Comparison of acromio-axillo-suprasternal notch index with upper lip bite test and ratio of height to thyromental distance for prediction of difficult intubation: a prospective study

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Preoperative evaluation of airway helps anaesthesiologists to make a strategy to secure airway to prevent life-threatening complications. The aim of the study was to compare the acromio-axillo-suprasternal notch index (AASI), the ratio of height to thyromental distance (RHTMD) and the upper-lip-bite test (ULBT) to predict difficult laryngeal visualization preoperatively.

Method: A total of 240 adult patients in American Society Anaesthesiologist physical status (ASA) I and II requiring general anaesthesia for routine surgery were enrolled. The airway was evaluated on the acromio-axillo-suprasternal notch index (AASI), upper lip bite test (ULBT), and the ratio of height to thyromental distance (RHTMD) for all enrolled patients. An experienced anaesthesiologist, not aware of the recorded preoperative airway evaluation, performed the laryngoscopy and laryngoscopic view was graded as per Cormack and Lehane classification. Primary objective was to assess the efficacy of AASI for prediction of the difficult airway. Secondary objective was to compare it with the RHTMD and ULBT.

Results: Difficult visualization of the larynx (DVL i.e: Cormack Lehane III and IV) was observed in 33 patients. Higher sensitivity 93.94%, specificity 97.58%, PPV 86.1 %, diagnostic accuracy (97.08%) with low false positive (5) was for AASI as compared to the ULBT with the sensitivity of 42.4%, specificity of 87.7%, PPV 35% and diagnostic accuracy 81.25% and the corresponding value for the RHTMD was 75.76%, 47.34%, 18.66% and 51.25% respectively. Thus suggest, AASI to be superior to the RHTMD and the ULBT in the prediction of difficult visualization of the larynx. The area under the curve for the receiver operating curve (AUC of ROC) of AASI (0.965, 95%CI=0.93-0.98; p=<0001) was significantly higher than the ULBT and RHTMD (0.720, 95% CI =0.658-0.776; p=<000.1) and (0.576, 95% CI,0.511-0.639;p=<0.133) further, testify AASI to be superior to RHTMD and ULBT in the prediction of difficult intubation The best cut-off value for the AASI>0.49cms, RHTMD< 21cms and for ULBT>2 were endorsed for predicting difficulty in endotracheal intubation

Conclusion: Preoperative assessment valueof AASI >0.49was found to be a good and reliable predictor for difficult visualization of the larynx.

Keywords: Difficult intubation; airway assessment tests; acromio-axillo-suprasternal notch index; upper-lip bite test; ratio of height to thyromental distance

Introduction

Unanticipated difficult or failed intubation put anaesthesiologists in a scary situation of life-threatening complications such as hypoxic brain damage and death.[1] Preoperative prediction of difficult laryngoscopy thus plays a paramount role in airway management as proper planning and strategies may decrease the morbidity or mortality.[2,3]

Acromio-axillo suprasternal notch index (AASI)[4] is an easy to perform bedside test for predicting difficulty in intubation. But little data is available comparing the AASI with other indices. Upper lip bite test (ULBT) and the ratio of height to thyromental distance (RHTMD) are claimed to have high predictability.[5,6] Therefore the aim of this study was to evaluate the

efficacy of AASI for assessing difficult laryngoscopy as an objective and comparing AASI with RHTMD and ULBT as a secondary objective.

Method

After approval from the hospital ethics committee, 240 consenting adult of ASA class I and II and in the age range from 20 to 65 years of either sex, scheduled for routine surgery under general anaesthesia were enrolled in this prospective observational study during the period of June 2015 to May 2016. Patients with upper airway deformity, recent head and neck surgery, ASA class III and IV, and BMI ≥ 30 were excluded. Preoperatively each patient's airway was evaluated on AASI, ULBT and RHTMD.

Taking the observed sensitivity of UBLT, RHTMD and AASI for identifying DVL as 52.38%, 38.10%, and 66.67% respectively, and their specificity was 85.98%, 77.34%, and 98.44% respectively with prevalence DVL as 18.43%.[7] The estimated sample size with the desired precision of 15% and 5% level of significance was 234 patients. To reduce the margin of error, the total sample size of 240 was taken.

Calculation of AASI[4]-(Figure 1)

With the patient in a supine position and arms by the sides of the body, the AASI was calculated

(1) Using a scale, vertical Line A was drawn from the top of the acromion process to the upper border of the axilla at the pectoralis major muscle.
(2) Horizontal Line B was drawn from supra-sternal notch to meet line A and
(3) The Line C will be part of line A that lies above the point at which line B meet line A

So, AASI is a ratio of the length of line C to Line A (AASI = C/A)

Measurement of RHTMD-

The patient in a supine position and arms by the sides of the body with head extended, thyromental distance (TMD) was measured from the centre of the mentum to thyroid notch. Then the ratio of the height of patient to TMD will be RHTMD.

Figure 1: Measurement of Acromio-Axillo-Sternal notch index
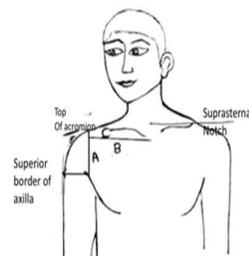
LINE A: From top of acromion to Superior border of axilla
LINE B : perpendicular line from suprasternal notch on Line A
LINE C: Portion of line A above where line B intersects on line A

Measurement of ULBT-

With patient either in supine or sitting position and arms by the sides of the body: ULBT is classified Class 1-the lower incisors can touch the upper lip above the vermilion line. Class II-lower incisors could touch the upper lip below the vermilion line. Class III-lower incisors could not bite the upper lip.

General anaesthesia was induced as per standard departmental protocol. Direct laryngoscopy was performed by an anaesthesiologist with a minimum of 3 years clinical experience who was also blinded to preoperative airway indices, with head in sniffing position, using appropriately sized Macintosh blade. The best laryngoscopy view was noted according to the Cormack – Lehane (CL)grading system. Grade I = full glottis view; Grade II = glottis partly visible, anterior commissure not visualized; Grade III = only epiglottis is visible; Grade IV = no epiglottis visualized.

Visualization of C-L Grades I and II was inferred as an easy visualization of the larynx (EVL) and C-L Grades III and IV as DVL. The DVL is synonymous with difficult intubation during laryngoscopy.[3]

If difficult intubation was encountered in the first attempt, intubation was then attempted with adjustment of external laryngeal pressure, the number of attempts, or any other method adopted to intubate was recorded. If airway could not be secured in 3 attempts, it was considered as failed intubation.

Patient data were recorded as mean ± SD. Quantitative variables were compared using the

T-test/Mann Whitney test between DVL and EVL. The diagnostic test was done to calculate the sensitivity and specificity of UBLT, RHTMD and AASI. McNemar test was used to compare the sensitivity and specificity of AASI with UBLT and RHTMD. The area under the receiver operating curve (AUC of ROC) was used to find cut off point and to compare AUC of UBLT, RHTMD, and AASI for predicting difficult visualization of laryngoscopy. A p value of <0.05 was considered statistically significant. The data was analysed using Statistical Package for Social Sciences (SPSS) 21.

Results
A total of 240 patients of both sexes (53.3% were males) requiring endotracheal intubation for general anaesthesia were analysed. DVL was observed in 33 (13.7%) patients in our study. The demographic characteristics based on Cormack-Lehane's view on direct laryngoscopy of patients showed no statistical difference in EVL and DVL. DVL was best assessed by AASI and ULBT. Such association was not observed with RHTMD (p value= 0.57)
(Table1). There was no failed intubation, however, in 8 patients (3.33%) intubation was done with videolaryngoscope.

Table 1: Patient characteristics and relation with Cormack-Lehane grade

	AASI	ULBT	RHTMD
Sensitivity 95%CI	93.75 [77.97-99.26]	50.14 [29.48-70.79]	75.76 [17.74-68.9]
Specificity 95% CI	98.7 [94.7- 99.21]	87.7 [82.14-91.4]	47.34 [50.38-84.38]
PLR 95%CI	3889 [16.29-92.85]	338 [1.98-5.77]	144 [1.14-1.81]
NLR 95%CI	6.0 [0.02-0.24]	63 [0.49-0.89]	51 [0.49-0.89]
PPV 95%CI	86.1 [70.5-95.3]	35 [20.63-51.68]	18.66 [12.45-26.3]
NPV 95% CI	99.02 [96.5-99.88]	90.5 [85.67-94.18]	92.45 [85.67-96.69]
Diagnostic accuracy	97.08%	81.25%	51.25%
TP	31	14	25
TN	202	181	98
FP	5	26	109
FN	2	19	8

Data is presented as n (%) or mean ± standard deviation EVL- easy visualization of the larynx; DVL- difficult visualization of the larynx; BMI – body mass index; CL – Cormack – Lehane grading. AASI – acromio- axillo- suprasternal notch index; RHTDM- ratio of height to thyromental distance; ULBT- upper lip bite test;

ASA- American society of Anaesthesiologists physical status classification

In our study, AASI was observed with the highest predictive values. ULBT with a sensitivity of {50.4[29.48-70.79]} and specificity {87.7[82.14-91.4]} was better than RHTMD. RHTMD had the least sensitivity and other predictive values. (Table 2)

Table 2: Predictive values for AASI, ULBT and RHTMD to predict DVL on C-L grade

	Total	CL		P value
		Easy	Difficult	
Gender				
MALE	128 (53.33%)	111 (53.62%)	17 (51.52%)	0.822
FEMALE	112 (46.67%)	96 (46.38%)	16 (48.48%)	
AGE (years)	39.02 ± 14.68	38.61 ± 14.57	41.58 ± 15.35	0.275
WEIGHT (Kg)	59.25 ± 14.14	58.76 ± 14.02	62.33 ± 14.74	0.337
HEIGHT (cm)	159.05 ± 8.66	158.99 ± 9.02	159.46 ± 6	0.198
BMI (kg/m²)	23.48 ± 5.46	23.28 ± 5.28	24.76 ± 6.38	0.371
AASI	0.40 ± 0.96	0.38 ± 0.08	0.55 ± 0.05	<.0001
RHTMD	20.96 ± 3.18	21.09 ± 3.25	20.12 ± 2.57	0.157
ULBT	1.95 ± 0.62	1.88 ± 0.6	2.42 ± 0.5	<.0001
ASA 1	162 (67.15%)	139 (69.7%)	23(69.7%)	
ASA II	78 (32.85%)	68 (32%)	10 (30.3%)	0.77

AASI :acromio-axillo-suprasternal notch index; ULBT: upper lip bite test; RHTMD: ratio of height to thyromental distance; PLR: positive likelihood ratio; NLR: negative likelihood ratio; PPV: positive predictive value; NPV: negative predictive value; TP: true positive; TN: true negative; FP: false positive; FN: false negative; CI: confidence internal

Table 3: Comparison of area under curve ROC of AASI, ULBT, RHTMD

	Area under the ROC curve	P value	Cut-off
AASI 95%CI	0.965± 0.213 0.933- 0.98	<0.0001	>0.49
ULBT 95%CI	0.7202 ± 0.0365 0.65-0.78	<0.0001	>2
RHTMD 95% CI	0.576±0.051 0.511-0.699	0.133	<21

Figure 2: Receiver operating curve for AASI in prediction of difficult laryngoscopy
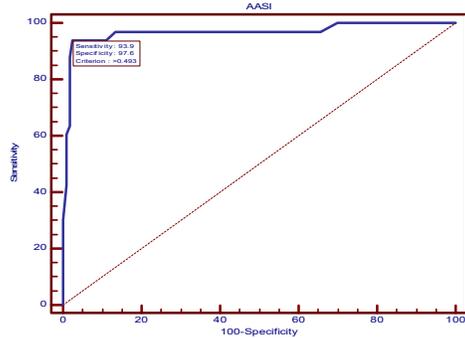

Figure 3: Receiver operating curve for ULBT in prediction of difficult laryngoscopy.
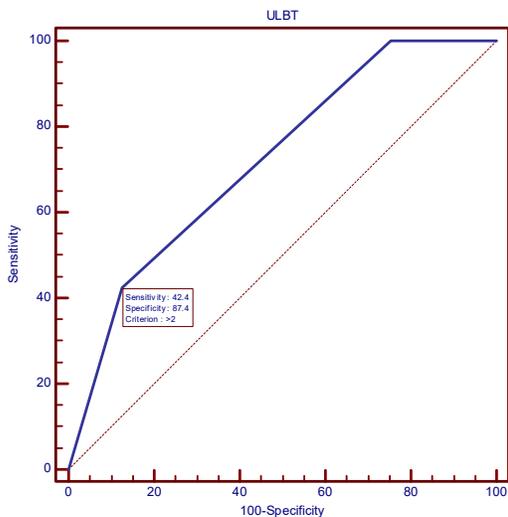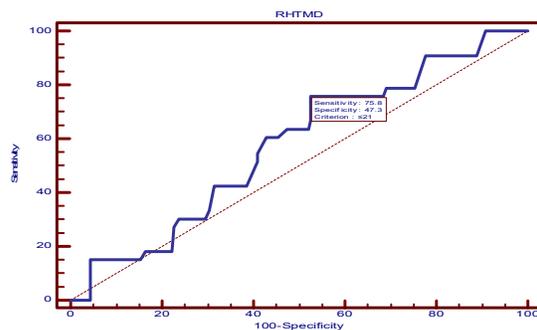

Figure 4: Receiver operating curve for RHTMD in prediction of difficult laryngoscopy

Similarly, the area under ROC for AASI was statistically higher as compared to RHTMD and ULBT.The best cutoff points for predicting difficulty in endotracheal intubation observed as for AASI > 0.49, RHTMD < 21cm, ULBT > grade 2 (Table 3, Figure 2,3,4).

Discussion

To minimize the risk of complications associated with a difficult airway, the screening test should be easy to perform and should have high sensitivity, specificity and high positive predictive values, and low false-positive value. Despite various tests available, none can correctly predict difficult intubation with 100% accuracy.

Although difficulty in laryngoscopy was found in 13.7%, there was no failed intubation in our study. However, in 3.33% patients video laryngoscope was used for intubation. Twenty-three patients required external laryngeal pressure and ten patients needed external laryngeal pressure plus stylus for successful intubation.

The incidence of difficult laryngoscopy reported in various studies range from 1.3%, to 13%.[8,9,10] This variation could be due to the lack of uniformity in grading laryngoscopy views, inter-observer error and available facilities.

Thirty-three patients, who had CL grade IIIand IV (DVL), AASI with value > 0.49 correctly predicted difficulty in 31 patients (true positive), RHTMD <21c min 25 patients where as ULBT grade III could predict difficulty in intubation in14 patients only. Thus, suggesting a strong correlation of higher AASI value with difficult intubation. AASI had PPV of 86.11% and PLR of 3869 further endorse this that AASI>0.49has a statistically higher ability to predict difficult intubation. Again, the accuracy of AASI was found to be higher than the other tests, which again testifies that the AASI carries lower false positives in predicting a difficult laryngoscopic view.

High sensitivity and specificity of AASI were consistent with the result of previous study.[4] Sensitivity and specificity in our study was higher than that in the original study and it could be the result of variation in the measurement.

ULBT has been inferred as a simple and useful predictor of difficult intubation.[11] A high diagnostic accuracy (81.5%), and low false-positive testifies that ULBT could reasonably be a good bedside test for prediction of difficult intubation. Our result for ULBT was comparable to some previous studies.[11,12] However,

ULBT has some limitation as to the inability of the patient to understand how to perform correctly and variation in cranio facial configuration among the population.[13]

In our study, sensitivity (75.6%) and specificity (47.34%) of RHTMD was in concurrence with other studies.[14,15] The low specificity and PPV of RHTMD, in our study, can be explained by a large number of false-positive cases (109 out of 240). Assessment done by RHTMD depends on the patients' thyromental distance and the height, so the cut-off point may vary with the ethnicity and inter-observer error while measuring.

In our study, patients who had AASI<0.49cms proved that the chances of difficult intubation were very low. Thus, higher NPV of AASI in our study suggests that the test correlated well with the ease of laryngoscopy and adequately eliminated patients with difficult intubation. ULBT with a specificity of 87% showed that ULBT I and II can also be a good predictor of easy intubation. On comparing, unlike AASI and ULBT, RHTMD had the least correlation with the laryngeal view.

The results of our study validate the superiority of AUC for AASI over ULBT and RHTMD for its efficacy in predicting difficult laryngoscopy. AUC of ROC for AASI (AUC =0.89) was large as documented in the original study.[7] We observed the best predictive cut-off point for predicting difficulty with endotracheal intubation for AASI as >0.49cms, RHTMD<. 21cm, ULBT >2. AASI value of less than 0.49cms is regarded as EVL and value more than 0.49cms is taken as criteria for DVL.

The limitation of our study was that it included non-obese adult north Indian population, so may not be reliable for other populations because of ethnic variation. Also, further studies with bigger sample size and also studies using AASI in comparing alone and in combination with other tests of airway assessment viz, sternomental distance, neck circumference, hyomental distance is needed to establish the usefulness of AASI in predicting the difficult airway.

Conclusion

AASI with high sensitivity, specificity, predictive value, and low false negativity, is a sensitive, easy bedside test to identify a difficult airway in the normal adult population for surgery under general anaesthesia especially when the cut off >0.49.

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