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Comparison of Acromio-Axillo-Suprasternal Notch Index with Combination cf Modified Mallampati Score and Thyromental Distance in Predicting Difficult Visualization of Larynx

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ABSTRACT

Introduction

Various bedside clinical tests, singly or in combinations are used to predict difficult airway. This study aimed to compare Acromio-axillo-suprasternal notch index with combination of Modified Mallampati score and thyromental distance to predict difficult visualization of larynx by direct laryngoscopy.

Methods

This prospective, analytical study included 142 patients scheduled for elective surgery requiring general anesthesia with endotracheal intubation. Modified mallampati score, thyromental distance and Acromio-axillo suprasternal notch index were assessed preoperatively. In operation theatres, laryngoscopy was done and Cormack- Lehane grading was taken as standard for prediction of difficult visualization of larynx. The sensitivity, specificity, positive predictive value, negative predictive value, accuracy and area under curve of Acromio-axillo-suprasternal notch index was compared with combination of Modified Mallampati score and thyromental distance.

Results

The overall incidence of difficult laryngoscopy, defined by Cormack-Lehane III and IV was 17.6%. The combined use of Modified Mallampati score and thyromental distance demonstrated a sensitivity of 80%, specificity of 85.5%, PPV of 54.1%, NPV of 95.2% and an overall accuracy of 84.5% (p=0.001). The sensitivity, specificity, PPV, NPV and accuracy of Acromio-axillo-suprasternal notch index was 84%, 88.9%, 61.8%, 96.3% and 88% respectively(p=0.001). Likewise, the AUC of Acromio-axillo-suprasternal notch index was (AUC=0.88; 95% CI, 0.82-0.93, p<0.001) whereas AUC of combination of Modified Mallampati score and thyromental distance was (AUC= 0.82; 95%CI, 0.75- 0.89, p< 0.001) which was comparable.

Conclusion

Acromio-axillo-suprasternal notch index is equivalent to combination of Modified Mallampati score and thyromental distance in predicting difficult visualization of larynx.

Keywords

Acromio-axillo-suprasternal notch index; Cormack-lehane grading; difficult laryngoscopy; modified mallampati score; thyromental distance

INTRODUCTION

Unanticipated difficult intubation, particularly when accompanied by difficult or impossible ventilation in anesthetized patients, remains the leading cause of anesthesia related morbidity and mortality such as hypoxic brain injury or death, accounting for 30% to 40% of anaesthetic deaths.[1-3] Difficult laryngoscopy and tracheal intubation occurs in 1.7% to 20.2 % of patients undergoing surgery.[4] Common airway assessments, such as thyromental distance (TMD), mouth opening (MO), sternomental distance (SMD), modified Mallampati (MMP) are used either individually or in combination to predict a difficult airway but none is fully reliable predictor.[5] These bedside screening tests depend on patient cooperation for accurate evaluation. The modified Mallampati test, a standard airway assessment conducted in the sitting position, may not be possible in certain clinical situations, including hemodynamic instability, cervical spine trauma, prolapsed discs, unconsciousness, or poor patient cooperation during emergency procedures with limited evidence available for airway assessment in the supine position.

Acromio-axillo suprasternal notch index (AASI), is a promising predictor of difficult laryngoscopy, with higher sensitivity, accuracy, and area under the curve than MMP.[1] A meta-analysis by Shiga et al.[4] found that combining MMP with TMD predicts difficult intubation better than using single tests such as TMD, SMD, MO, Wilson risk sum score due to higher likelihood ratio and diagnostic accuracy. Although several studies compare AASI with individual airway assessment parameters, very few studies have yet evaluated AASI against the combined use of MMP and TMD. MMP and TMD are among the most widely used conventional bedside tests assessing oropharyngeal anatomy and mandibular space respectively. It has been observed that difficult visualization of larynx (DVL) was present in individuals with neck situated deep in chest, as AASI is based on surface landmark and uses the portion of arm chest junction above the level of suprasternal notch as an indicator to assess DVL.[1]

Therefore, we aimed to compare the ability of AASI with the combined MMP and TMD to predict difficult laryngeal visualization in elective surgical patients, assessing sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

METHODS

A prospective comparative observational study was conducted in Tribhuvan University Teaching Hospital and Manmohan Cardiothoracic Vascular and Transplant Centre after obtaining the Institutional Review Committee approval [Ref: 183(6-11) E2 077/078]in 142 patients, aged 18-65 years undergoing elective surgery under general anaesthesia with direct laryngoscopy and endotracheal intubation.

Pregnant patients, patients who were unable to open mouth and with gross airway abnormality like tumours, maxillofacial fractures, past history of atlanto-occipital fusion, obesity with BMI ≥ 30kg/m^2, ASA≥III were excluded from the study. Written informed consent was taken from all the eligible patients and the total duration of study was six months.

A probability sampling method was used to select the participants in our study. We calculated the sample size using the following formula: n= z^2pq/ d^2 where z = standard normal deviate; 1.96 at 95% confidence interval level. p = proportion in the target population estimated to have a particular characteristic, expressed as decimal, taken 0.063 for incidence of difficult laryngoscopy being 6.3 percent.[6] q = 1-0.063 =0.937, d = maximum tolerable error = 4 % of p = 0.04. Therefore, 142 was taken as sample size.

On the day of surgery, airway assessment was done with MMP, TMD and AASI in preoperative preparation room. MMP I /II were grouped as Easy-MMP and MMP III/IV were grouped as Difficult-MMP. TMD > 6.5 cms was grouped as Easy-TMD and ≤ 6.5 cms was grouped as Difficult-TMD. If any of these was present (MMP grade III /IV or TMD ≤ 6.5cms or both) was grouped as Difficult- MMP+TMD group. If both of the above was not present (MMP grade I/II and TMD > 6.5cms) was grouped as Easy-MMP+TMD group.

Acromio-axillo-suprasternal notch index (AASI): With the patient in the supine position and the upper limbs resting alongside the body, AASI was measured in centimetres using the following method: A vertical line (Line A) was drawn with a ruler from the tip of

the acromion process to the superior border of the axilla at the level of the pectoralis major muscle. A second line (Line B) was drawn perpendicular to line A extending from the suprasternal notch to intersect Line A and the segment of line A above the point where Line B intersected it was designated as Line C. AASI was calculated as the ratio of the length of Line C to Line A (AASI= C/A). AASI value <0.5 was grouped as Easy AASI, whereas a value ≥0.5 was grouped as Difficult AASI.

In the operating room, after routine induction with the patients' head in sniffing position direct laryngoscopy was done by attending Anesthesiologist with an appropriate Mackintosh blade and Cormack-Lehane (CL) grade was assessed. CL grades 1 and 2 were categorised as Easy visualization of the larynx (EVL) and CL grades 3 and 4 were categorised as Difficult visualization of the larynx (DVL).

Statistical analysis was performed using SPSS software. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of the different tests were compared with each other. Receiver operating characteristic (ROC) curves were generated to evaluate and compare AASI with the combined use of MMP and TMD. Differences in the proportion of patients with DVL and EVL were analysed using the Chi-square test for diagnostic accuracy and *t* test for continuous independent variables. A p-value < 0.05 was considered statistically significant for all analysis.

RESULTS

A total of 142 patients were enrolled in this study. The mean age of cases was 42.3 ±12.2 years, with 60 (42.3%) male and 82 (57.7%) female, with average Body Mass Index (BMI) of 23.7± 2.3kg/m^2 belonging to American Society of Anesthesiologist Physical Status (ASA-PS) I (38.7%) and ASA-PS II (61.3%).

Among 37 patients grouped as Difficult -MMP+ TMD (MMP III/IV and/or TMD≤6.5cm), 20 had truly DVL (CL grade III/IV) whereas 17 had EVL (CL grade I/II) on laryngoscopy. Likewise, among 105 patients grouped as Easy-MMP+TMD (MMP I/II and TMD>6.5cm), 100 had truly EVL (CL I/II) whereas 5 had DVL (CL III/IV) on laryngoscopy. The relationship between MMP+TMD and CL grade was statistically significant (p=0.001, kappa test). Among 34 patients grouped as Difficult- AASI (AASI≥ 0.5cm), 21 had truly DVL (CL III/IV) whereas 13 had EVL (CL I /II) on laryngoscopy. Likewise, among 108 patients grouped as Easy-AASI (AASI<0.5cm), 104 had truly EVL (CL I/II) whereas 4 had DVL (CL I/II) on laryngoscopy. The relationship between AASI and CL grade was statistically significant (p=0.001, kappa test) (Table 1)

Table 1. Comparison of MMP+TMD and AASI with CL grade in study population

Test	Prediction	DVL	EVL	Total	p-value (kappa test)
MMP+TMD	Difficult	20 (TP)	17 (FP)	37	0.001
	Easy	5 (FN)	100 (TN)	105	
	Total	25	117	142	
AASI	Difficult	21 (TP)	13 (FP)	34	0.001
	Easy	4 (FN)	104 (TN)	108	
	Total	25	117	142	

In terms of predicted difficult and easy laryngoscopy, the distribution of combination of MMP and TMD, AASI and CL grade is given in table 2. The incidence of actual difficult laryngoscopy in this study confirmed from CL grading was 17.6%.

Table 2. Distribution of MMP+TMD and AASI in terms of predicted difficult and easy laryngoscopy in study population

	MMP+TMD	AASI	CL
Difficult	37(26.1%)	34(23.9%)	25(17.6%)
Easy	105 (73.9%)	108(76.1%)	117(82.4%)
TOTAL	142(100%)	142(100%)	142(100%)

The comparison of AASI with MMP, TMD alone and in combination in terms of sensitivity, specificity, PPV, NPV and accuracy is given below (Table 3). The sensitivity, specificity, PPV, NPV and accuracy of AASI was found to be higher than MMP or TMD alone or in combination 84%, 88.9%, 61.8%, 96.3% and 88% (p=0.001, kappa test) respectively.

Table 3. Sensitivity, specificity, PPV, NPV and accuracy of study tests

	Sensitivity	Specificity	PPV	NPV	Accuracy
MMP	68%	85.5%	50%	92.6%	82.4%
TMD	60%	88%	51.7%	91.2%	83.1%
MMP+TMD	80%	85.5%	54.1%	95.2%	84.5%
AASI	84%	88.9%	61.8%	96.3%	88%

The area under curve was also obtained in our study to compare two diagnostic test AASI and combination of MMP and TMD. The area under curve of AASI figure 1 (AUC=0.88; 95% CI, 0.82-0.93, p <0.001) was higher than that of combination of MMP and TMD figure 2 (AUC= 0.82; 95%CI, 0.75-0.89, p< 0.001). Thus, AASI was comparable to combination of MMP and TMD in predicting difficult visualization of larynx.

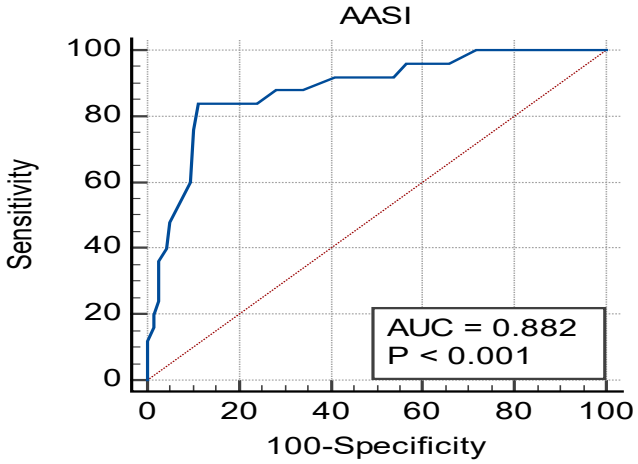

Figure 1. Receiver operating characteristic curves for the AASI.

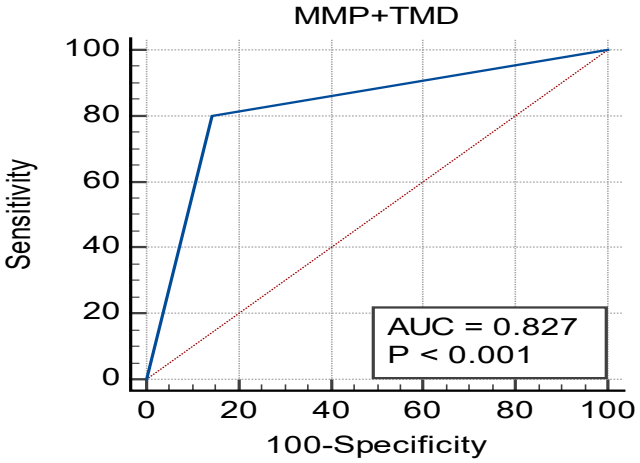

Figure 2. Receiver operating characteristic curves for MMP+ TMD.

DISCUSSION

The identification of an optimal predictor for difficult tracheal intubation remains an evolving area of research. Although numerous predictors have been proposed over the years, none has achieved the level of sensitivity and specificity desired by practicing anesthesiologists. As there is limited literature comparing AASI with the combined assessment of MMP and TMD, we conducted a study involving 142 patients to evaluate and compare the effectiveness of these two airway assessment methods in predicting a difficult airway.

The incidence of difficult visualization of larynx in our study was 17.6%, which is comparable to some of the studies. The incidence of difficult laryngoscopy obtained in our study was almost

thrice than that of Kamranmanesh et al.[1] where incidence of difficult laryngoscopy was 6.3%. The variability in incidence of difficult visualization of larynx has been attributed to age, gender, obesity, degree of muscle relaxation, application of external laryngeal maneuvers, population under evaluation.

We observed difficult visualization of larynx had a male preponderance. Out of 25 difficult visualizations of larynx, 15 were male patients. Similar finding was observed by Rose et al.[7] This can possibly be explained by increased muscle mass around neck in men as compared to women.

High BMI is usually considered as a predictor of difficult laryngoscopy and intubation.[8] But in our study, average BMI was 23.7± 2.3kg/m^2 and obese patients with BMI >30kg/m^2 were excluded which if included, would have better shown the association with difficult laryngoscopy and intubation.

In this study, the sensitivity, specificity, PPV and NPV of MMP alone were found to be 68%, 85.5%, 50%, 92.6% respectively (p=0.0001) and for TMD alone the values were 60%, 88%,51.7%, 91.2% respectively (p=0.0001). Both the test had low sensitivity and PPV. Thus, they are poor in identifying difficult laryngoscopy.

A meta- analysis by Lee et al.[9] showed that sensitivity of MMP ranged from 12% to 100% and specificity varied between 44% and 98% among various studies. Another meta-analysis by Lunderstrom LH et al.[10] showed that pooled sensitivity, specificity of MMP was 35% and 91% respectively. In cochrane review by Roth D et al.[11] the pooled sensitivity and specificity of MMP for difficult laryngoscopy was 53% and 80% respectively. In a study by Kamranmanesh et al.[1] the sensitivity, specificity, PPV and NPV of MMP was 52.4%, 85.7%, 21.6%, 96%. These studies showed MMP alone had low sensitivity and PPV and concluded that MMP is a poor predictor of difficult laryngoscopy. The variation may be attributed to factors relating to patient population studied, interobserver variation, involuntary phonation, amount of maximum extrusion of tongue and opening of the mouth.

Likewise, in Cochrane review by Roth D et al.[11] the sensitivity, specificity of TMD was found to be 37% and 89% respectively. In the studies by Rajkhowa T et al.[5] and Girish K.N et al.[12] the sensitivity, specificity, PPV, NPV of TMD was 6.25%, 93.4%, 3.45%, 96.35% and 38.7%, 93.6%, 46.2%, 91.5% respectively. The low sensitivity and PPV of TMD in these studies reflect that TMD alone is a poor predictor of difficult laryngoscopy which is consistent with our study. Influence of height of patients, use of three fingers and lack of standardized TMD values to categorize the patients might have resulted in wide variability of predictability of TMD for a difficult laryngoscopy and intubation.

In our study combination of MMP and TMD showed better predictive values as compared to MMP or TMD alone. The sensitivity, specificity, PPV and NPV of combination of MMP and TMD was found to be 80%, 85.5%, 54.1% and 95.2% respectively (p=0.001) which was higher than MMP or TMD alone. The result is comparable to other studies. In a study with a large sample size, researchers noted that combination of MMP and TMD were good predictors of a difficult laryngoscopy in Thai population.[13] However, they had used TMD <6 cm as a parameter instead of <6.5cm used in the current study. The meta-analysis by Shiga T et al.[4] found that the most useful bedside test for prediction for difficult laryngoscopy was a combination of MMP and TMD due to high positive likelihood ratio (9.9) and high area under receiver operating curve (0.84). The sensitivity of combination of MMP and TMD in this meta-analysis was low as comparative to our study (36% vs 80%) whereas specificity (87% vs 85.5%) and area under receiver operating curve (0.84 vs 0.88) were consistent in both studies.

In our study, the sensitivity, specificity, PPV and NPV of AASI was 84%, 88.9%, 68.1% and 96.3% respectively. An accuracy of 88% and Area under receiver operating curve of 0.88 was obtained in our study. These findings were consistent with the study by Bamba C and Gupta P[14], Rajkhowa T et al.[5], Safavi M et al.[15,16] Whereas in the study by Girish KN et al.[11] sensitivity of AASI was lower 67.7% as compared to our study whereas other predictors were in line with our study. Likewise, the sensitivity and specificity of AASI was lower 47.9% and 45.6% respectively in a study done by Mansouritehrani N et al.[17] The difference in results has been explained due to the fact that different cut off points for AASI has been used and also variation in position of the patient with hand by the side can affect the result.

When comparing AASI with combination of MMP and TMD, the sensitivity (84% vs 80%), specificity (88.9% vs 85.5%), PPV (96.3% vs 95.2%), accuracy of (88% vs 84.5%) was found in our study. The area under receiver operating curve of AASI was AUC=0.88; 95% CI, 0.82-0.93, p <0.001 whereas that of MMP and TMD was AUC= 0.82; 95%CI, 0.75- 0.89, p< 0.001. Thus, our result shows that AASI is equivalent to combination of MMP and TMD in predicting difficult visualization of larynx. Although in previous studies no comparision is done between AASI and combination of MMP and TMD, they have compared AASI with many other airway tests which has shown that AASI is better in predicting difficult laryngoscopy.

CONCLUSION

The sensitivity, specificity, PPV, NPV, accuracy and AUC of AASI is comparable to that of combination of MMP and TMD. So, AASI is equivalent to combination of MMP and TMD in predicting difficult visualization of the larynx.

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CONFLICT OF INTEREST

None.

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