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Original Research Article

A Comparative Study of Acromio-Axillo-Suprasternal Notch Index with Modified Mallampati Grading and Thyromental Distance in Predicting Difficult Visualization of Larynx

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Abstract

Background: Accurate preoperative prediction of difficult laryngoscopy remains essential for safe airway management. Conventional bedside tests such as the Modified Mallampati Grade (MMG) and Thyromental Distance (TMD) have limited predictive accuracy. The Acromio-Axillo-Suprasternal Notch Index (AASI) has emerged as a promising alternative.

Aim: To evaluate the effectiveness of AASI in comparison with MMG and TMD for predicting difficult visualization of the larynx (DVL) during direct laryngoscopy.

Methods: This prospective observational study included 60 adult patients (ASA I–II), aged 18–60 years, undergoing elective surgery under general anesthesia with endotracheal intubation. Preoperative airway assessment was performed using AASI, MMG, and TMD. Laryngoscopic view was graded according to the Cormack–Lehane classification. Diagnostic accuracy, sensitivity, specificity, area under the receiver operating characteristic curve (AUC), and logistic regression analysis were performed.

Results: AASI demonstrated the highest diagnostic performance with 75% sensitivity, 96% specificity, 93% accuracy, and an AUC of 0.85. TMD showed 25% sensitivity, 92% specificity, and 83% accuracy, while MMG demonstrated 50% sensitivity, 85% specificity, and 80% accuracy. Logistic regression identified AASI ≥0.5 as an independent predictor of DVL (β=4.80, p=0.0002), whereas TMD and MMG were not statistically significant predictors.

Conclusion: AASI is a simple, reliable, and superior bedside airway assessment tool compared with MMG and TMD. Incorporating AASI into routine preoperative airway evaluation may improve the prediction and preparedness for difficult laryngoscopy.

Keywords: Acromio-Axillo-Suprasternal Notch Index (AASI); Difficult laryngoscopy; Difficult airway; Cormack–Lehane grading; Modified Mallampati Grade; Thyromental Distance; Airway assessment; Endotracheal intubation.

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Introduction

Airway management is a fundamental component of anaesthetic practice and plays a pivotal role in ensuring patient safety during general anaesthesia. Securing and maintaining a patent airway is essential not only during elective surgical procedures but also in emergency and critical care settings. Failure to establish an adequate airway after induction of anaesthesia may result in hypoxaemia, aspiration, brain injury, or death, making accurate preoperative airway assessment an indispensable part of anaesthetic evaluation.[1]

Direct laryngoscopy and endotracheal intubation remain the standard techniques for airway management. However, difficult visualization of the larynx (DVL) and difficult tracheal intubation continue to pose significant challenges despite advances in airway devices and techniques [2]. The reported incidence of difficult laryngoscopy ranges from 0.1% to 20.2%, depending on the patient population, clinical setting, and criteria used for defining difficulty.[3-5]

The risk is particularly higher in emergency situations and intensive care units, where limited time for assessment and altered patient physiology may further complicate airway management.[6] Several bedside clinical tests have been developed to predict difficult airway, including the Modified Mallampati Classification, thyromental distance (TMD), sternomental distance, inter-incisor distance, and upper lip bite test.[7,8] These methods are simple, inexpensive, and routinely used during pre-anaesthetic evaluation. Nevertheless, their predictive performance remains inconsistent, with considerable variation in reported sensitivity, specificity, and predictive values across different studies.[9-11] Moreover, these conventional assessments primarily evaluate oral and mandibular anatomy while overlooking other anatomical factors that may influence laryngoscopic view.

Clinical observations have shown that patients with a deeply seated neck, sloping shoulders, or bulky upper thorax often present greater difficulty during direct laryngoscopy. These anatomical characteristics are inadequately represented by traditional airway assessment methods. To address this limitation, the Acromio-Axillo-Suprasternal Notch Index (AASI) was introduced as a novel surface landmark-based predictor of difficult laryngoscopy.[11] The AASI is calculated using fixed anatomical landmarks involving the acromion, axilla, and suprasternal notch, thereby reflecting upper chest and neck configuration. Individuals with short necks, sloping clavicles, or increased thoracic bulk generally demonstrate higher AASI values, which may restrict neck extension and reduce glottic visualization during laryngoscopy.[11]

Previous studies have reported that an AASI value greater than 0.5 is significantly associated with difficult visualization of the larynx and has demonstrated encouraging sensitivity and specificity for predicting difficult airway.[12] However, most available evidence originates from limited populations, and anatomical differences among ethnic groups may influence its diagnostic performance. Cephalometric and anthropometric studies have demonstrated important variations in airway anatomy between Western and Asian populations, highlighting the need for population-specific validation of airway assessment tools.[12,13]

Although the Modified Mallampati Classification and thyromental distance remain among the most widely accepted screening methods, each possesses inherent limitations. Mallampati grading is subjective and susceptible to interobserver variability, whereas thyromental distance is influenced by patient positioning and evaluates only a single anatomical dimension.[13-15] Consequently, reliance on any single conventional test may fail to identify patients with potentially difficult laryngoscopy. In view of these limitations, the present study was undertaken to evaluate the diagnostic performance of the Acromio-Axillo-Suprasternal Notch Index in predicting difficult visualization of the larynx and to compare its accuracy with the Modified Mallampati Classification and thyromental distance.

Materials and Methods

A hospital-based observational study was conducted in the Department of Anaesthesiology, Basaweshwara Teaching and General Hospital, affiliated with Mahadevappa Rampure Medical College, Kalaburagi, and Karnataka. The study was carried out over a period of 18 months from 1st May 2023 to 31st October 2024.

Study Population: The study included adult patients scheduled for elective surgeries under general anaesthesia requiring endotracheal intubation. A total of 60 patients fulfilling the eligibility criteria were enrolled using a purposive sampling technique.

Sampling Technique: Patients meeting the eligibility criteria were recruited consecutively using purposive sampling after obtaining written informed consent.

Inclusion Criteria

The study included:

- Patients aged 18–60 years.
- Patients belonging to American Society of Anesthesiologists (ASA) physical status I and II.
- Patients undergoing elective surgery under general anaesthesia requiring endotracheal intubation.

Exclusion Criteria

Patients were excluded if they had:

- Obvious anatomical abnormalities of the upper airway (tumours, trauma, fractures, or congenital anomalies).
- History of previous head or neck surgery.
- Inability to open the mouth adequately.

Preoperative Airway Assessment: All enrolled patients underwent a detailed preoperative airway evaluation by the same anaesthesiologist to minimize interobserver variability.

Acromio-Axillo-Suprasternal Notch Index (AASI): The AASI was measured with the patient in the supine position and both upper limbs resting comfortably by the sides.

- A vertical line (Line A) was drawn from the superior border of the acromion process to the

superior border of the axilla at the pectoralis major muscle.
- A perpendicular line (Line B) was drawn from the suprasternal notch to intersect Line A.
- The portion of Line A lying above the intersection was designated as Line C.
- The AASI was calculated using the formula:

$$AASI = C/A$$

Patients with AASI >0.5 were categorized as having predicted difficult visualization of the larynx (DVL), whereas those with AASI ≤0.5 were categorized as having easy visualization of the larynx (EVL).

Modified Mallampati Classification: The Modified Mallampati Classification was assessed with the patient in the sitting position. Patients were instructed to open the mouth widely and protrude the tongue without phonation. The visibility of the oropharyngeal structures was classified into Mallampati Classes I to IV according to standard criteria.

Thyromental Distance: The thyromental distance was measured as the straight distance between the thyroid notch and the mentum with the head fully extended. A distance less than 6.5 cm was considered predictive of difficult laryngoscopy.

Anaesthetic Technique and Laryngoscopic Assessment: After standard fasting guidelines had been followed, all patients were shifted to the operating room and standard monitoring, including electrocardiography, non-invasive blood pressure, pulse oximetry, and capnography, was instituted. Patients were premedicated with midazolam (0.05 mg/kg) and glycopyrrolate (0.2 mg) intravenously. Anaesthesia was induced using propofol (2 mg/kg) and fentanyl (2 μg/kg). Neuromuscular blockade was achieved with vecuronium (0.1 mg/kg), and laryngoscopy was performed after complete muscle relaxation, confirmed by disappearance of the fourth twitch on train-of-four monitoring. Direct laryngoscopy was performed in the sniffing position using a Macintosh blade No. 3 by an experienced anaesthesiologist who was blinded to the results of the preoperative airway assessment. If difficulty was encountered during the first attempt, laryngoscopy was repeated using a Macintosh blade No. 4, along with optimization manoeuvres such as external laryngeal pressure and repositioning.

The laryngeal view was graded according to the Cormack-Lehane classification:

- **Grade I:** Full view of the glottis
- **Grade II:** Partial view of the glottis
- **Grade III:** Only epiglottis visible
- **Grade IV:** Neither glottis nor epiglottis visible

Cormack-Lehane Grades I and II were categorized as Easy Visualization of the Larynx (EVL), whereas Grades III and IV were considered Difficult Visualization of the Larynx (DVL).

Data Collection

Patient demographic characteristics, including age, sex, body mass index (BMI), ASA physical status, haemoglobin level, and random blood sugar (RBS), were recorded. Airway assessment parameters including AASI, Modified Mallampati Classification, thyromental distance, and Cormack-Lehane grading were documented using a structured case record proforma.

Ethical Considerations

Institutional Ethics Committee approval was obtained prior to commencement of the study. Written informed consent was obtained from all participants in their vernacular language after explaining the study objectives, procedures, benefits, and possible risks. Confidentiality of patient information was maintained throughout the study.

Statistical Analysis: The collected data were entered into Microsoft Excel and analysed using IBM Statistical Package for the Social Sciences (SPSS) version 25.0.Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequency and percentage. Associations between categorical variables, including AASI, Modified Mallampati Classification, thyromental distance, and difficult visualization of the larynx, were analysed using the Chi-square test. Comparisons of continuous variables between groups were performed using the independent Student's t-test.Binary logistic regression analysis was performed to identify independent predictors of difficult visualization of the larynx, and the results were expressed as regression coefficients, odds ratios (OR), and 95% confidence intervals (CI).The diagnostic performance of AASI, Modified Mallampati Classification, and thyromental distance was further evaluated using Receiver Operating Characteristic (ROC) curve analysis, and the area under the curve (AUC) was calculated for each predictor. A p-value <0.05 was considered statistically significant throughout the analysis.

Results

A total of 60 patients undergoing elective surgery under general anaesthesia were included in the study. The baseline demographic and clinical characteristics of the study population are summarized in Table 1. The mean age of the participants was 34.50 ± 14.22 years, with a slight female predominance (53.3%). The mean body mass index (BMI), haemoglobin level, and random

blood sugar (RBS) were 23.75 ± 12.35 kg/m², 11.72 ± 4.22 g/dL, and 99.93 ± 25.26 mg/dL, respectively. The majority of patients belonged to ASA physical status I (66.7%), while the remaining 33.3% were classified as ASA II (Table 1).

The distribution of preoperative airway assessment parameters is presented in Table 2. The mean thyromental distance (TMD) was 7.11 ± 2.36 cm, whereas the mean Line A, Line C, and Acromio-Axillo-Suprasternal Notch Index (AASI) values were 9.92 ± 1.36 cm, 4.06 ± 1.98 cm, and 0.40 ± 0.32, respectively. Most patients had Mallampati Class I (41.7%) or Class II (38.3%), while 20.0% belonged to Class III. An AASI value greater than 0.5 was observed in 13.3% of patients, and 10.0% had a TMD of ≤6.5 cm (Table 2).

The laryngoscopic findings based on the Cormack–Lehane grading are shown in Table 3 and Figure 1. Grade I laryngoscopic view was observed in 50.0% of patients, followed by Grade II in 36.7% and Grade III in 13.3%. No patient demonstrated Grade IV laryngoscopy. Overall, 52 patients (86.7%) had easy visualization of the larynx (Grades I–II), whereas 8 patients (13.3%) had difficult visualization (Grades III–IV). The association between the airway assessment parameters and difficult visualization of the larynx (DVL) is summarized in Table 4. AASI demonstrated a highly significant association with DVL (χ^2 = 24.53, $p < 0.001$), indicating its strong predictive value. In contrast, neither thyromental distance (χ^2 = 0.79, p = 0.38) nor Modified Mallampati grading (χ^2 = 0.61, p = 0.43) showed statistically significant associations with DVL (Table 4).

The diagnostic performance of the three airway assessment methods is presented in Table 5 and Figure 2. AASI demonstrated the highest sensitivity (75%), specificity (96%), positive predictive value (75%), negative predictive value (96%), and overall diagnostic accuracy (93%). Furthermore, AASI showed the largest area under the receiver operating characteristic (ROC) curve (AUC = 0.85), indicating superior discriminative ability compared with thyromental distance (AUC = 0.58) and Modified Mallampati grading (AUC = 0.67).

Logistic regression analysis evaluating independent predictors of difficult visualization of the larynx is presented in Table 6 and Figure 3. An AASI ≥0.5 emerged as a significant independent predictor of DVL (β = 4.80, z = 3.71, p = 0.0002; 95% CI: 2.26–7.34). Although a TMD <6.5 cm showed a positive association, it did not reach statistical significance (p = 0.0855). Similarly, a Modified Mallampati grade greater than III was not a significant predictor (p = 0.6031). These findings indicate that AASI was the most reliable independent predictor of difficult laryngoscopy among the evaluated airway assessment methods.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (n = 60)

Variable	Value
Age (years), Mean ± SD	34.50 ± 14.22
Male, n (%)	28 (46.7)
Female, n (%)	32 (53.3)
BMI (kg/m²), Mean ± SD	23.75 ± 12.35
Hemoglobin (g/dL), Mean ± SD	11.72 ± 4.22
Random Blood Sugar (mg/dL), Mean ± SD	99.93 ± 25.26
ASA I, n (%)	40 (66.7)
ASA II, n (%)	20 (33.3)

Table 2: Distribution of Preoperative Airway Assessment Parameters

Variable	Value
Thyromental Distance (cm), Mean ± SD	7.11 ± 2.36
Line A (cm), Mean ± SD	9.92 ± 1.36
Line C (cm), Mean ± SD	4.06 ± 1.98
AASI, Mean ± SD	0.40 ± 0.32
Mallampati Class I, n (%)	25 (41.7)
Mallampati Class II, n (%)	23 (38.3)
Mallampati Class III, n (%)	12 (20.0)
AASI >0.5, n (%)	8 (13.3)
AASI ≤0.5, n (%)	52 (86.7)
TMD ≤6.5 cm, n (%)	6 (10.0)
TMD >6.5 cm, n (%)	54 (90.0)

Table 3: Laryngoscopic View According to Cormack–Lehane Grade

Cormack–Lehane Grade	Number (%)
Grade I	30 (50.0)
Grade II	22 (36.7)
Grade III	8 (13.3)
Grade IV	0 (0.0)
Easy Visualization (Grade I–II)	**52 (86.7)**
Difficult Visualization (Grade III–IV)	**8 (13.3)**

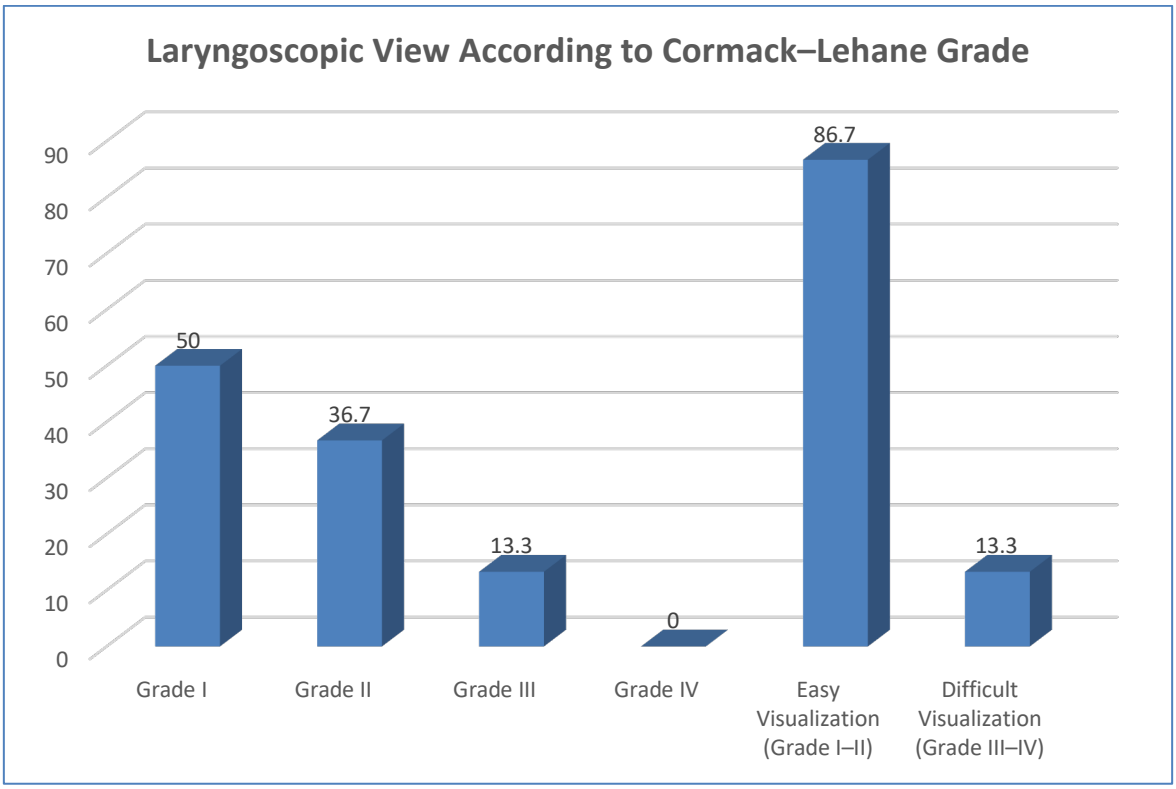

Figure 1: Laryngoscopic View According to Cormack–Lehane Grade

Table 4: Association of Airway Assessment Tests with Difficult Visualization of the Larynx (DVL)

Predictor	Chi-square	p-value	Interpretation
AASI	24.53	<0.001	Significant
Thyromental Distance	0.79	0.38	Not Significant
Modified Mallampati Grade	0.61	0.43	Not Significant

Table 5: Diagnostic Performance of AASI, Thyromental Distance and Modified Mallampati Grading

Diagnostic Parameter	AASI	TMD	Mallampati
Sensitivity (%)	75	25	50
Specificity (%)	96	92	85
Positive Predictive Value (%)	75	33	35
Negative Predictive Value (%)	96	89	92
Overall Accuracy (%)	93	83	80
Area Under ROC Curve (AUC)	0.85	0.58	0.67

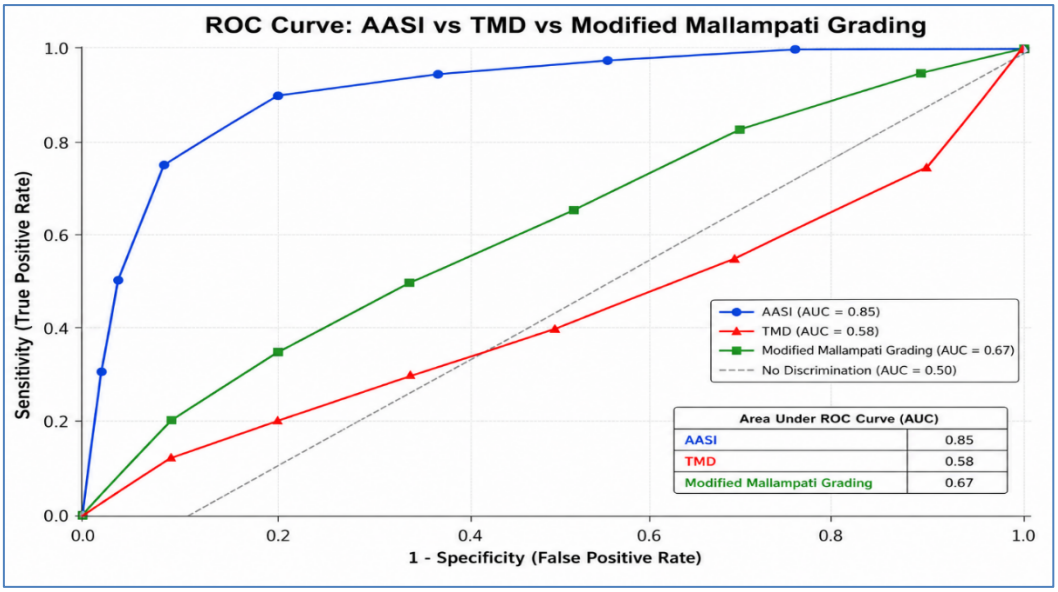

Figure 2: Diagnostic Performance of AASI, Thyromental Distance and Modified Mallampati Grading

Table 6: Logistic Regression Analysis for Predicting Difficult Visualization of the Larynx

Predictor	β Coefficient	Standard Error	z-value	p-value	95% Confidence Interval
AASI ≥0.5	4.80	1.29	3.71	0.0002	2.26–7.34
TMD <6.5 cm	2.51	1.46	1.72	0.0855	–0.35–5.38
Mallampati >III	0.47	0.90	0.52	0.6031	–1.29–2.22

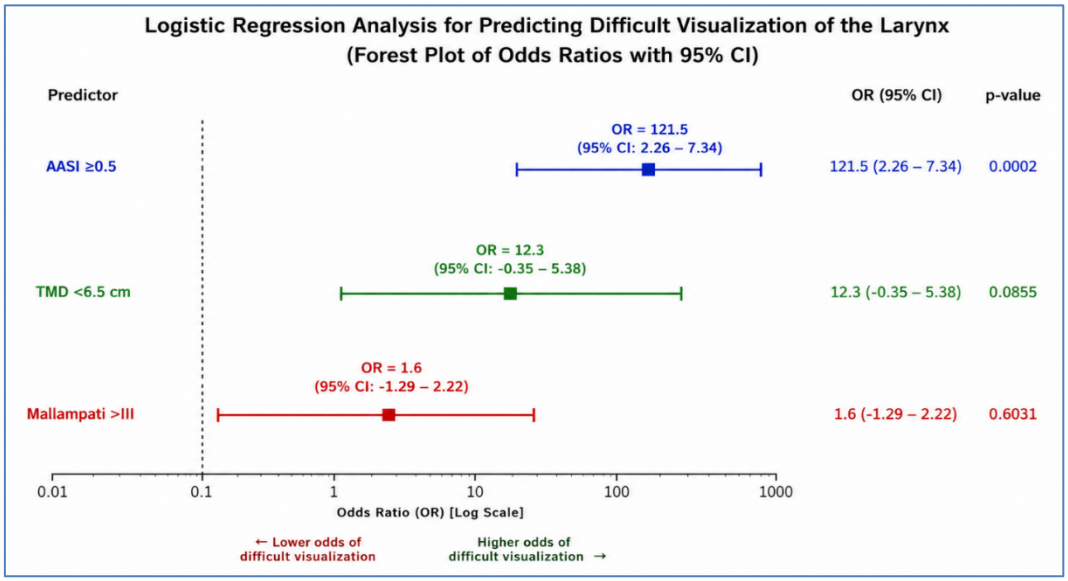

Figure 3: Logistic Regression Analysis for Predicting Difficult Visualization of the Larynx

Discussion

The present prospective observational study evaluated the diagnostic performance of the Acromio-Axillo-Suprasternal Notch Index (AASI) compared with the Modified Mallampati Grade (MMG) and Thyromental Distance (TMD) for predicting difficult visualization of the larynx (DVL) in 60 adult patients undergoing elective surgery. The study population had a mean age of 34.50 ± 14.22 years, with 66.7% of patients aged 18–37 years and a nearly equal gender distribution (53.3% females, 46.7% males). These findings are comparable with Chitralekha and Vishwanath (2021) [16], who reported a mean age of 34.28 ± 12.74 years, and Das et al. (2018) [17], who observed a mean age of 35.9 ± 13.2 years. Likewise, the balanced gender distribution is similar to Anjali et al. (2022) [18], indicating that demographic characteristics have minimal influence on airway prediction.

Most participants belonged to ASA I (66.7%), while 33.3% were ASA II, reflecting a relatively

healthy elective surgical population. Similar distributions were reported by Chitralekha and Vishwanath [16] (ASA I: 68.4%; ASA II: 31.6%) and Acharya et al. [19] (ASA I: 70%; ASA II: 30%), supporting the suitability of these patients for evaluating airway prediction indices. Regarding airway assessment, the mean TMD was 7.11 ± 2.36 cm, and 90% of patients had TMD >6.5 cm. Mallampati grading showed 41.7% Class I, 38.3% Class II, and 20% Class III, closely matching the findings of Chitralekha and Vishwanath [16] and Anjali et al. [18], who reported approximately 40% Class I, 36–38% Class II, and 20–24% Class III. However, these traditional tests demonstrated only moderate predictive ability, consistent with previous reports that neither TMD nor Mallampati alone reliably predicts difficult laryngoscopy.

AASI emerged as the most reliable predictor in the present study. Eighty-six percent of patients had AASI ≤0.5, whereas only 13.3% had AASI >0.5. Comparable proportions were reported by Suryawanshi and Bhatia (2024) [20] (87.5% and 12.5%, respectively) and Acharya et al. [19] (85.4% and 14.6%). These studies consistently demonstrated that an AASI >0.5 is significantly associated with difficult laryngoscopy, supporting our observations. Cormack–Lehane grading revealed Grade I in 50%, Grade II in 36.7%, and Grade III in 13.3%, comparable to Chitralekha and Vishwanath [16] and Suryawanshi et al. [20], who also reported Grade III laryngoscopy in approximately 12–13% of patients. This confirms that difficult laryngoscopy occurs in about one-tenth of elective surgical patients.

The principal finding of our study was the superior diagnostic performance of AASI. It demonstrated 75% sensitivity, 96% specificity, 93% overall accuracy, and an AUC of 0.85, outperforming TMD (accuracy 83%; AUC 0.58) and Mallampati (accuracy 80%; AUC 0.67).

Similar diagnostic performance has been reported by Suryawanshi et al. [20] (sensitivity 73.3%, specificity 95.2%, AUC 0.84) and Chitralekha and Vishwanath [16] (accuracy 91.3%, AUC 0.86), confirming the superiority of AASI over conventional airway tests. Furthermore, logistic regression demonstrated AASI ≥0.5 as the only independent predictor of DVL ($\beta = 4.80$, $p = 0.0002$), whereas TMD <6.5 cm ($p = 0.0855$) and Mallampati >III ($p = 0.6031$) were not significant.

These findings are in agreement with Anjali et al. [18], Acharya et al. [19], and Suryawanshi et al. [20], who also identified AASI as the strongest independent predictor of difficult laryngoscopy. Overall, our findings reinforce that incorporating AASI into routine preoperative airway assessment can substantially improve the prediction of difficult laryngoscopy compared with conventional methods alone.

Conclusion

The Acromio-Axillo-Suprasternal Notch Index (AASI) demonstrated superior accuracy in predicting difficult visualization of the larynx compared with the Modified Mallampati Grade and Thyromental Distance. An AASI ≥0.5 was identified as an independent and statistically significant predictor of difficult laryngoscopy, with high specificity and overall diagnostic accuracy. In contrast, TMD and Mallampati grading showed lower predictive performance when used individually. Therefore, incorporating AASI into routine preoperative airway assessment may improve the early identification and safe management of patients at risk for difficult intubation.

Limitation

This study was conducted at a single center with a relatively small sample size, which may limit the generalizability of the findings. Only ASA I and II patients undergoing elective surgery were included, excluding high-risk and emergency airway cases. Additionally, difficult intubation was assessed using conventional laryngoscopy only, without evaluating advanced airway devices or operator-related variability. Larger multicenter studies are required to validate the clinical utility of AASI across diverse patient populations.

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