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Original Article

Anaesthesia Section

Comparison of Acromio-Axillo-Suprasternal Notch Index with Upper Lip Bite Test to Predict Difficult Visualisation of Larynx: A Prospective Observational Study

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ABSTRACT

Introduction: Preoperative prediction of Difficult Visualisation of Larynx (DVL) remains a critical aspect of safe anaesthetic practice. Failure to anticipate airway difficulty leads to serious complications. Various bedside airway assessment tests like the Upper Lip Bite Test (ULBT) are widely used, but none provide complete reliability. The Acromio-Axillo-Suprasternal Notch Index (AASI) is a newer anatomical parameter proposed to improve predictive accuracy.

Aim: To compare the diagnostic performance of AASI and ULBT to predict DVL in adult patients undergoing elective surgery under general anaesthesia.

Materials and Methods: This single-blinded prospective observational study was conducted in the Department of Anaesthesiology at Smt. BKS Medical Institute and Research Centre, Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat, India. The study included 166 patients aged 18-60 years, classified as American Society of Anaesthesiologists (ASA) I-III, scheduled for elective surgeries. Patients with Body Mass Index (BMI) ≥35 kg/m², airway deformities, or emergency conditions were excluded. Preoperative airway assessment was performed using ULBT and AASI (cut-off ≥0.49). Following induction of anaesthesia, direct laryngoscopy was performed and graded using the Cormack-Lehane (CL) classification. Grades I-II were considered easy and Grades III-IV as DVL. Quantitative data were analysed using the independent student's t-test, qualitative data using the Chi-square test, and the diagnostic validity of AASI and ULBT was assessed by sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive value (NPV), and accuracy.

Results: Out of 166 patients, 23 (13.86%) had DVL. Mean age and gender distribution was comparable between two groups (38.44±10.89 vs 40.53±11.09, p=0.24), (p-value=0.25). There were no significant differences in mean weight, height, or BMI between groups (p-value >0.05). Distribution of ASA grades also did not differ significantly (p-value=0.08). AASI demonstrated sensitivity of 60.87%, specificity of 91.61%, PPV of 53.85%, NPV of 93.57%, and accuracy of 87.35%. ULBT showed sensitivity of 47.83%, specificity of 90.21%, PPV of 44.00%, NPV of 91.49%, and accuracy of 84.34%.

Conclusion: AASI is a superior predictor of DVL compared to ULBT, with higher sensitivity, specificity, and overall diagnostic accuracy. Its high negative predictive value makes it a useful screening tool in clinical practice. However, as no single test is completely reliable, combining AASI with other airway assessment methods may further enhance prediction and improve patient safety.

Keywords: Airway management, Anaesthesia, Difficult airway, Laryngoscopy, Sensitivity, Specificity

INTRODUCTION

Effective airway management stands as a fundamental pillar of anaesthesiology, with endotracheal intubation serving as a common and often life-sustaining procedure [1]. Failure to establish and maintain a patent airway can result in catastrophic complications such as hypoxaemia, aspiration, brain injury, and cardiovascular collapse [2]. Consequently, the preoperative identification of a potential DVL is a paramount concern for anaesthesiologists, enabling anaesthesiologists to formulate an appropriate airway management plan, arrange advanced airway equipment, and reduce perioperative morbidity and mortality [3]. Despite advances in airway devices and visualisation techniques, unanticipated difficult intubation continues to contribute significantly to anaesthesia-related complications worldwide.

Numerous clinical bedside tests have been developed to forecast DVL, including the Modified Mallampati Test (MMT), Thyromental Distance (TMD), Sternomental Distance (SMD), ULBT, inter-incisor gap, neck mobility assessment, and Wilson risk score [4-6]. Although these tests are simple and non-invasive, their predictive value remains inconsistent across different patient populations. Most bedside tests demonstrate either low sensitivity or low specificity when used individually, and none has proven sufficiently reliable as a standalone predictor of DVL [7-9]. For instance, MMT, while commonly performed, often exhibits moderate discriminative power when used in isolation [10]. Consequently, anaesthesiologists often combine multiple airway assessment methods to improve diagnostic accuracy.

The AASI, a more recently introduced anatomical measurement, proposes an objective ratio derived from the vertical distance from the acromion to the axillary fold and the perpendicular offset to the suprasternal notch [11,12]. Comparisons with other ratios, such as Hyomental Distance Ratio (HMDR), suggest that AASI as simpler and more visually intuitive, with better sensitivity and PPV [13].

The ULBT has gained recognition for its potential utility, with some studies suggesting its superiority over MMT in certain predictive parameters [14,15]. Introduced as a simple bedside maneuver assessing mandibular subluxation, ULBT evaluates the patient's ability to bring the lower incisors to the upper lip vermilion border, graded from Class-I (full coverage) to Class-III (inability to reach) [16]. Multiple investigations have reported variable performance of ULBT across populations, this may be related to craniofacial anatomical variations, differences in dentition, and study methodology. Thus,

although ULBT is widely accepted as a useful bedside test, its universal applicability remains uncertain [16-18].

Despite these advancements, most previous studies have evaluated either ULBT or AASI independently against conventional airway assessment tests rather than comparing them head-to-head [17-20]. Only few studies have compared AASI with ULBT [11,21]. Existing literature reveals inconsistencies: ULBT's performance fluctuates across demographics (e.g., higher specificity in Asians versus lower in North Americans) [22], while AASI shows consistent superiority in anatomical predictability but requires validation against dynamic tests like ULBT [19,23]. This research gap — the limited direct evaluation of AASI versus ULBT — highlights the need for comparative studies especially regarding specificity, PPV, and execution time in standard cohorts-highlights the need for comparative studies to refine airway assessment protocols. By directly comparing a relatively newer anatomical index with an established bedside functional assessment tool, this study seeks to address existing gaps in the literature and contribute evidence toward improving preoperative airway assessment and patient safety. The present study aimed to compare the AASI with the ULBT in predicting DVL using CL grading as the reference standard.

MATERIALS AND METHODS

This single-blinded prospective observational study was conducted in the Department of Anaesthesiology at Smt. BKS Medical Institute and Research Centre, Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat, India, from October 2025 to December 2025 following approval from the Institutional Ethics Committee (SVIEC/ON/Medi/ SRP/May/25/83) with Clinical Trial Registry - India (CTRI) number CTRI/2025/08/093477. Written informed consent was obtained from all participants.

Sample size calculation: To calculate the required sample size for sensitivity estimation, the following statistical formula was used:

$$n=Z^2\times P\ (1-P)/d^2$$

- n=Required sample size.
- Z=Z-score for the desired confidence level (2.576 for 99% confidence).
- P=Expected sensitivity derived from previous literature.
- d=Margin of error (Precision), set at 10% (0.10).

considering sensitivity of 61.1% for AASI and 50% for the ULBT from the study done by Shunkam R et al., [11], the parameters were substituted into the formula:

$$n=2.576^2\times0.5\times(1-0.5)/0.10^2=\sim166$$

So, total of 166 participants were included in this study

To minimise observer bias, a single-blinded approach was implemented. The experienced anaesthesiologist (with minimum 3 years' experience) performing the laryngoscopy and grading the DVL using the Cormack-Lehane scale was unaware of the preoperative AASI and ULBT assessment results, which were recorded by primary investigator.

Inclusion criteria: Total 166 adult patients aged 18 to 60 years, classified as ASA physical status I, II & III and scheduled for elective surgeries under general anaesthesia were included in the study.

Exclusion criteria: Those patients having history of significant neck or spine deformities, emergency surgeries, and those with a body mass index >35 kg/m^2 were excluded from the study.

Study Procedure

All patients underwent a detailed preanaesthetic check-up a day prior to the scheduled elective surgery to determine fitness and eligibility for the study.

During the preoperative evaluation, all patients were assessed using two primary screening indices:

- **Upper Lip Bite Test (ULBT) [22]:** Patients were asked to bite their upper lip with their lower incisors, and results were categorised into Class I, II, or III.

  Class I: Lower incisor can hide mucosa of upper lip;

  Class II: Lower incisor partially hides mucosa of upper lip;

  Class III: Lower incisor unable to touch mucosa of upper lip;

  ULBT class III was considered for predicting DVL.
- **Acromio-Axillo-Suprasternal Notch Index (AASI) [23]:** Measurements were taken on 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). Cut off value of 0.49 was taken for predicting DVL [23].

Upon transfer to the operating room, standard monitoring like non-invasive blood pressure cuff, SpO_2 probe, Electrocardiogram leads was applied. Following induction of general anaesthesia according to institutional protocol, direct laryngoscopy was performed by an experienced anaesthesiologist using a Macintosh laryngoscope. The laryngeal view was graded using the CL Grading System [24].

- Grade-I: Full view of the glottis.
- Grade-II: Partial view of the glottis.
- Grade-III: Only epiglottis visible.
- Grade-IV: No view of the glottis.

Visualisation of larynx was categorised based on these findings: Easy (Grade I/II) or Difficult (Grade III/IV) [23]. Postoperatively, the recorded preoperative values of AASI and ULBT were compared against the intraoperative CL grades.

Predictive values of AASI and ULBT were calculated as below [25].

Sensitivity=True Positives/True Positives+False Negatives

Specificity=True Negatives/True Negatives+False Positives

Positive Predictive Value (PPV)=True Positives/True Positives+False Positives

Negative Predictive Value (NPV)= True Negatives/True Negatives +False Negatives

STATISTICAL ANALYSIS

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25.0. Quantitative data were expressed as Mean±Standard Deviation and comparison was performed using the independent student's t-test. Qualitative data were expressed as numbers (percentages) and comparison was performed using the Chi-square test. A p-value <0.05 was considered statistically significant. Sensitivity, specificity, PPV, NPV, and Accuracy were calculated for both AASI and ULBT against the gold standard (Cormack-Lehane Grading).

RESULTS

Demographic data are shown in [Table/Fig-1]. The baseline demographic and clinical characteristics were comparable between the CL 1-2 (n=143) and CL 3-4 (n=23) groups. There were no statistically significant differences in age, sex distribution, weight, height, BMI, or ASA physical status between the two groups (all p-value >0.05), indicating that the study groups were well matched at baseline. Although a higher proportion of patients in the CL 3-4

Variables		Mean±SD or Number (%)	CL 1 and 2 (n=143)	CL 3 and 4 (n=23)	p-value
Age (years)		39.18±10.98	38.44±10.89	40.53±11.09	0.24
Sex	Male, n (%)	90 (54.22)	75 (52.44)	15 (65.22)	0.25
	Female, n (%)	76 (45.78)	68 (47.22)	8 (34.78)	
Weight (kg)		72.15±9.4	71.03±11.36	73.26±7.44	0.35
Height (cm)		171.29±7.51	170.47±8.35	172.11±6.66	0.371
BMI (kg/m^2)		24.71±3.92	24.55±4.40	24.88±3.44	0.739
ASA grading	I	80 (48.2)	64 (44.76)	16 (69.57)	0.08
	II	51 (30.72)	47 (32.87)	4 (17.39)	
	III	35 (21.08)	32 (22.38)	3 (13.04)	

[Table/Fig-1]: Demographic and clinical characteristics of participants. Continuous variables are expressed as mean±standard deviation and categorical variables as number (%). p<0.05 was considered statistically significant.
(Independent students' t-test for age, weight, height and BMI. Chi-square test for sex and ASA grading)

group were classified as ASA I (69.57% vs. 44.76%), this difference did not reach statistical significance (p-value=0.08).

Preoperative grading of patients for ULBT, AASI values and intraoperative CL grade are shown in [Table/Fig-2]. Out of 166 patients, ULBT grades I, II, and III observed in 92, 49, and 25 patients, respectively and 140 patients (84.3%) had a AASI value <0.49, while 26 patients (15.7%) had a AASI value ≥0.49. Cormack–Lehane Grades I and II were the most common laryngoscopic findings (88 and 55 patients, respectively), while Grades III and IV were observed in 14 and 9 patients.

Variables	No. of patients
ULBT Grade (I/II/III)	92/49/25
AASI Value (<0.49/≥0.49)	140/26
Cormack Lehane Grade (I/II/III/IV)	88/55/14/9

[Table/Fig-2]: Result of ULBT, AASI and Cormack Lehane Grade.

Predictive values of AASI and ULBT are shown in [Table/Fig-3]. The AASI demonstrated better diagnostic performance than the ULBT for predicting difficult laryngoscopy, with higher sensitivity (60.87% vs 47.83%), specificity (91.61% vs 90.21%), PPV (53.85% vs 44.00%), NPV (93.57% vs 91.49%), and overall accuracy (87.35% vs 84.34%).

In the present study, AASI at a cut-off value of ≥ 0.49 demonstrated a sensitivity of 60.87%, specificity of 91.61%, PPV of 53.85%, NPV of 93.57%, and overall accuracy of 87.35%. A study done by Rajkhowa T et al., found AASI (≥0.5) had sensitivity of 81.25%, specificity of 96.7%, PPV 48.15%, NPV of 99.27% [19]. Similarly, a study by Suryawanshi CM and Bhatia J reported AASI sensitivity of 98.73%, specificity of 71.43%, and an AUC of 0.851, concluding that AASI (≥0.5) serves as an excellent predictor for DVL [20]. In study by Safavi M et al., AASI at a cut-off of 0.515 demonstrated sensitivity of 84.6%, specificity of 77.7%, PPV of 78.5%, NPV of 84%, and overall accuracy of 81.13%, with an AUC of 0.857 [28]. The lower sensitivity (60.87%) in this study may be due to population, sample size, or cut-off differences. However, the high NPV (93.57%) reliably excludes difficult intubation.

In the present study, ULBT demonstrated a sensitivity of 47.83%, specificity of 90.21%, PPV of 44.00%, NPV of 91.49%, and overall accuracy of 84.34%. A systematic review done by Faramarzi E et al., found that the accuracy of ULBT exceeded 85% in 24 out of 27 studies, and all but one study reported high specificity (>85%), with a consistently high NPV [18]. A study of ULBT and TMD done by Salimi A et al., reported sensitivity, specificity, PPV, NPV, and accuracy of 70%, 93.3%, 39%, 98.1%, and 92.6%, respectively, for ULBT, with specificity and PPV found to be significantly higher for ULBT than for TMD [29]. ULBT performance may be limited by dental status, patient cooperation, and grading variability, which could partly explain its lower sensitivity in this study.

When the two tests were compared, AASI outperformed ULBT across all key diagnostic parameters. This superiority of AASI is clinically meaningful, especially in terms of sensitivity - a higher sensitivity reduces the rate of missed difficult intubation cases (false negatives), which is critical for patient safety. The findings of the present study are consistent with the work by Bhaktavar J and Gupta P who conducted a study comparing AASI, ULBT, and the Ratio of Height to TMD (RHTMD) for predicting DVL [21]. In their study, AASI outperformed ULBT, showing higher sensitivity (93.9% vs 42.4%), specificity (97.6% vs 87.7%), and diagnostic accuracy (97.1% vs 81.3%). Despite lower sensitivity and accuracy in the present study (may be due to methodological differences); both studies confirmed AASI's superiority over ULBT. The findings of the present study are also in close agreement with those of Sunkam R et al., who conducted a study comparing AASI, ULBT, and MMP score for predicting DVL, using the same AASI cut-off of ≥ 0.49 [11]. In their study, AASI demonstrated higher sensitivity (61.1% vs 50.0%), specificity (93.2% vs 71.2%), PPV (55.0% vs 19.1%), NPV (94.6% vs 91.3%), accuracy (89.3% vs 68.7%), and odds ratio (21.5 vs 2.5) compared with ULBT for predicting DVL. This closely aligns with the findings of the present study.

	TP	FP	FN	TN	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)	Accuracy % ((95% CI)
AASI	14	12	9	131	60.87 (38.54-80.29)	91.61 (85.80-95.59)	53.85 (38.25-68.72)	93.57 (89.71-96.05)	87.35 (81.31-92.00)
ULBT	11	14	12	129	47.83 (26.82-69.41)	90.21 (84.12-94.54)	44.00 (28.97-60.21)	91.49 (87.87-94.10)	84.34 (77.90-89.51)

[Table/Fig-3]: Predictive value of AASI and ULBT.
TP: True positive; FP: False positive; FN: False negative; TN: True negative; PPV: Positive predictive value; NPV: Negative predictive value

DISCUSSION

The accurate prediction of difficult intubation remains a significant challenge in anaesthesiology, with no single test achieving perfect predictive capability [5,8]. This prospective study compared AASI and ULBT for predicting DVL in 166 adults undergoing elective surgery. In this study, among 166 patients, 23 (13.86%) had DVL (CL Grade 3 and 4). This incidence exceeds the reported pooled frequency of 6.8% and unanticipated DVL rate of 1.5–8.5%, possibly due to inclusion of ASA III patients with co-morbidities affecting airway anatomy [26,27].

The easy (CL 1 and 2, n=143) and difficult (CL 3 and 4, n=23) laryngeal visualisation groups were comparable in age, sex, weight, height, BMI, and ASA status (all p-value >0.05), minimising confounding and allowing valid assessment of airway prediction indices. These findings are consistent with those reported by Rajkhowa T et al., who found that baseline demographic characteristics did not differ significantly between easy and difficult laryngoscopy groups while evaluating the AASI [19]. Similarly, Kamranmanesh MR et al., observed that demographic variables were not significant between easy and difficult laryngoscopy group [23].

The anatomical rationale for the success of AASI lies in its measurement of the vertical distance between the acromio-axillary line and the suprasternal notch. A higher index indicates that the suprasternal notch is positioned deeper relative to the chest wall. Clinically, this often corresponds to an "anterior larynx" or a shorter, thicker neck, both of which are known to impede the alignment of the oral, pharyngeal, and laryngeal axis during direct laryngoscopy [19]. Furthermore, the AASI offers a distinct advantage in terms of objectivity. Unlike the ULBT, which requires the patient to have functional lower incisors and the ability to follow specific instructions, the AASI is a passive tape-measurement-based index. This makes it particularly useful in trauma, uncooperative patients, or edentulous

individuals where traditional dynamic tests may fail or provide inaccurate results [19,30].

Limitation(s)

The study was conducted at a single centre, which may limit generalisability. The time taken to perform each test was not recorded, which is a relevant practical metric. Exclusion of obese patients was also the limitation of this study.

CONCLUSION(S)

The AASI demonstrated superior sensitivity, specificity, PPV, NPV and overall accuracy in predicting DVL compared to the ULBT. Higher sensitivity reduces missed difficult intubations, while a higher NPV reliably excludes difficult airways — this provides strong reassurance that intubation will be straightforward, making the test valuable for preoperative airway assessment. Given its better diagnostic performance, AASI may serve as a more effective preoperative screening tool for anticipating difficult airway, potentially enabling anaesthesiologists to take early precautionary measures and improve patient safety. However, no single airway assessment test is perfect in isolation; a multimodal approach combining AASI with other clinical predictors may further enhance the accuracy of difficult intubation prediction. Further large-scale multicentric studies involving diverse patient populations and including additional airway assessment parameters are recommended to validate the predictive accuracy of AASI and ULBT.

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