Original Article

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TANAFFOS

Comparison of Acromio-Axillo-Suprasternal Notch Index (AASI) with Hyomental Distance Ratio Test (HMDR) in Predicting Difficult Visualization of the Larynx

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Background: Safe airway management during anesthesia induction is a challenging issue. Airway-related morbidity can be prevented by carefully evaluating patients and formulating a difficult airway management strategy. The purpose of this study is to investigate and compare two indices, AASI, and HMDR, in predicting difficult laryngoscopic visualization.

Materials and Methods: Six hundred and twenty-two patients, who entered the operating room for any type of elective surgery and were candidates for general anesthesia, underwent AASI and HMDR measurements after filling out a questionnaire containing personal information, oral examinations, and history of illness or surgery before anesthesia prescription. The Cormack grade was recorded during laryngoscopy, and finally, the predictive value of the two methods was compared.

Results: Based on analysis, AASI has a higher specificity than HDMR (87.5% vs. 76.1%) and the positive predictive value of AASI is 97%. Therefore, both HMDR and AASI are valid and significant indicators for predicting difficult laryngoscopy.

Conclusion: AASI has a better diagnostic profile than HMDR regarding sensitivity and positive predictive value, Additionally, AASI is more convenient to use because it is simpler and visually predictable, making it a reliable clinical predictor.

Keywords: Anesthesia; Laryngoscopy; Difficult intubation; Airway management; Cormack score

INTRODUCTION

Appropriate control of the difficult airway plays a critical role in reducing anesthesia-associated mortality and morbidity. Failure to evaluate the airway may contribute to negative outcomes and cause patient harm, ranging from minor issues such as oral trauma to increased risk of aspiration, hypoxia, brain damage, and death from oxygen deprivation (1, 2). The term "difficult airway" covers a spectrum of difficulties including difficulty with intensive ventilation with a face mask or supraglottic airway (SGA), difficulty in placing SGA, difficulty with tracheal intubation, and difficulty with laryngoscopy (3, 4). Failure to intubate the trachea might require a surgical airway. For difficult laryngoscopy, the Cormack score, a four-grade scoring system introduced by Cormack and Lehane, is typically used. A score of 3 (only the epiglottis is visible) or 4 (neither the glottis nor the epiglottis is visible) defines a difficult laryngoscopy (4). Various studies have shown that the incidence of difficult ventilation with a face mask is 0.66-2.5% (5, 6), difficult insertion of supraglottic airway device (SAD) or difficult ventilation is 0.5-4.7% (7, 8), difficult tracheal intubation is 1.9-10% (5, 6, 9), and the combined difficulty in both types of mask ventilation and tracheal intubation is 0.3-0.4% (5).

One way to evaluate the airway is a physical examination to detect the specific characteristics of the head and neck, and there are different indices for these screenings. The most common include the Mallampati test (MMP), Wilson risk score, thyromental distance (TMD), sternomental distance (SMD), hyomental distance (HMD), mouth opening test, upper lip bite test (ULBT) (10), Body Mass Index (BMI) (11), and recently, ratio of height to rhinion-mentum distance (RHRMD) (12). In 2013, a new test based on the anatomy of the chest called the Acromio-Axillo-Suprasternal Notch Index (AASI) was introduced. It has a higher predictive value than other indices in predicting difficult visualization of laryngoscopy, with a sensitivity of 78.9% and a specificity of 89.4% (13). Various studies have investigated the predictive value of each of the mentioned indices separately or in comparison with the others. Considering the importance of predicting difficult laryngoscopic views, this study aims to compare the AASI with the well-known method, HMDR, in evaluating the difficult visualization of the larynx.

MATERIALS AND METHODS

After obtaining approval from the ethics committee (Institutional Review Board) and in compliance with the Helsinki Declaration of Ethical Principles for Medical Research Involving Human Subjects as revised in 2013, written informed consent was obtained from patients after the procedure had been fully explained. A total number of 622 adult patients over 18 years old who were scheduled to undergo elective surgery requiring endotracheal intubation, were enrolled in this descriptive cross-sectional analytical cohort study. Exclusion criteria were as follows: Obvious malformation of the upper airway, inability to open the mouth more than two centimeters, rheumatic disease in the head and neck, and recent surgery or trauma (less than 6 months) in the head and neck region.

First, the height and weight of the patients were measured, and their Body Mass Index (BMI) was calculated. Then, mouth opening (the linear distance between the edge of the upper tooth and the edge of the lower tooth of the same side) and Mallampati classes (the state of opening the mouth and sticking out the tongue based on scoring: 1. Soft palate, pharynx, uvula, and pillars, 2. Soft palate, pharynx, and part of the uvula, 3. Soft palate and base of the uvula, 4. Hard palate only is seen) were evaluated. After that, each patient underwent a physical examination before surgery, and AASI and HMDR were assessed.

With the patients lying in a supine position and their upper extremities resting at the sides of the body, AASI was calculated based on the following measurements: (1) using a ruler, a vertical line was drawn from the top of the acromion process to the superior border of the axilla at the pectoralis major muscle; (2) a second line was drawn perpendicular to line A from the suprasternal notch (line B); and (3) the portion of line A that lay above the point at which line B intersected line A was line C. AASI was calculated by dividing the length of line C by that of line A (AASI = C/A).(13)

In the HMDR index, first, the linear distance between the hyoid bone and the tip of the chin was measured in the neutral position of the head (HMDn), and then the linear distance between the hyoid bone and the tip of the chin was measured in the full head extension position (HMDe). Finally, the ratio of the two was calculated.

All patients received the premedication with intravenous Midazolam (0.03 mg/kg), Fentanyl (2 µg/kg), Propofol (2.5 mg/kg), and Atracurium (0.5 mg/kg). After induction of anesthesia, laryngoscopy was attempted, Cormack score was determined, and finally, tracheal tube was intubated.

Statistical analysis

R Core Team software (2021) and report-ROC package were used for data analysis. Sensitivity values, specificity, positive and negative predictive value, positive and negative likelihood ratio of cut points, area under the ROC curve, and accuracy with 95% confidence interval for each of the 8 factors (HMDR, HMDn, HMDe, AASI, mouth opening, neck length, thyromental distance, sternomental distance, ULBT, and Mallampati) were calculated using statistical analysis. The significance of the results was checked.

RESULTS

A total of 622 patients were enrolled in the study. The characteristics of the patients are shown in Table 1. The values of sensitivity, specificity, positive and negative predictive value, the positive and negative likelihood ratio of cut points, area under the ROC curve, and accuracy with 95% confidence interval for each of the eight factors were calculated and the significance of their results is presented in Tables 2. The results were significant only for HMDR, HMDn, HMDe, AASI, and thyromental factors (p<0.05). The cut-point column shows the best one for each variable (HMDR=1.1, AASI=0.49, Mouth opening=3.75, Neck length=11.75, thyromental=6.75 steromental= 13.5). Values higher than the cut-off value predict group 1 (Cormack 1,2) and values lower than them predict group 2 (Cormack 3,4). The AUC column provides the area under the ROC curve. The largest area under the curve corresponds to the HMDR variable of 0.861. In all these variables, AUC was higher than 0.76 (Figure 1).

Using discrimination analysis, AASI had a higher rate of specificity (0.87), and the sensitivity was reported as 0.81. It also has a higher positive predictive value than other indices. The rate of sensitivity and specificity for HMDR is 0.88 and 0.78, respectively (Table 2).

Table 1. The patient's characteristics

Variables	M±SD
Age	42.67±13.77
Height	165.62±19.85
Weight	76.85±16.40
BMI	27.39±5.32

M: Mean, SD: Standard Deviation

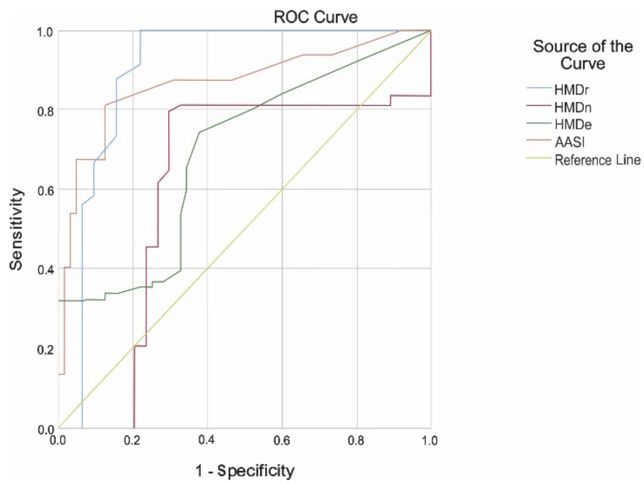

Figure 1. Receiver operating characteristic curves for the AASI and HMDR (HMDn, HMDe) in the prediction of difficult laryngoscopy.
HMDR= hyomental distance ratio; HMDn= Hyomental distance neutral position HMDe=hyomental distance extension; AASI= acromioaxillosuprasternal notch index

Table 2. Predictive values of HMDR, HMDn, HMDe, AASI, mouth opening, neck length, thyromental, and sternomental to predict the occurrence of difficult laryngoscopy

Variable	Cut-point	AUC	P-value	ACC	SEN	SPE	PPV	NPV	LR+	LR-
HMDR	1.1	0.861	0.012	0.873 (0.863,0.883)	0.888 (0.876,0.901)	0.781 (0.751,0.812)	0.962 (0.947,0.976)	0.532 (0.467,0.6)	4.061	0.143
HMDn	5.25	0.764	0.0001	0.793 (0.764,0.821)	0.812 (0.792,0.832)	0.672 (0.585,0.759)	0.938 (0.919,0.957)	0.368 (0.305,0.433)	2.475	0.280
HMDe	5.15	0.782	0.008	0.723 (0.691,0.756)	0.740 (0.691,0.79)	0.626 (0.532,0.72)	0.920 (0.885,0.956)	0.292 (0.225,0.363)	1.981	0.415
AASI	0.494	0.796	0.015	0.821 (0.815,0.825)	0.812 (0.804,0.820)	0.875 (0.852,0.898)	0.976 (0.953,0.99)	0.431 (0.41,0.452)	6.497	0.215
Mouth opening	3.75	0.596	0.058	0.712 (0.688,0.734)	0.734 (0.706,0.76)	0.582 (0.484,0.669)	0.911 (0.88,0.939)	0.273 (0.204,0.338)	1.759	0.456
Neck length	11.75	0.612	0.06	0.685 (0.659,0.71)	0.715 (0.648,0.783)	0.505 (0.449,0.561)	0.894 (0.86,0.927)	0.233 (0.179,0.29)	1.447	0.562
Thyromental	6.75	0.794	0.029	0.788 (0.744,0.831)	0.801 (0.766,0.833)	0.714 (0.59,0.838)	0.942 (0.909,0.975)	0.380 (0.276,0.485)	2.801	0.279
Sternomental	13.5	0.812	0.055	0.717 (0.68,0.75)	0.734 (0.687,0.781)	0.615 (0.536,0.694)	0.917 (0.878,0.956)	0.284 (0.228,0.343)	1.910	0.431

AUC= area under the curve; ACC= highest amount of accuracy; SEN= sensitivity; SEP= specificity; PPV= positive predictive value; NPV= negative predictive value; LR+=positive likelihood ratio; LR-= negative likelihood ratio. HMDR: Hyomental Distance Ratio, HMDn: Hyomental Distant in neutral position, HMDe: Hyomental Distant in extension position, AASI: Acromio-Axillo-Suprasternal-notch Index

Table 3. Predictive values of ULBT and Mallampati to predict the occurrence of difficult laryngoscopy

Variable	AUC	P-value	ACC	SEN	SPE	PPV	NPV	LR+	LR-
ULBT	0.795	0.032	0.751 (0.75,0.752)	0.738 (0.73,0.75)	0.824 (0.801 , 0.847)	0.961 (0.938,0.984)	0.350 (0.329,0.371)	4.199	0.318
Mallampati	0.781	0.029	0.641 (0.636,0.646)	0.612 (0.536,0.688)	0.813 (0.8,0.826)	0.950 (0.918,0.982)	0.264 (0.249,0.279)	3.276	0.477

ULBT: Upper Lip Bite Test, AUC= area under the curve; ACC= highest amount of accuracy; SEN= sensitivity; SEP= specificity; PPV= positive predictive value; NPV= negative predictive value; LR+=positive likelihood ratio; LR-= negative likelihood ratio.

To study the relationship between ULBT and Mallampati variables with Cormack, a Chi-square test was used. The result of the Chi-square test shows the relationship between each Mallampati and ULBT variables with Cormack ($p<0.001$). Cross tables of these two variables indicate a direct relationship between the results of each of these two variables with Cormack's results. Predictive values were checked for these factors, the results of which are presented in Table 3. The results for ULBT and Mallampati factors are significant ($p<0.05$). The values of sensitivity and specificity for ULBT are 0.73 and 0.82, respectively, and for Mallampati are 0.61 and 0.81.

DISCUSSION

The present study aimed to compare two methods of AASI and HMDR in evaluating difficult laryngoscopy. According to the significant results, it was shown that both indices are suitable for evaluating difficult laryngoscopy and have the power to distinguish the difficult and easy visualization of the airway. Although, the study revealed that AASI and HMDR have similar predictive values, the specificity and predictive value of AASI are slightly higher than HMDR. This finding, along with the easier measurement method, can even show the superiority of this test over HMDR. Also, the positive predictive value of the AASI is slightly higher than HMDR (97% vs. 96%).

Since airway management remains one of the challenging issues during the induction of anesthesia, various studies have investigated it. Previous studies have confirmed that AASI is a suitable index for diagnosing difficult airways and the results are consistent (13-19) and the sensitivity and specificity of these studies are close to the present study. In 2013, Kamranmanesh et al. designed the AASI as a new screening tool based on body surface anatomy. To calculate this index, they used the measurement of the brachial chest attachment fraction above the suprasternal notch. Also, they compared this index with the Mallapmati index in predicting difficulties of laryngoscopic view. The results showed that AASI has a better predictive value and a lower false negative rate than the Mallampati index (13).

Nasr-Esfahani et al. conducted a cross-sectional study with diagnostic values on 108 patients with indications for endotracheal intubation in the emergency department. They found that the AASI scale has a high sensitivity (84.7%) and specificity (77.7%) in predicting the difficulty of tracheal intubation (20). Some studies have reported higher sensitivity and specificity than this study, which confirms the validity and usefulness of this index. In a study of 716 patients, Safavi et al. compared AASI with other predictors of laryngoscopy and intubation difficulty including tyromental distance, modified Mallampati test, ULBT, and ratio of neck circumference to tyromental distance. The results showed that AASI has the highest specificity (94.8%) compared to other predictive factors. They also noted that AASI is less sensitive to neck circumference. According to their study, AASI was a more accurate predictor for difficult laryngoscopy than other indicators (21).

Another finding in the present study is the significance of two other indicators, ULBT and Mallampati. However, they have lower sensitivity and specificity than AASI. The sensitivity and specificity of the ULBT test were 0.73 and 0.82, respectively, and those of the Mallampati index were

0.61 and 0.81. Previous studies that compared the AASI test with other tests such as Mallampati have also shown the superiority of AASI in sensitivity and specificity, which confirms the findings of the present study.

Shekhawat et al. conducted a prospective observational study comparing the Mallampati test with the AASI on 200 patients. AASI was 92% sensitive and 97.71% specific in predicting difficult intubation, while the sensitivity and specificity of Mallampati were 76% and 84.57%, respectively. Therefore, AASI has higher sensitivity and positive predictive value in predicting difficult laryngoscopy compared to Mallampati with a cut-off value >0.49 (22).

In another study, researchers compared the AASI with other classic measures of head and neck anatomy to predict laryngeal difficulty profile in children aged 1-18 years. Based on the results, AASI has a better predictive ability than ULBT, Mallampati, and thyromental distance index. AASI was introduced as a new but adequate method for predicting the difficult laryngeal view in a population of children aged 1-18 years under general anesthesia with endotracheal intubation (23). The present study's results about the HMDR index are consistent with previous research. Previous studies have suggested that this index could predict difficult laryngoscopic visualization (24). The present study confirms its usefulness, making it a reliable and easy test for patients undergoing elective surgery.

In 2022, Hrithma et al. investigated the HMDR index's accuracy in predicting difficult laryngoscopy in 104 ICU patients aged between 18 to 70 years old who underwent tracheal intubation in the intensive care unit. This index showed high sensitivity (88.5%) and specificity (85.9%). The negative predictive value of HMDR in predicting difficulties in laryngoscopy was also high (86.5%) (25). Some other studies have shown slightly higher sensitivity and specificity than the present study. Kalezić et al. conducted a prospective study to evaluate the sensitivity and specificity of HMDR in predicting difficult tracheal intubation in 262 patients. The results showed that HMDR had the highest sensitivity (95.6%) and specificity (69.2%) as a predictor of difficult laryngeal view (26). Minor differences in sensitivity and specificity rates can be due to differences in the study population, topographical variations such as race, gender, and age, types of laryngoscope blades, or even surgery. In this study, more than 600 adults of both genders and mostly from Persian ethnicity anesthetized for various types of surgeries were enrolled. However, most studies have shown the significance, sensitivity, high specificity, and appropriateness of the HMDR index. In contrast, Montemayor-Cruz and Guerrero-Ledezma obtained different results in a cross-sectional study on 70 patients in 2015, aimed at developing a diagnostic index as a predictor of difficult intubation. They found that the HMDR index had low sensitivity (60%) and specificity (20%) and was of little use for predicting the difficult laryngoscopy (27). This difference in the results may be due to the differences in the sample size.

Finally, the findings of this study showed that both AASI and HMDR indices have a high diagnostic power in differentiating difficult laryngoscopic visualization. This should be taken into consideration that the AASI measurement can be estimated even visually due to the cutoff point of approximately 0.5, making it an easy and faster method that does not require accurate measurement and calculation like HMDR. Therefore, it is easier to use. In the present study, AASI has higher specificity and lower sensitivity, but the difference in its sensitivity with HMDR is not significant. The main advantage of AASI is its high sensitivity and specificity, which minimizes false positive and negative predictions, making it a more powerful index to confirm the difficult laryngoscopy diagnosis. Although the AASI test alone has high diagnostic accuracy, future studies should look for an optimal combination of various indicators instead of using it alone and should also be implemented on a larger sample population.

CONCLUSION

In conclusion, HMDR and AASI are both valid indicators of predicting difficult laryngoscopy. Although these two indices do not differ much in total, AASI has a better diagnostic profile than HMDR and is more convenient to use because it is much simpler and visually predictable, making it a reliable clinical predictor.

Main Points

- Prediction of difficult airways is crucial for anesthesiologists to prevent mortality and morbidity.
- Although different tests and techniques have been proposed to predict the difficult airway, none of them is 100% specific and sensitive; therefore, anesthesiologists apply a combination of these tests.
- AASI and HMDR are recently proposed techniques to make the prediction of difficult airways more accurate.
- AASI has a better diagnostic profile than HMDR, has a higher diagnostic value, and is more convenient to use because it is much simpler and visually predictable, making it a reliable clinical predictor.

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