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Comparison of Modified Mallampati Classification and Acromio-Axillo-Suprasternal Notch Index in Predicting Difficult Laryngoscopy: A Prospective cohort study.

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Abstract

Background:

Difficult airway management remains a major concern in anesthesia, with unanticipated intubation failures increasing perioperative morbidity and mortality. Accurate preoperative identification of at-risk patients is essential for safe airway management and reducing complications like hypoxia and failed intubation. Among airway assessment tools, the Modified Mallampati Classification (MMP) and Acromio-Axillo-Suprasternal Notch Index (AASNI) are commonly used. This study compared the predictive accuracy of MMP and AASNI in forecasting difficult visualization of the larynx (DVL) during direct laryngoscopy.

Methods:

A prospective cohort study was conducted on 106 adult patients aged between 18 and 60 years, scheduled for elective surgeries requiring general anesthesia and endotracheal intubation. Each patient underwent preoperative airway assessments using MMP and AASNI. During laryngoscopy, the Cormack-Lehane (CL) grading was recorded. Diagnostic parameters—sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), odds ratio, and likelihood ratios—were calculated to evaluate the predictive performance of MMP and AASNI.

Results:

Of the 106 participants, 58 (54.7%) were male and 48 (45.3%) were female. The mean age was 38.11 ± 9.88 years, with the majority aged 40–50 years (38.7%). The average BMI was 24.75 ± 2.33 kg/m². AASNI showed higher sensitivity (83.3%) and NPV (93.9%) compared to MMP (41.67% and 83.7%, respectively), while MMP had greater specificity (87.8%). Both tools shared equal PPV (50%) and diagnostic accuracy (77.36%). AASNI demonstrated a higher odds ratio (15.5 vs. 5.14) and lower negative likelihood ratio (0.220 vs. 0.664), confirming superior predictive performance.

Conclusion:

AASNI is a more reliable and objective predictor of difficult laryngoscopy than MMP. It enhances preoperative airway assessment and supports better preparedness for airway management.

Recommendations:

Routine use of AASNI is recommended in pre-anesthetic evaluations. Future multicentric studies with larger, diverse populations are warranted to further validate its effectiveness and generalizability.

Keywords: Difficult airway, laryngoscopy, Modified Mallampati Classification, Acromio-Axillo-Suprasternal Notch Index, airway assessment
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INTRODUCTION

Airway management is a fundamental responsibility of anesthesiologists, ensuring the maintenance of an open airway and effective ventilation[1]. Endotracheal intubation remains the gold standard for securing the airway, yet difficult airway (DA) scenarios continue to pose significant challenges, potentially leading to severe complications such as hypoxic brain damage or even mortality[2]. Studies have reported that 30–40% of anesthesia-related deaths result from an inability to manage a difficult airway, highlighting the need for accurate preoperative prediction of difficult intubation to improve patient safety and reduce perioperative morbidity[3].

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Despite the availability of various airway assessment tools, no single test has demonstrated universal reliability in predicting difficult intubation. The Cormack-Lehane (CL) grading system is widely accepted for assessing difficult laryngoscopy, but it can only be determined at the time of direct laryngoscopy, limiting its preoperative utility[2,4]. Therefore, there is a need for reliable, bedside predictive tests that can be performed preoperatively to identify patients at risk of difficult intubation and facilitate better airway management planning.

The Modified Mallampati Classification (MMP) remains one of the most commonly used preoperative airway assessment methods. However, MMP is limited by its subjectivity, interobserver variability, and dependency on patient positioning and cooperation[5]. Studies have shown that MMP has relatively low sensitivity, which reduces its effectiveness as an independent predictor of difficult airway visualization[6].

To overcome the limitations of traditional airway assessment methods, the Acromio-Axillo-Suprasternal Notch Index (AASNI) has been proposed as a newer screening tool. AASNI is an objective and quantitative measure that evaluates thoracic and neck anatomy, making it less dependent on patient positioning compared to MMP. Recent studies suggest that AASNI has a higher predictive accuracy for difficult airway visualization, making it a promising alternative to conventional tests[3,7].

Several comparative studies have demonstrated that AASNI performs better than MMP and other airway assessment tools, such as the Upper Lip Bite Test (ULBT) and Thyromental Distance (TMD), in predicting difficult laryngoscopy[1,2]. Moreover, AASNI is easier to perform, reproducible, and can be assessed in different patient positions, further increasing its clinical applicability in anesthesia practice .

This study aims to compare the predictive accuracy of MMP and AASNI in determining difficult visualization of the larynx (DVL) during direct laryngoscopy. The validity of these methods will be assessed based on their sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) in relation to the Cormack-Lehane (CL) grading system obtained during laryngoscopic examination.

METHODOLOGY

Study Design and Setting lgz

This study was conducted as a prospective **cohort study** in the Department of Anaesthesiology at Konaseema Institute of Medical Sciences and Research Foundation, Andhra Pradesh. The study spanned from November 2022 to November 2023.

Sample Size and Patient Selection

A total of 106 patients undergoing elective surgeries requiring general anesthesia and endotracheal intubation were included in this study.

Inclusion Criteria

- Patients of any gender (male, female, transgender)
- Age group 18–60 years
- American Society of Anesthesiologists (ASA) Classification I and II
- Patients scheduled for elective surgeries requiring endotracheal intubation

Exclusion Criteria

- Patients with head, neck, face, or oral cavity injuries
- Presence of oral cavity tumors
- Patients with severe chest injury

Pre-Anesthetic Evaluation and Airway Assessment

Patients scheduled for surgery were evaluated during their pre-anesthetic check-up. Baseline vital parameters were recorded, including blood pressure (BP), pulse rate (PR), respiratory rate (RR), and oxygen saturation (SpO_2). Preoperative airway assessments were conducted using Modified Mallampati Classification (MMP) and Acromio-Axillo-Suprasternal Notch Index (AASNI).

Modified Mallampati Classification (MMP)

The MMP classification was recorded with patients in a seated position, with their mouth fully opened and tongue maximally protruded. MMP was classified into four grades:

- **Class 1:** Full visibility of the soft palate, fauces, uvula, and tonsillar pillars
- **Class 2:** Visibility of the soft palate, fauces, and uvula
- **Class 3:** Visibility of the soft palate and base of the uvula
- **Class 4:** Only the hard palate is visible (soft palate not visible)

Acromio-Axillo-Suprasternal Notch Index (AASNI)

AASNI was assessed with patients in a supine position, using the following measurements :

- **Line A:** Distance from the acromion to the upper axillary fold, parallel to the body's longitudinal axis
- **Line B:** A perpendicular line extending from Line A to the suprasternal notch
- **Line C:** Intersection of Lines A and B measured using a ruler

AASNI was calculated as: C / A

AASNI ≥ 0.5 was classified as DVL predictor, while AASNI < 0.5 indicated easy visualisation of the larynx (EVL)

Perioperative Procedure

On the day of surgery, patients were transferred to the operation theatre, where standard monitors (ECG, NIBP, pulse oximetry) were attached. An intravenous (IV) line was secured, and preoxygenation (100% O_2 for 3 minutes) was administered. Anesthesia was induced using:

Premedication: Glycopyrrolate (0.2 mg), Midazolam (2 mg), and Fentanyl (2 mcg/kg)

- **Induction Agents:** Propofol (2 mg/kg)
- **Muscle Relaxant:** Succinylcholine (2 mg/kg, max dose 100 mg)
- After one minute of manual ventilation with 100% oxygen, direct laryngoscopy was performed using a Macintosh blade (No. 3 or 4). The Cormack-Lehane (CL) grading was recorded for each patient .
- **Laryngoscopic Examination and Cormack-Lehane Grading**

After performing direct laryngoscopy, laryngeal visualization was classified as follows:

- **Grade 1:** Full visibility of the glottic aperture
- **Grade 2:** Partial visibility of the glottis
- **Grade 3:** Only the epiglottis is visible
- **Grade 4:** No glottic structure is visible

Patients with CL Grade 3 or 4 were classified as having difficult visualisation of the larynx (DVL), whereas those with CL Grade 1 or 2 were classified as having easy visualisation of the larynx (EVL).

Statistical Analysis

The predictive accuracy of MMP and AASNI was assessed by comparing them with CL grading using statistical measures including: Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), Odds Ratio and Likelihood Ratios

All data were analyzed using SPSS software (version 22.0) and Microsoft Excel. The receiver operating characteristic (ROC) curve analysis was performed to determine the diagnostic accuracy of AASNI and MMP.

Outcome Measures

The primary outcome measure was the ability of MMP and AASNI to predict difficult visualisation of the larynx (DVL) during direct laryngoscopy. The efficacy of both tests was compared using statistical analysis to determine which test is more reliable for preoperative airway assessment.

Bias

To minimize selection bias, participants were consecutively enrolled based on predefined inclusion and exclusion criteria, ensuring a representative sample of patients undergoing elective surgeries. Observer bias was reduced by ensuring that the anesthesiologist performing the preoperative airway assessments (MMP and AASNI) was different from the one recording the Cormack-Lehane grading during laryngoscopy, both of whom were blinded to each other's findings. Standardized procedures and calibrated measurement tools were used to enhance consistency and reduce measurement bias. Data entry and analysis were cross-verified by an independent researcher to minimize data handling errors.

Ethical Considerations

This study was conducted following the ethical principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee (IEC/CD/2022/05/11/2022) of Konaseema Institute of Medical Sciences and Research Foundation, Andhra Pradesh. Written informed consent was obtained from all participants before enrollment. Patient confidentiality and data privacy were strictly maintained throughout the study.

RESULTS

A total of 106 patients were included in this prospective observational study. The results of demographic characteristics, airway assessments, and statistical comparisons of the modified Mallampati classification (MMP) and Acromio-Axillo-Suprasternal Notch Index (AASNI) in predicting

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difficult visualisation of the larynx (DVL) are presented below.

Demographic Data

The gender distribution of the study participants showed that 58 (54.7%) were male and 48 (45.3%) were female (Table 1).

Table 1: Gender Distribution

Gender	Number	Percentage
Male	58	54.7%
Female	48	45.3%
Total	**106**	**100%**

The age of the patients ranged from 18 to 59 years, with the highest proportion belonging to the 40–50-year age group (38.7%), followed by the 30–40-year group (28.3%) (Table 2).

Table 2: Age Distribution

Age Group (Years)	Number	Percentage
<20	5	4.7%
20-30	20	18.87%
30-40	30	28.3%
40-50	41	38.7%
50-60	10	9.42%
Total	**106**	**100%**

The mean age of the participants was 38.11 years (SD: 9.88) (Table 3).

Table 3: Demographic Data

Characteristics	Minimum	Maximum	Mean	Standard Deviation
Age (years)	18	59	38.11	9.88
Height (cm)	150	176	162.04	5.79
Weight (kg)	40	98	66.02	8.33
BMI	17.3	31.63	24.75	2.33

The mean height of the participants was 162.04 cm (SD: 5.79), and their weight ranged from 40 to 98 kg, with a mean of 66.02 kg (SD: 8.33). The mean BMI was 24.75 (SD: 2.33), with the majority of participants classified as normal weight (52.83%), while 43.40% were overweight, 2.83% were obese, and 0.94% were underweight (Table 4).

Table 4: BMI Classification

Classification	BMI (Kg/m²)	Number	Percentage
Underweight	<18.5	1	0.94%
Normal	18.5-24.99	56	52.83%
Overweight	25-29.99	46	43.40%
Obese	≥30	3	2.83%

Vital Parameters

- The vital parameters recorded in this study showed:
- **Mean systolic blood pressure (SBP):** 111.698 mmHg (Range: 90–130 mmHg)
- **Mean diastolic blood pressure (DBP):** 71.13 mmHg (Range: 60–90 mmHg)
- **Mean arterial pressure (MAP):** 84.66 mmHg (Range: 70–103.33 mmHg)
- **Mean pulse rate (PR):** 76 beats/min (Range: 52–102 beats/min)
- **Mean respiratory rate (RR):** 15 breaths/min (Range: 12–17 breaths/min)
- **Mean oxygen saturation (SpO2):** 99% (Range: 98–100%) (**Table 5**).

Table 5: Vital Parameters

Vital Parameter	Minimum	Maximum	Mean	Standard Deviation
SBP (mmHg)	90	130	111.698	10.279
DBP (mmHg)	60	90	71.13	8.872
MAP (mmHg)	70	103.33	84.66	9.001
PR (per min)	52	102	76	11.956
RR (per min)	12	17	15	1.293
SpO2 (%)	98	100	99	0.756

Airway Examination

Modified Mallampati Classification (MMP)

The MMP classification was assessed preoperatively for all patients, revealing:
Class 1: 30 patients (28.3%)
Class 2: 56 patients (52.83%)
Class 3: 18 patients (16.98%)
Class 4: 2 patients (1.89%) (**Table 6**).

Table 6: Airway Examination - MMP Classification

MMP Class	Number	Percentage
Class 1	30	28.3%
Class 2	56	52.83%
Class 3	18	16.98%
Class 4	2	1.89%
Total	**106**	**100%**

A total of 20 patients (18.87%) were classified as having difficult visualisation of the larynx (DVL) based on MMP (Class 3 and 4).

Acromio-Axillo-Suprasternal Notch Index (AASNI)

Based on AASNI classification:

≥0.5 (Predicting DVL): 40 patients (37.73%)

<0.5 (Predicting Easy Visualisation of Larynx - EVL): 66 patients (62.26%) (**Table 7**).

Table 7: Airway Examination - AASNI Classification

AASNI	Number	Percentage
≥0.5	40	37.73%
<0.5	66	62.26%
Total	**106**	**100%**

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Cormack-Lehane (CL) Grading

The direct laryngoscopic view was classified using the Cormack-Lehane (CL) grading system: **Grade 1:** 52 patients (49.06%), **Grade 2:** 30 patients (28.3%), **Grade 3:** 24 patients (22.64%), **Grade 4:** 0 patients (0%) (**Table 8 & Figure No:1**). A total of 24 patients (22.64%) were classified as having difficult visualisation of the larynx (DVL) based on CL grading (Grade 3 and 4).

Table 8: Airway Examination - Cormack-Lehane (CL) Grading

CL Grade	Number	Percentage
Grade 1	52	49.06%
Grade 2	30	28.3%
Grade 3	24	22.64%
Grade 4	0	0%
Total	**106**	**100%**

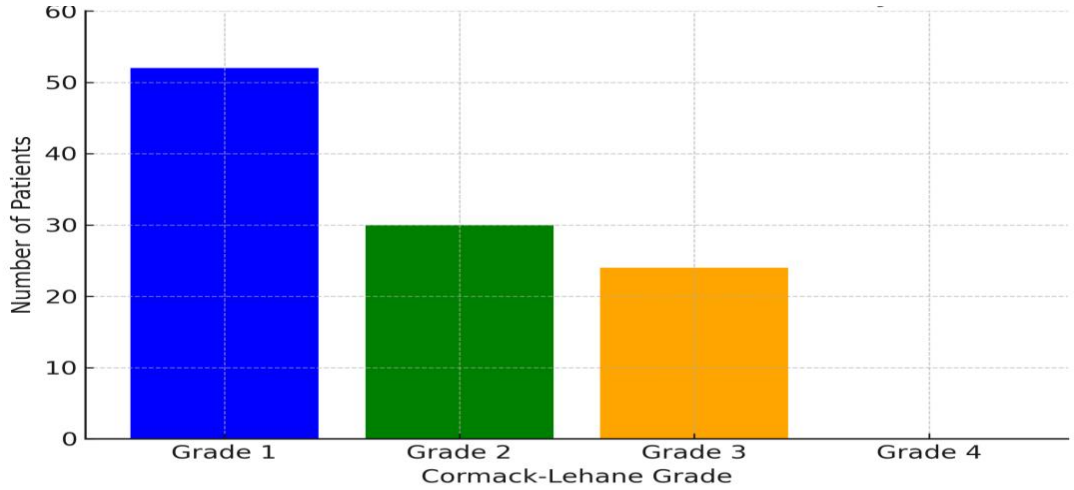

Figure No:1.Distribution of Cormack-Lehane (CL) Grading in Airway Examination

Comparison of MMP and AASNI in Predicting DVL

To evaluate the predictive value of MMP and AASNI, their sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated (Table 9 & **Figure No:2**).

Table 9: Comparison of MMP and AASNI in Predicting DVL

Parameter	MMP (%)	AASNI (%)
Sensitivity	41.67	83.3
Specificity	87.8	75.6
PPV	50	50
NPV	83.7	93.9

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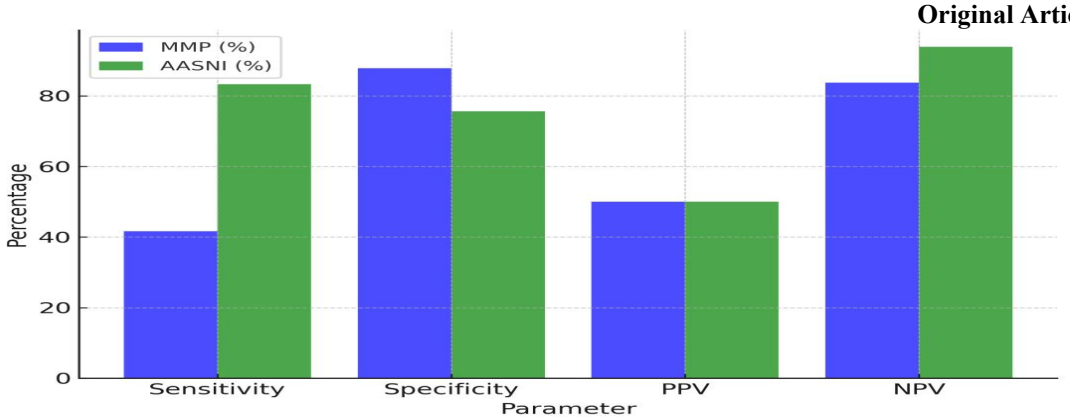

Figure No:2.Comparison of MMP and AASNI in Predicting DVL

Sensitivity was significantly higher for **AASNI (83.3%)** compared to **MMP (41.67%)**, indicating that AASNI was better at correctly identifying patients with DVL. **Specificity** was higher for MMP (87.8%) than AASNI (75.6%). **Positive Predictive Value (PPV)** was equal for both (50%). **Negative Predictive Value (NPV)** was greater for AASNI (93.9%) than MMP (83.7%), suggesting that AASNI had a lower false-negative rate.

Odds Ratio, Likelihood Ratio, and Accuracy

Further statistical comparisons of MMP and AASNI were performed using odds ratio, likelihood ratio, and accuracy (Table 10):

Table 10: Odds Ratio, Likelihood Ratio, and Accuracy

Parameter	MMP	AASNI
Odds Ratio	5.14	15.5
Likelihood Ratio (+)	3.41	3.41
Likelihood Ratio (-)	0.664	0.220
Accuracy	0.7736	0.7736

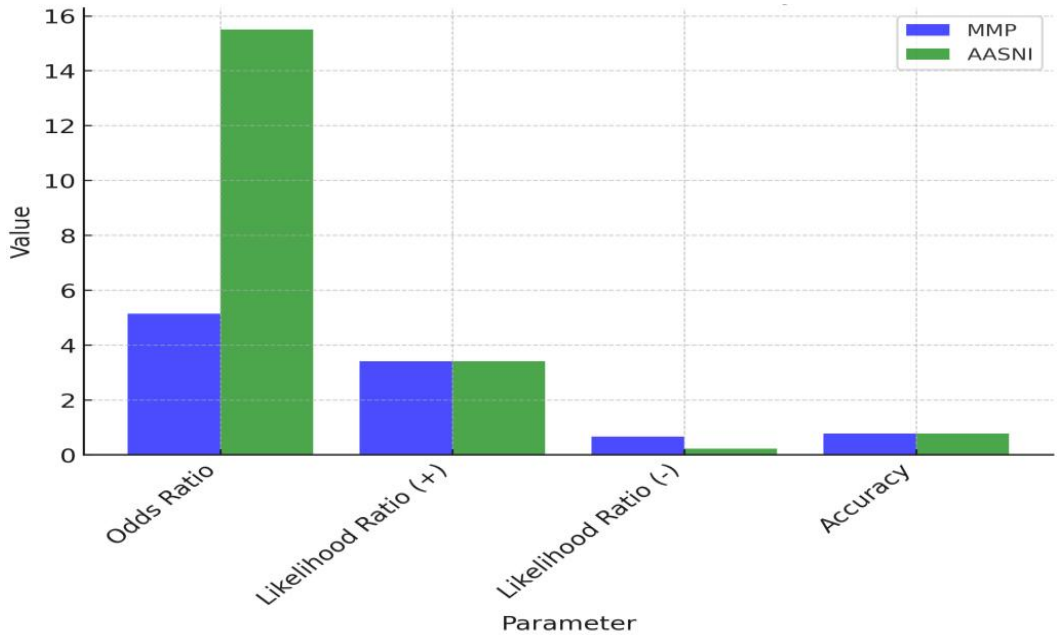

Figure No:3.Odds Ratio, Likelihood Ratio, and Accuracy

Odds Ratio: AASNI (**15.5**) was higher than MMP (**5.14**), indicating that AASNI had a stronger predictive ability for DVL.

Positive Likelihood Ratio (+LR): Both AASNI and MMP had the same value of **3.41**.

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Negative Likelihood Ratio (-LR): AASNI (**0.220**) was much lower than MMP (**0.664**), highlighting the stronger ability of AASNI to rule out DVL.

Overall Accuracy: Both tests had an equal accuracy of 77.36%.

Discussion

This study evaluated the predictive accuracy of Modified Mallampati Classification (MMP) and Acromio-Axillo-Suprasternal Notch Index (AASNI) in assessing difficult visualisation of the larynx (DVL). The findings demonstrate that AASNI has superior sensitivity (83.3%) and negative predictive value (93.9%) compared to MMP (41.67% and 83.7%, respectively), indicating that AASNI is a more reliable screening tool for identifying patients at risk of difficult laryngoscopy. While MMP exhibited higher specificity (87.8%) than AASNI (75.6%), its low sensitivity limits its utility as an independent predictor. These results highlight AASNI's effectiveness as a preoperative airway assessment tool, offering a more objective and reproducible alternative to MMP. Similar findings have been reported in previous studies where AASNI was shown to be a better predictor of difficult airway visualization compared to MMP and other conventional airway assessment tools[8,9] .

The predictive value of airway assessment tools has been extensively studied, with no single test being universally reliable for predicting a difficult airway[12]. The Modified Mallampati Classification (MMP) remains widely used in clinical practice but is often criticized for its subjectivity, dependency on patient cooperation, and variability in observer interpretation. Previous studies have reported low sensitivity values for MMP, ranging from 35–50%, reinforcing its limited ability to predict difficult laryngoscopy accurately[8,9]. The current study's findings align with these observations, as MMP demonstrated a sensitivity of only 41.67%, making it an unreliable sole predictor of DVL. Ethiopia study also reported suboptimal agreement between MMP and Cormack-Lehane grading, further emphasizing MMP's limitations[11].

In contrast, AASNI offers a more standardized and quantifiable approach. The present study found that AASNI exhibited a significantly higher odds ratio (15.5 vs. 5.14) and a lower negative likelihood ratio (0.220 vs. 0.664) compared to MMP, suggesting that AASNI provides a more robust and reliable prediction of difficult airway cases. These results are consistent with previous studies that have reported higher sensitivity and predictive accuracy for AASNI compared to conventional airway assessment tools[10,13]. Furthermore, studies have compared AASNI with other traditional airway assessment tools, such as thyromental distance (TMD) and upper lip bite test (ULBT), and found AASNI to be superior in predicting difficult airway cases.

Clinical Implications

The findings of this study underscore the importance of incorporating AASNI into routine preoperative airway assessment. Given its higher sensitivity and ease of measurement in both supine and upright positions, AASNI serves as a practical and reliable screening tool for predicting difficult laryngoscopy before anesthesia induction. The clinical significance of these results lies in the potential reduction of unanticipated difficult intubations, which remains a leading cause of anesthesia-related complications, including hypoxic brain injury and perioperative mortality[12,13].

Furthermore, while AASNI demonstrated superior predictive ability, this study reinforces the need for a multi-modal approach to airway assessment. Relying solely on a single screening tool may not provide adequate predictive accuracy. Combining AASNI with other preoperative assessments, such as thyromental distance (TMD), sternomental distance (SMD), and neck mobility tests, could further enhance the ability to identify difficult airway cases[14]. Machine learning algorithms have also been proposed as an advanced method to integrate multiple airway assessment parameters and improve difficult airway prediction[13]

Generalizability

The findings of this study are potentially generalizable to adult patients aged 18–60 years undergoing elective surgery under general anesthesia in similar hospital settings. However, since the study was conducted at a single tertiary care center with a relatively small sample size (n=106), extrapolation to emergency cases, pediatric patients, or those with complex comorbidities should be done with caution. Multicenter studies with more diverse populations are recommended to enhance external validity..

Conclusion

This study demonstrated that AASNI is a superior predictor of difficult laryngoscopy compared to MMP, with higher sensitivity, better negative predictive value, and stronger predictive accuracy. Although MMP remains a commonly used tool, its low sensitivity limits its reliability as an independent predictor. The findings support the incorporation of AASNI into routine preoperative airway assessments, as it provides a more objective, reproducible, and accurate method for predicting difficult airway cases. Future research should focus on validating these

findings in larger and more diverse patient cohorts to establish AASNI as a standardized airway assessment tool in clinical anesthesia practice.

Limitations of the Study

This study has several limitations, including its single-center design, which limits the generalizability of the findings. The relatively small sample size of 106 patients could be improved to enhance statistical power. Additionally, the exclusion of key airway parameters, such as sternomental distance and neck circumference, restricts the comprehensiveness of the airway assessment model. Future research should address these limitations to provide more robust conclusions.

Recommendations

Based on the findings of this study, it is recommended that the Acromio-Axillo-Suprasternal Notch Index (AASNI) be routinely incorporated into pre-anesthetic airway assessment due to its higher sensitivity and predictive accuracy compared to the Modified Mallampati Classification (MMP). AASNI is simple, objective, and easily reproducible in clinical settings. While AASNI performs better individually, combining it with other airway assessment tools such as thyromental distance and neck mobility tests can further improve predictive accuracy. Standardized training on AASNI measurement is advised to reduce interobserver variability. Multicenter studies with larger and more diverse populations are needed to confirm generalizability. Incorporating AASNI into institutional protocols and airway management guidelines is encouraged. This approach can improve early identification of difficult laryngoscopy and enhance patient safety.

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List of Abbreviations :

AASNI – Acromio-Axillo-Suprasternal Notch Index
MMP – Modified Mallampati Classification
DVL – Difficult Visualization of the Larynx
EVL – Easy Visualization of the Larynx
CL – Cormack-Lehane
ASA – American Society of Anesthesiologists
SBP – Systolic Blood Pressure
DBP – Diastolic Blood Pressure
MAP – Mean Arterial Pressure
PR – Pulse Rate
RR – Respiratory Rate
SpO_2 – Oxygen Saturation
PPV – Positive Predictive Value
NPV – Negative Predictive Value
+LR – Positive Likelihood Ratio
−LR – Negative Likelihood Ratio
ROC – Receiver Operating Characteristic

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Conflicts of interest:

Author declares no conflict of interest.

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Author's contribution:

MNPK-Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript. **PAV**-Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript,

revision of manuscript.**KGK-**Review of literature and preparing first draft of manuscript. Statistical analysis and interpretation.

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