Original Article

How to Predict Difficult Tracheal Intubation: The Application of Acromio-axillo-suprasternal Notch Index

Abstract

Background: The incidence of difficult laryngoscopy or tracheal intubation is high, which needs a method to predict the difficulty of tracheal intubation to decrease the rate of complications. Therefore, the aim of this study was to evaluate acromio-axillo-suprasternal notch index (AASI) method for predicting difficult tracheal intubation and difficult laryngoscopy. **Materials and Methods:** This cross-sectional and diagnostic value study was performed on 108 patients who had indication for endotracheal intubation in the emergency department. Before endotracheal intubation, AASI was evaluated in all patients. The sensitivity, specificity, and total accuracy for predicting the power of AASI for the difficulty of tracheal intubation were measured. **Results:** Based on Cormack and Lehane grading system, 54 patients had easy endotracheal intubation (33.3% Grade I and 66.6% Grade II) and 52 patients had difficult endotracheal intubation (57.7% Grade III and 32.7% Grade IV). The sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy for AASI in cutoff point 0.515 for predicting difficulty of endotracheal intubation with 0.857 area under the receiver operating characteristic curve were 84.6%, 77.7%, 78.5%, 84%, and 81.13%, respectively. **Conclusions:** Our results showed that predicting difficulty of endotracheal intubation by AASI is accurate and with high sensitivity and specificity values, therefore, training this method to emergency physicians should be considered in our country or other countries. Further studies are required to confirm our findings.

Keywords: *Acromio-axillo-suprasternal notch index, laryngoscopy, tracheal intubation*

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Introduction

According to recent studies, 1%–4% of patients require multiple attempts for tracheal intubation,[1] and the incidence of difficult laryngoscopy or tracheal intubation was reported 0.1%–20.2% in different studies, while this incidence increased 4%–26% in emergency departments.[2-9] A difficult intubation depends on different factors including patient factors (obsess patients, diabetic patients etc.), clinical settings, and the skills of the practitioner.[1] Therefore, several simple methods have been introduced to aid in predicting the probability of difficult intubation. For the first time, Chou and Wu[10] in 1993 described hyomandibular distance that increased in patients with difficult tracheal intubation. In the following, other methods including the modified Mallampati (MMP) classification[11] and assessment of thyromental distance (TMD),[12] sternomental distance, upper lip bite test, and hyomental distance ratio

have been introduced for this purpose.[13,14] Although these methods are used routinely in the emergency department or in the operation room, but their sensitivity, specificity, and reproducibility have been disputed.[15]

A new method named acromio-axillo-suprasternal notch index (AASI) which has been introduced for the first time by Kamranmanesh *et al.* in 2013 showed to have high sensitivity and specificity in predicting difficult intubation.[16] This method has been introduced in cases whose neck was situated deep in the chest (i.e. with a sloping clavicle), which makes intubation difficult in these cases. This method is focused on the portion of the armechest junction above the level of the suprasternal notch as an indicator to estimate the difficult visualization of the larynx.[16]

To the best of our knowledge, there was no study about this issue in emergency

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patients needing laryngoscopy and tracheal intubation, so we designed this study to evaluate the AASI method for predicting difficult tracheal intubation and difficult laryngoscopy.

Materials and Methods

This study was a cross-sectional and diagnostic value study. The present study was conducted in the emergency department of universal hospitals from January 2015 to March 2016.

The study population included patients who were a candidate for tracheal intubation presented at Emergency Department of Kashani and Alzahra Hospitals in Isfahan. Based on a confidence level of 95%, the test power of 80%, the error level of 0.17, and a difficult intubation ratio of 68% provided by literature, we assigned 54 patients in each group. We applied convenience sampling due to the necessity of assessment and identification of difficult intubation. Accordingly, Cormack and Lehane's criterion was used by an emergency medicine specialist to recognize and select two groups of patients, including with and without difficult intubation.

Inclusion criteria consisted of patients referred to the Emergency Department of Alzahra and Kashani Hospitals who aged 20–65 years, had body mass index (BMI) of ≤25 kg/m², and required endotracheal intubation based on clinical conditions (decreased level of consciousness, hypoxemia, airway obstruction, and manipulation of the airway, etc.). Patients with obvious anatomical abnormalities, upper airway disorders including tongue cancer, oral or maxillofacial tumors and fractures, recent head-and-neck surgery, and disability to open the mouth, did not include in the study. Two patients were excluded due to the urgent need for treatment during the study and refused to cooperate [Figure 1].

The study received ethics approval from the Ethics Committee of Isfahan University of Medical Sciences (IR. MUI. REC. 1394.3.712).

The difficulty of endotracheal intubation was measured based on the Cormack and Lehane grading system. Cormack and Lehane grading system has four different grades, including Grade I – full view of the glottis; Grade II – glottis partly exposed, anterior commissure not seen; Grade III – only epiglottis seen; and Grade IV – epiglottis not seen.[12] Grades I and II were considered as easy endotracheal intubation and Grades III and IV as difficult endotracheal intubation.

Then, rapid sequence intubation (RSI) protocol was performed for all patients. In this protocol, patients were monitored, including continuous pulse oximetry, end-tidal waveform capnography, and electrocardiography. Intubation was performed after 3 min preoxygenation with 100% oxygen or vital and capacity breath. Drug therapy for RSI protocol in our hospital consisted of lidocaine (1.5 mg/kg) (Caspian Co., Gilan, Iran), fentanyl (3 mcg/kg) (Darou Pakhsh Co., Tehran, Iran), etomidate (0.3 mg/kg) (Janssen Co., Belgium), and succinylcholine (1.5 mg/kg) (Caspian Co., Gilan, Iran) administered in rapid succession. A minimum of 500 mL fluid bolus (lactated Ringer's solution) was administered.

Finally, AASI was evaluated in all patients. For this purpose, 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 (line A); (2) a second line was drawn perpendicular to the 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) [Figure 2].[16] It should be noted that two experts evaluating the degree of difficult endotracheal intubation by Cormack and Lehane and AASI were not aware of the results.

Statistical analysis

Finally, collected data were analyzed using the Statistical Package for the Social Sciences (version 22; SPSS Inc., Chicago, Ill., USA). The data were shown by mean, standard deviation, and frequency (*n* and %). As descriptive statistics, we used independent *t*-test, Chi-square test, and receiver operating characteristic (ROC) analysis. In all analyses, we considered a significant level of <0.05.

Results

The mean age of studied patients was 56.09 ± 19-years, and 70.8% of patients were male (75 cases), the mean of BMI was 24.22 ± 4.19. Two patients were dropped out, and finally, 106 patients completed the study. Based on Cormack and Lehane grading system, 54 patients had easy endotracheal intubation (33.3% Grade I and 66.6% Grade II) and 52 patients had difficult endotracheal intubation (57.7% Grade III and 32.7% Grade IV, 5.7% had ≥2-time attempt for intubation, and 3.8% had ≥10-min attempt for intubation). The mean AASI score in patients with for patients with difficult endotracheal intubation was 0.61 ± 0.11, and for patients with easy endotracheal intubation was 0.44 ± 0.1 (*P* < 0.001), while comparison groups in the term of age (*P* = 0.76), sex (*P* = 0.089), and BMI (*P* = 0.401) did not show significant differences [Table 1].

The sensitivity, specificity, positive predictive value, negative predictive value (NPV), overall accuracy for AASI in cutoff point 0.515 for predicting difficulty of endotracheal intubation with 0.857 area under the ROC curve were 84.6%, 77.7%, 78.5%, 84%, and 81.13%, respectively [Table 2 and Figure 3].
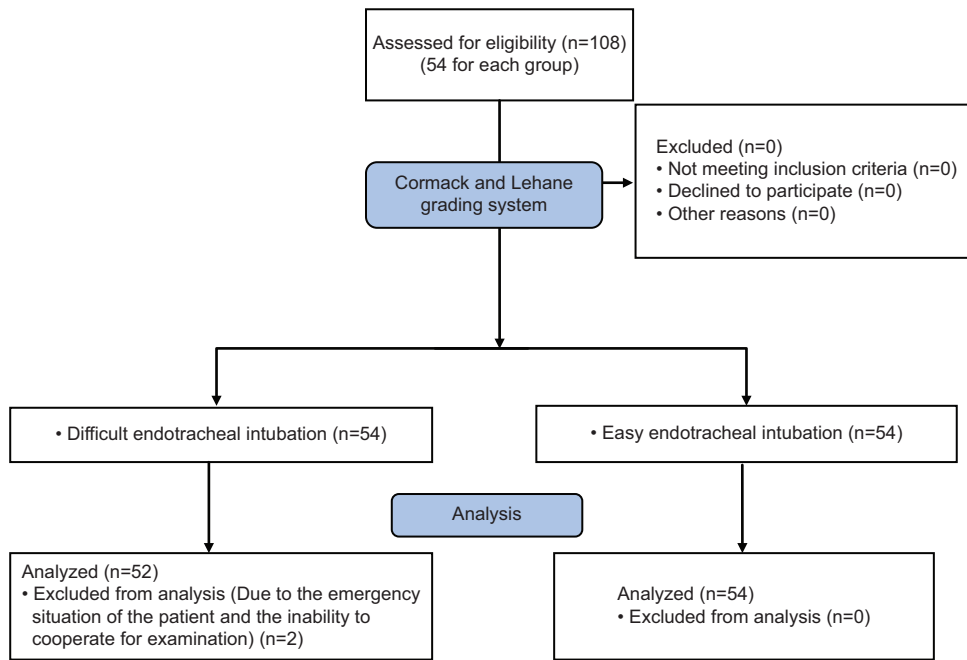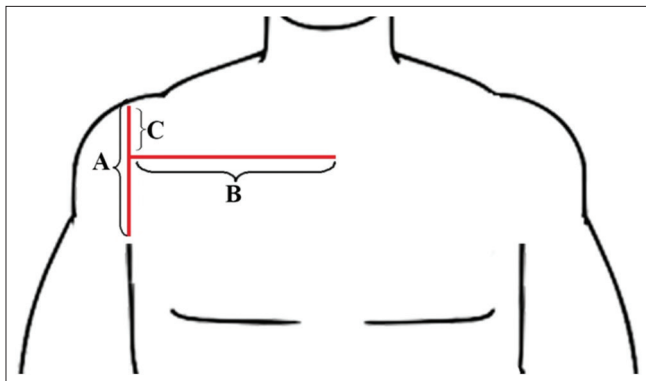
Figure 1: Study flowchart

Figure 2: Acromio-axillo-suprasternal notch index method with 3 lines (A, B, and C)

Table 1: Demographic variables in both difficult and easy endotracheal intubation groups

Variables	Group		
	Difficult endotracheal intubation (%)	Easy endotracheal intubation (%)	*P*
Age (year)	56.67±19.71	55.53±18.46	0.76*
Sex (male)	34 (63)	41 (78.8)	0.089**
BMI (kg/m^2)	24.57±4.01	23.88±4.37	0.401*
AASI	0.61±0.11	0.44±0.1	<0.001*

*Used of independent sample *t*-test, **Used of Chi-square test. BMI: Body mass index, AASI: Acromio-axillo-suprasternal notch index

Discussion

To the best of our knowledge, this is the first study on diagnosing the accuracy of AASI in predicting the difficulty of endotracheal intubation in critically ill patients. According to our results, the AASI score with cutoff point 0.515 had high and acceptable sensitivity, specificity, positive predictive value (PPV), and NPV in predicting the difficulty of endotracheal intubation (84.6%, 77.7%, 78.5%, 84%, and 81.13%, respectively).

In the first study performed by Kamranmanesh *et al*. showed that difficult visualization of the larynx (based on Cormack–Lehane III and IV) was observed in 38 (6.3%) patients. The best cutoff point for difficult visualization of the larynx was defined at AASI >0.49. AASI had a lower FN rate (8 vs. 20) and higher predictive values sensitivity (78.9% vs. 52.4%), PPV (33.3% vs. 21.6%), and accuracy (88.7% vs. 83.4%) in comparison with MMP.[16] In comparison to Kamranmanesh study, we found higher sensitivity (84.6% vs. 78.9%) and PPV (78.5% vs. 33.3%), while the other predictive values including specificity (77.7% vs. 89.4%) and NPV (84% vs. 98.4%) were lower in our study. These differences may due to different study population (we study in Emergency Department, while in the mentioned study, the patients were intubated in operation room), sample size, and different cutoff points.

Another performed by Safavi *et al*. showed that the incidence of difficult visualization of the larynx was 2.9%. AASI had the highest specificity (98.4%), likelihood ratio + (42.85), PPV (56%), and NPV (99%) in comparison with the other predictive tests. AASI with cutoff point ≤0.6 had a higher cutoff point. AASI has the highest ROC with a significant difference in other prediction tests.[17] However, in comparison to our study, they evaluate lower PPV (78.5% vs. 56%) with a lower cutoff point (0.515 vs. 0.6).

Difficulties with airway management continue to represent a patient safety concern, especially in ED, which requires

Table 2: Sensitivity, specificity, positive predictive value, and negative predictive value of acromio-axillo-suprasternal notch index in predicting difficulty of endotracheal intubation

Method	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	LR+ (%)	LR- (%)	Overall accuracy (%)	*P**
AASI	0.857	84.6	77.7	78.5	84	3.79	0.19	81.13	<0.00

*Used of ROC analysis. AASI: Acromio-axillo-suprasternal notch index, AUC: Area under the curve, PPV: Positive predictive value, NPV: Negative predictive value, LR+: Positive likelihood ratio, LR: Negative likelihood ratio
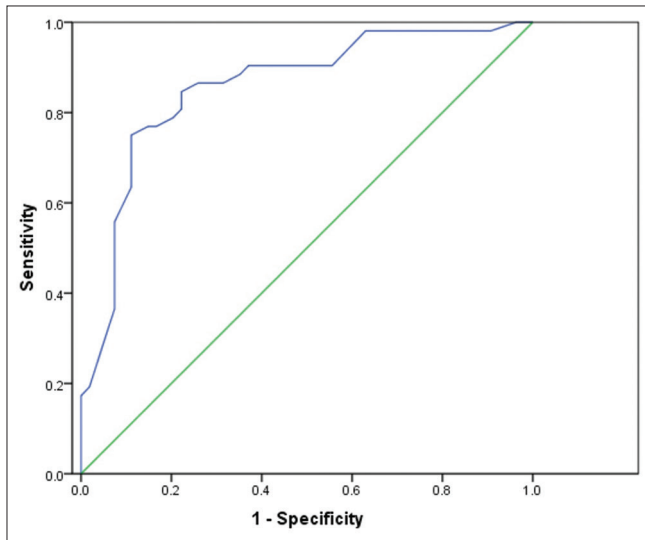

Figure 3: Receiver operating characteristic curve of acromio-axillo-suprasternal notch index in predicting difficulty of endotracheal intubation

RSI for emergent patients. Bedside airway assessment tests have limited discriminative capacity and diagnostic value[18] in different settings and patient populations. It remains a challenge for individual providers to decide what strategies and devices to select for the benefit of their individual patients.[5] Considering this, some scoring methods with different values were presented using a combination of several measurements, such as Wilson (weight, head-and-neck movement, jaw movement, receding mandible, and buck teeth), Arne (previous history of difficult intubation, disease associated with difficult intubation, clinical symptoms of airway pathology, interincisor distance, and mandible subluxation, TMD, maximum range of head-and-neck movement, and Mallampati), and Naguib (thyrosternal distance [TSD], Mallampati score, TMD, and neck circumference) models.[19] A new method named AASI has been introduced recently with acceptable sensitivity (66.67–84.6) and specificity (77.7%–98.44%); however, in future, further studies are suggested to compare AASI with other tests.

There are several prevailing tests to predict difficult tracheal intubation, which should be noticed by anesthesiologists. A combination of several measurements can be used to present some models such as Wilson (weight, head-and-neck movement, jaw movement, receding mandible, and buck teeth), Arne (previous history of difficult intubation, disease associated with difficult intubation, clinical symptoms of airway pathology, IID and mandible subluxation,

TMD, maximum range of head-and-neck movement, and Mallampati), and Naguib ([TSD], Mallampati score, TMD, and neck circumference) models. Hence, the strength point of the study was to notice AASI in critically ill emergency patients; because of the need for a fast assessable method in its higher level in these patients. Although the lack of comparison of the scoring system with other scoring systems is of weak point of the study, further studies are suggested to compare AASI with other tests.

Conclusions

According to this study, the prediction of the difficult endotracheal intubation by AASI was a precise method with high sensitivity and specificity values. In fact, this scoring system allows difficult endotracheal intubation to be provided immediately at the emergency department for critically ill patients.

Conflicts of interest

There are no conflicts of interest.

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