Original Article

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Role of Acromioaxillosuprasternal Notch Index (AASI) as a New Predictor of Difficult Visualization of Larynx in Comparison with Modified Mallampati Test

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Abstract

Background: Pre-operative airway assessment should be able to predict potential difficult airway, allowing management plan to be developed ahead of time. Hence this study was aimed to compare Acromio-Axillo-Suprasternal Notch Index (AASI), a new simple bedside test with Modified Mallampati Test (MMP) in predicting difficult visualization of larynx.

Materials and Methods: After ethical committee clearance and informed written consent, 320 patients of ASA I and II posted for elective surgery under general anaesthesia were included in this study. AASI and MMP were noted during preanaesthetic airway assessment. After induction of anaesthesia, a blinded and experienced anaesthetist did laryngoscopy, intubated the patient and noted Cormack-Lehane(CL) grading of laryngeal view. The data observed was analysed using Receiver operating characteristic curve(ROC) analysis to compare AASI and MMP. A P value less than 0.05 was considered statistically significant.

Results: Incidence of Difficult Visualization of Larynx(DVL) in our study was 8.4%. AASI had better Sensitivity(88.89% v/s 22.22%), Specificity(98.63% v/s 95.22%),Positive predictive value (85.71% v/s 26.32%), Negative predictive value (98.97% v/s 93%) and Diagnostic accuracy(97.81% v/s 89.03%) in comparison with MMP respectively (P <0.001) when cut off reference value of 0.56 AASI was taken.

Conclusion: AASI is a better predictor of difficult laryngoscopy with a higher sensitivity and positive predictive value in comparison with MMP. Hence AASI can be used as a simple bedside test to predict difficult airway during pre-anaesthetic airway assessment.

Keywords: Acromioaxillosuprasternal notch index (AASI); Modified Mallampati test (MMP); Cormack-Lehane (CL) grade; Difficult visualization of larynx (DVL); Airway assessment.

Introduction

Maintenance of a patent airway and successful intubation is the primary responsibility of an anaesthesiologist[1] and poses challenges to conduct a safe anaesthesia. Nearly 50-75% of cardiac arrests in patients undergoing general anaesthesia are because of difficult intubation that causes inadequate oxygenation or ventilation, out of which 55-93% of them can cause death.[2,3] Hence one-third of anaesthesia related deaths have been related to inability to maintain a patent airway.[4]

Incidence of difficult laryngoscopy or intubation has been reported to be in the range of 0.1- 20.2%.[5-12] This wide variation is due to different patient

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demographic characters and tests used to assess airway. The purpose of the preoperative airway assessment should therefore be able to predict potential problems which might be encountered in the operating room, allowing a management plan to be developed ahead of time.[12]

Several preoperative airway assessment tests such as Inter-Incisor Gap(IIG), Modified Mallampati Test(MMP), Head and Neck Movements(HNM), Horizontal Length of Mandible(HLM), Sternomental Distance(SMD), Thyromental Distance(TMD), Upper Lip Bite Test(ULBT) etc have been used to predict difficult intubations, but sensitivity and positive predictive value of these individual tests are low (33%-71%) with higher false positive results.[12]

Acromio-Axillo-Suprasternal Notch Index [AASI] a new and simple bedside test introduced by Md Kamranmanesh[13] is claimed to have higher sensitivity, specificity and predictive values than Modified Mallampati Test (MMP). Hence this study was designed to evaluate the validity of the new test AASI in prediction of difficult visualization of larynx in our population and compare it with routinely used MMP.

Materials and Methods

After ethical committee clearance and informed written consent, 320 consecutive patients of ASA I and II aged between 18 to 55 years scheduled for elective surgery under general anaesthesia were included in this prospective double blind observational study in the hospitals attached to Bangalore Medical College and Research Institute. Patients not giving consent, history of burns/trauma involving head and neck, airway surgeries, tumor/mass in the neck or airway, restricted mobility at neck and mandible, edentulous, patients requiring awake or rapid sequence intubation, pregnant females, obese patients(BMI >35), ASA III and IV patients were excluded from this study.

During routine pre anaesthetic check up, AASI and MMP were assessed. AASI was calculated with the patients lying in a supine position and their upper extremities resting on the sides of the body, based on the following measurements. (1) Using a ruler, a vertical line is drawn from the top of the acromion process to the superior border of the axilla at the pectoralis major muscle(line A); (2) A second line is drawn perpendicular to line A from the suprasternal notch (line B); (3) The portion of line A that lies above the point where line B intersects it is line C[13].AASI was calculated by dividing the length of line C by that of line A(AASI=C/A).

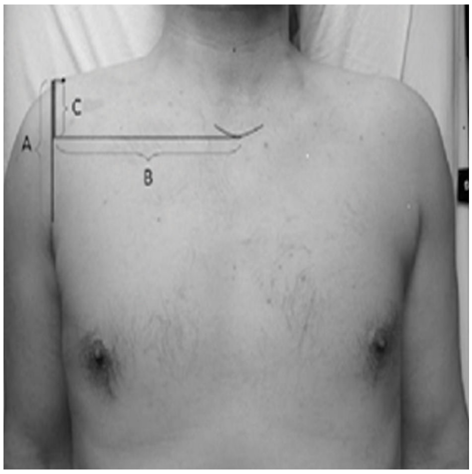

Fig. 1: Method for measuring the AASI. A represents the vertical distance between the superior aspect of the acromion process and superior border of axillary area, B the perpendicular line from suprasternal notch to line A, and C the portion of line A that lies above the cross-section between lines A and B. AASI is defined as C divided by A (AASI ¼ C/A). AASI ¼ acromioaxillosuprasternal notch index.[13]

MMP score was assessed with the patients in sat up position with a fully protruded tongue without saying “ah” and graded as follows, class I= soft palate, fauces, uvula and tonsillar pillars were visible, class II= soft palate, fauces and uvula were visible, class III = soft palate and base of uvula were visible, and class IV = soft palate not visible[11].

After shifting the patient to operation theatre on the day of surgery, an intravenous (IV) line was secured and Ringer lactate was kept on flow. Standard monitors like pulse oximeter (SpO2), Non-Invasive Blood Pressure (NIBP) and Electrocardiogram (ECG) were connected and baseline parameters were recorded.

All patients were premedicated with Glycopyrolate 0.2mg, midazolam 1 mg and fentanyl 2 mcg/kg iv. After pre-oxygenation with 100% oxygen for 3 min patients were induced with propofol 2 mg/kg and paralysed with vecuronium bromide 0.1 mg/kg iv.

After ventilating for 3 minutes with 1% sevoflurane in oxygen and with patient’s head in the sniffing position, direct laryngoscopy was performed by a blinded and experienced anaesthesiologist with Macintosh blade size 3 and Cormack Lehane grade(CL grade) was noted as follows : Grade 1 – visualization of the entire glottis aperture, Grade 2 – visualization of only the posterior aspects of the glottic aperture, Grade 3 – visualization of the tip of the epiglottis, Grade 4 –visualization of no more than the soft palate[14]. CL grades 1 and 2 were considered as “Easy visualization of larynx”(EVL) and grade 3 and 4 as

"Difficult visualization of larynx"(DVL). If where the first intubation attempt was failed/difficult, intubation was reattempted with Macintosh blade size 4 with external laryngeal manipulation and they were excluded from the study.

After endotracheal intubation further anaesthetic management was continued as per institutional standard practice. Vital parameters were observed throughout the procedure at regular intervals.

Based on the sensitivity of 78.9% in the previous study done by Kamranmanesh et al[13], keeping the power at 80% and alpha error of 5% a sample size of 320 was calculated using the suitable formula. Hence 320 patients were included in the study.

Statistical evaluation of data was done by SPSS software version.[16] Chi-square test or Fischer's exact test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. ANOVA (Analysis of Variance) was used as test of significance for quantitative data. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were calculated. Data observed was analyzed using Receiver operative characteristic (ROC) curves and Area under the Curve (AUC) was used to assess whether the score was clinically useful. A P value of <0.05 was considered statistically significant.

Results

Our study involved 320 patients with equal gender distribution and none of the patients were excluded. There were 271 (84.69%) ASA I and 49(15.31%) ASA II patients.

Table 1 shows the demographic characteristics of the study population including gender, age, height, weight and BMI which didn't bear any statistical significant impact on occurrence of Easy/Difficult Visualization of Larynx.

Table 1: Patients characteristics.

Variables	EVL	DVL	P value
Gender			
Male (160)	142	18	0.07
Female (160)	151	9	
Age (yrs)	36.74±9.89	38.48±11.79	0.39
Height (cm)	160.7±7.1	161.2±8.6	0.72
Weight (kg)	69.7±12.8	74.3±18.3	0.31
BMI (kgm^{-2})	25.71±2.73	26.37±3.20	0.23

The Area under the Curve of ROC curve was calculated for both AASI and MMP and found that AASI had higher AUC of 0.98 when compared to 0.60 of MMP.

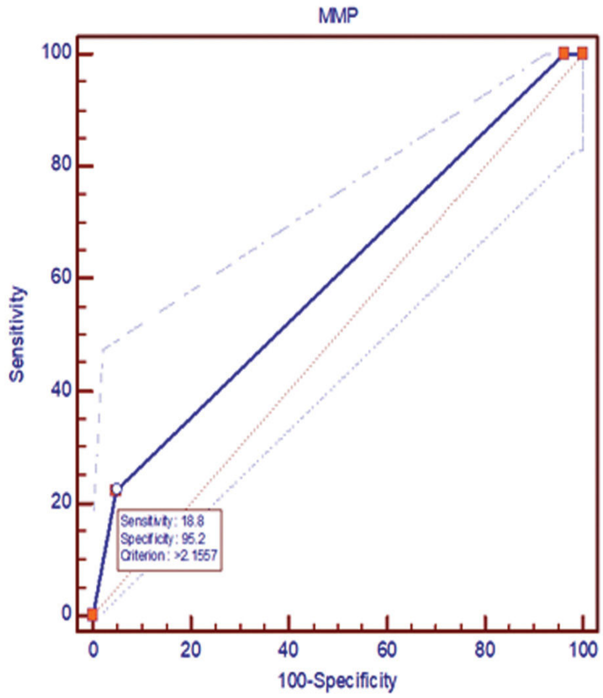

Fig. 2: ROC Curve showing Validity of MMP in predicting difficult intubation (Based on CL grading).

The observed cumulative frequencies of AASI at different cut-off points are given in the table 2. In our study when ROC curve was applied, a cut-off point of ≥0.56 had the best trade-off between false and true positives.

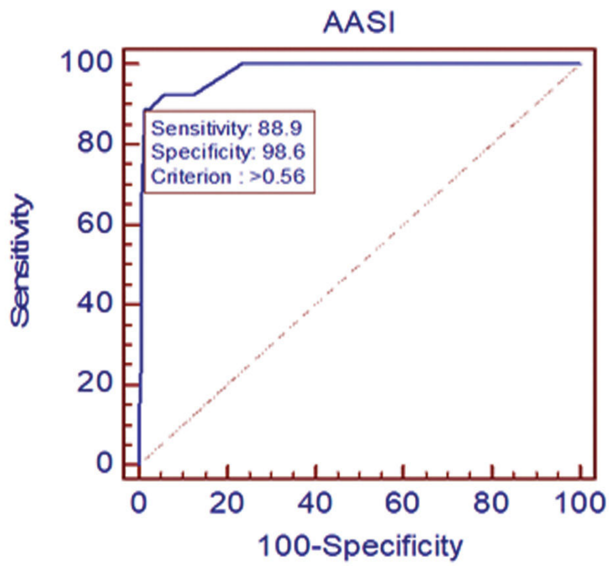

Fig. 3: ROC Curve showing Validity of AASI in predicting difficult intubation (Based on CL grading).

Table 2: Criterion values and coordinates of the ROC curve.

Criterion	Sensitivity	95% CI	Specificity	95% CI	+PV	-PV
≥0.33	100.00	87.2 - 100.0	0.00	0.0 - 1.3	8.4	
>0.49	100.00	87.2 - 100.0	76.79	71.5 - 81.5	28.4	100.0
>0.5	92.59	75.7 - 99.1	87.37	83.0 - 91.0	40.3	99.2
>0.53	92.59	75.7 - 99.1	94.20	90.9 - 96.6	59.5	99.3
>0.54	88.89	70.8 - 97.6	97.61	95.1 - 99.0	77.4	99.0
>0.56	88.89	70.8 - 97.6	98.63	96.5 - 99.6	85.7	99.0
>0.57	66.67	46.0 - 83.5	99.32	97.6 - 99.9	90.0	97.0
>0.61	25.93	11.1 - 46.3	99.32	97.6 - 99.9	77.8	93.6
>0.62	22.22	8.6 - 42.3	99.66	98.1 - 100.0	85.7	93.3
>0.63	18.52	6.3 - 38.1	99.66	98.1 - 100.0	83.3	93.0
>0.66	14.81	4.2 - 33.7	100.00	98.7 - 100.0	100.0	92.7
>0.75	0.00	0.0 - 12.8	100.00	98.7 - 100.0		91.6

The distribution of AASI, MMP and CL grading among the study subjects is shown in the table 3. The incidence of DVL was 8.4% in our study population.

Table 3: The distribution of EVL and DVL for each parameter.

Variables	EVL(%)	DVL(%)
AASI	292(91.2)	28(8.8)
MMP Grade	300(93.8)	20(6.2)
CL Grade	293(91.6)	27(8.4%)

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy and area under the curve (AUC) of AASI and MMP of our study are shown in the table 4.

Discussion

Failed mask ventilation or intubation being one of the main cause for morbidity or mortality in anaesthesia, management of unanticipated difficult airway is still a challenging task for the anaesthesiologist. Cochrane data base of systemic reviews on detection of difficult airways has concluded that bedside airway examination screening tests are expected to have high sensitivities and positive predictive values.[15] There

Table 4: Predictive values of the AASI and MMP score to predict the occurrence of DVL(CL grading III/IV).

Test	Sensitivity % (95% CI)	Specificity%	PPV	NPV	Accuracy	AUC
AASI (≥0.56)	88.89% (71.94-96.15)	98.63% (96.54-99.47)	85.71% (68.51-94.3)	98.97% (97.02-99.65)	97.81% (95.55-98.94)	0.98 (0.95-0.99)
MMP	22.22% (8.6-42.3)	95.22% (92.14-97.4)	30% (11.9-54.3)	93% (89.54-95.6)	89.06% (85.17-92.03)	0.60 (0.54-0.65)

Table 5: Shows the test characteristics of AASI and MMP done by different authors in comparison with our study.

Test	Author	Sensitivity(%)	Specificity(%)	PPV(%)	NPV(%)
AASI	Our study(≥0.56)	88.89	98.63	85.7	99
	Kamranmanesh et al[13] (>0.49)	78.9	89.4	33.3	98.4
	Safavi et al[19] (≥0.6)	66.67	98.44	56	99
	Rajkhowa et al[18] (≥0.5)	81.25	96.7	48.15	99.27
	Rupesh Sunkam et al[23] (≥0.49)	61.1	93.2	55	94.6
MMP	Our study	22.22	95.22	30	93
	Kamranmanesh et al[13]	52.4	85.7	21.6	96
	Safavi et al[19]	47.62	79.49	6.5	98
	Rajkhowa et al[18]	25	91.98	10.53	97.01
	Rupesh Sunkam et al[23]	77.8	62.1	21.9	95.4
	Ittichaikulthol et al[24]	41.7	95.5	23.1	98
	Ruchi Garg et al[20]	16.3	97	63.6	78
	Shoba Philip et al[25]	65	65.7	58.3	94.1

is no single test with adequate sensitivity and a low false positive rate.[16]

We came across a new index based on surface anatomy called Acromio-Axillo-Suprasternal Notch Index while searching for a simple bed side test for predicting difficult airway defined by Md Kamranmanesh et al[13] in 2014. According to authors difficult visualization of larynx (DVL) was observed in individuals whose neck was deeply situated in the chest with a sloping clavicle. The authors hypothesized that the portion of the arm chest junction above the level of suprasternal notch might be used as an indicator to predict DVL. Using the AASI index they evaluated predictive validity of this index with a cut off of 0.49 in comparison with routinely used MMP for assessing DVL.

Cephalometric studies suggest that there are definite differences of anatomy between Asian and western population that influences airway characteristics.[17] Not many studies have been done to assess AASI as a predictor of DVL in our population. Hence we designed this study to evaluate the predictive validity of AASI, to know the best cut-off of AASI which depicts DVL in our population by using ROC curve and calculating AUC and to compare the same with routinely used MMP as sensitivity of MMP was less in the previous studies done.[18,19,20]

Variability in the incidence of difficult visualization of larynx may be due to difference in anthropometric features, degree of muscle relaxation, intubation protocol, head position, type and size of blade and external laryngeal manipulation.[21,22] Our findings showed no statistical difference in age, sex, weight, height and BMI of the study population.

Considering a cut-off of ≥ 0.56 for AASI our study showed that AASI has a sensitivity of 88.89% v/s 22.22% , specificity of98.63% v/s 95.22%, PPV of 85.7% v/s 30% and NPV of 99% v/s 93% when compared to MMP respectively with P<0.01which was statistically very significant. In our study Area under the Curve of ROC curve was higher for AASI with 0.98 when compared to MMP with 0.6 which was also significant statistically. Diagnostic accuracy of AASI and MMP was 97.81% and 89.06% respectively.

T. Rajkhowa et al[18] and M. Safavi et al[19] in 2016-17 conducted similar studies comparing AASI and MMP in 440 patients and 728 patients respectively and concluded that AASI ≥0.5 and ≥ 0.6 as a good predictor of difficult airway respectively. Based on the best possible trade-off between the cumulative rates of false and true positives (Table 2) our study also suggest a cut-off of ≥ 0.56 for AASI.

The incidence of DVL in our population was 8.4%. Our study revealed that sensitivity, specificity and predictive values of AASI were superior to those of MMP and it was significant statistically. In a meta-analysis done recently, sensitivity of MMP ranged from 0.12 to 1.00 and specificity ranged from 44% to 98% and overall accuracy ranged from poor to good.[26]

Cattano et al in a study of 1956 patients found that MMP test alone is insufficient for predicting difficult intubation.[27] Therefore a diagnostic test should be having low false negative rate with maximum sensitivity and a reasonable specificity. Hence AASI better suits as a preoperative predictive test for DVL when compared to MMP. However it should be kept in mind that no single test can reliably predict DVL, so we should use several combinations of tests wherever possible.

Limitations of our study was inter-observer variation while grading DVL and is influenced by technique used, head position, height of operating table etc. AASI has a limitation to apply in obstetric patients as the airway dimensions changes with the progression of pregnancy. Errors can occur while measuring AASI. AASI works well in presumed normal upper airway, neck mobility and normal upper trunk anatomy and not otherwise.

According to Cochrane data analysis, Upper Lip Bite Test (ULBT) has highest sensitivity of 67% as an individual predictor.[15] Hence further studies are suggested to compare AASI with ULBT and other tests.

In conclusion our study suggest that AASI can be used as a routine preoperative bed side test to predict DVL as it has higher sensitivity , specificity, accuracy and predictive values when compared to routinely used MMP test.

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