TMD, mouth opening and neck movement.^[19] According to the existing literature, the bedside tests are considered poor predictors of difficult intubation, especially if each of them is used alone.^[9]

Based on the AUC, we also found a relatively poor diagnostic accuracy for the TMD, STMD, RHTMD and IID. The model incorporating all four variables achieved a moderate to fair diagnostic accuracy, which - as expected - was higher than each test alone.

The studied anatomic features of the neck: TMD, STMD, RHTMD and IID were found to be relatively poor single predictors of difficult laryngoscopy. Finally, a model including all four variables exhibited a statistically significant predictive accuracy, and may possibly represent a helpful alternative in patients unable to perform properly the other tests that require patient cooperation.

It should also be noted that the variables we studied exhibit better inter-observer reproducibility than other tests, such as head-neck mobility, which are characterized by high inter-rater variability and thus reduced predictive reliability,^[28] especially in poorly cooperating

patients. In the present study, in order to eliminate any bias from inter-observer variability, a single investigator performed all the pre-operative measurements.

A limitation of the study is that laryngoscopy was undertaken by different anaesthesiologists. Nevertheless, only experienced anaesthetists were involved in order to limit the possibility of systematic error in our results. Furthermore, the incidence of difficult laryngoscopies was comparable among them. Another limitation of the study, although inevitable in studies investigating anthropometric features, is that possibly our results should be interpreted and extrapolated with caution to populations with significantly different morphological characteristics.

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