International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Acromio–Axillary–Suprasternal Notch Index (AASI) as a Predictor of Difficult Visualization of the Larynx: An Observational Study

Dr Ashley Elizabeth Thomas[1], Dr Sonia M Lal[2*], Dr Sandhya Sudheer[3], Dr Ushadevi RS[4]

[1] Junior resident Department of Anaesthesiology, Sree Gokulam Medical College, and Research Foundation, Trivandrum, Kerala, India
[2] Associate Professor, Department of Anaesthesiology, Sree Gokulam Medical College, and Research Foundation, Trivandrum, Kerala, India
[3] Specialist Anaesthetist, Department of Anaesthesiology, NMC Specialty Hospital, AlNahda, Dubai, United Arab Emirates
[4] Professor and Head of the Department, Department of Anaesthesiology, Sree Gokulam Medical College, and Research Foundation, Trivandrum, Kerala, India

OPEN ACCESS

Corresponding Author:

Dr Sonia M Lal
Associate Professor, Department of Anaesthesiology, Sree Gokulam Medical College, and Research Foundation, Trivandrum, Kerala, India

Received: 14-10-2025
Accepted: 29-10-2025
Available online: 12-11-2025

ABSTRACT

Background: Unexpected difficulty during intubation can lead to serious complications. The Acromio–Axillary–Suprasternal Notch Index (AASI) has been proposed as a simple bedside test for predicting difficult visualization of the larynx (DVL). This study evaluated the diagnostic accuracy of AASI compared with conventional predictors.
Methodology: A prospective observational study was conducted in 131 adult patients (ASA I–II) undergoing elective surgery under general anesthesia. Preoperative AASI was measured in the supine position, and the Cormack–Lehane (CL) grade during direct laryngoscopy was recorded by an anesthesiologist blinded to AASI values. Grades I–IIa were classified as easy visualization (EVL) and grades IIb–IV as DVL. Receiver operating characteristic (ROC) analysis determined the optimal AASI cutoff for predicting DVL.
Results: DVL occurred in 33.6% (44/131) of patients. Mean AASI was significantly higher in DVL cases (0.53 ± 0.08) than in EVL cases (0.38 ± 0.07; $p < 0.001$). ROC analysis yielded an AUC of 0.86. The optimal AASI cutoff value (0.46) predicted DVL with 72.7% sensitivity, 87.4% specificity, a positive predictive value of 74.4%, and a negative predictive value of 86.4%.
Conclusion: AASI is a simple, non-invasive, and reliable bedside index for predicting difficult laryngoscopy in supine patients. It can complement conventional assessments such as the Modified Mallampati classification, especially when patient cooperation is limited. Further studies with larger populations are warranted to validate its routine use.

Keywords: *Acromio–Axillary–Suprasternal Notch Index, Airway Predictors , Difficult Airway, Laryngoscopy, Mallampati Classification*

INTRODUCTION

Unanticipated difficulty during endotracheal intubation remains a major cause of anesthesia-related morbidity and mortality, with complications ranging from hypoxia and arrhythmias to cardiac arrest.[1,2] Accurate preoperative prediction of difficult visualization of the larynx (DVL) is therefore essential for effective airway management and improved patient safety. Several bedside screening tests such as the Modified Mallampati classification (MPC), thyromental distance, and sternomental distance have been traditionally used to predict difficult laryngoscopy. However, these tests often show limited sensitivity and specificity and depend on patient cooperation and proper positioning, which may not always be feasible—particularly in critically ill or supine patients.[3–6] In 2013, Kamranmanesh *et al.* introduced the Acromio–Axillary–Suprasternal Notch Index (AASI) as a novel, objective, and position-independent predictor of DVL.[7] AASI measures the relative depth of the neck into the thorax and can be assessed easily in the supine position. Early studies reported high diagnostic accuracy for AASI, but evidence remains limited, especially among diverse populations.[8,9,10] The present study was designed to evaluate the diagnostic accuracy of AASI in predicting difficult visualization of the larynx in adult patients undergoing elective surgery under general anesthesia. We aimed to determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of AASI and to compare its performance with the Modified Mallampati classification.

Methodology

Study Design and Setting

A prospective observational study was conducted in the Department of Anaesthesiology, in a superspeciality medical college hospital from September 2022 to September 2023, after obtaining Institutional Research committee (IRC No: 378/08/2022) and Ethics Committee approval (IEC No: 47/623/09/2022).

Participants

Adult patients (18–70 years, ASA physical status I–II) scheduled for elective surgeries under general anesthesia with endotracheal intubation were included by consecutive sampling. Patients with head, neck, or thoracic deformities; cervical spine abnormalities; prior head and neck surgery; history of difficult airway; obesity (BMI > 30 kg/m²); obstetric cases; or inability to open the mouth were excluded.

Sample size

Consecutive sampling was done- consecutive cases meeting the eligibility criteria was included in the study. Sample size was calculated using sensitivity and specificity. Highest sample size was found to be 131.

Measurement of AASI

With the patient in the supine position and arms resting alongside the body, a vertical line (A) was drawn from the acromion process to the upper border of the axilla at the level of the pectoralis major. A perpendicular line (B) was extended from the suprasternal notch to intersect line A. The segment above the intersection was designated as line C. The Acromio–Axillary–Suprasternal Notch Index (AASI) was calculated as C/A.

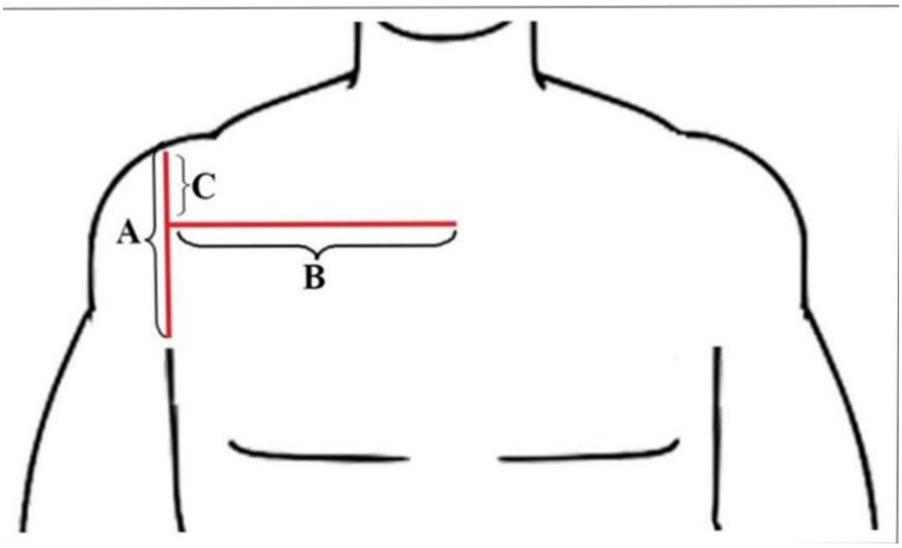

Fig 1: Measurement of AASI

Airway Assessment and Laryngoscopy

Preoperative airway assessment included the Modified Mallampati classification (MPC). Following induction of general anesthesia with standard agents, laryngoscopy was performed in the sniffing position using a Macintosh blade by an anesthesiologist blinded to the AASI values. The laryngeal view was graded according to the modified Cormack–Lehane (CL) scale. Grades I–IIa were classified as easy visualization of the larynx (EVL) and grades IIb–IV as difficult visualization (DVL).

Statistical Analysis

Data were analyzed using SPSS version 25. Receiver operating characteristic (ROC) curve analysis was used to determine the diagnostic accuracy of AASI and identify the optimal cutoff value for predicting DVL. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated. A p-value < 0.05 was considered statistically significant.

Results

Age distribution

131 patients were enrolled for this study whose age group ranges from 21(minimum) to 70 (maximum) . Majority were of the age group 41-50 years (28.2%) and least patients from the age group 61- 70 years (9.9%). We noticed that majority patients had EVL, but in elderly (61-70) and younger (21-30)groups , EVL and DVL both had roughly the same prevalence.

Table 1: Age distribution

Age in years	Frequency	Percent
21-30	21	16
31 – 40	27	20.6
41 – 50	37	28.2
51 – 60	33	25.2
61 – 70	13	9.9
Total	131	100

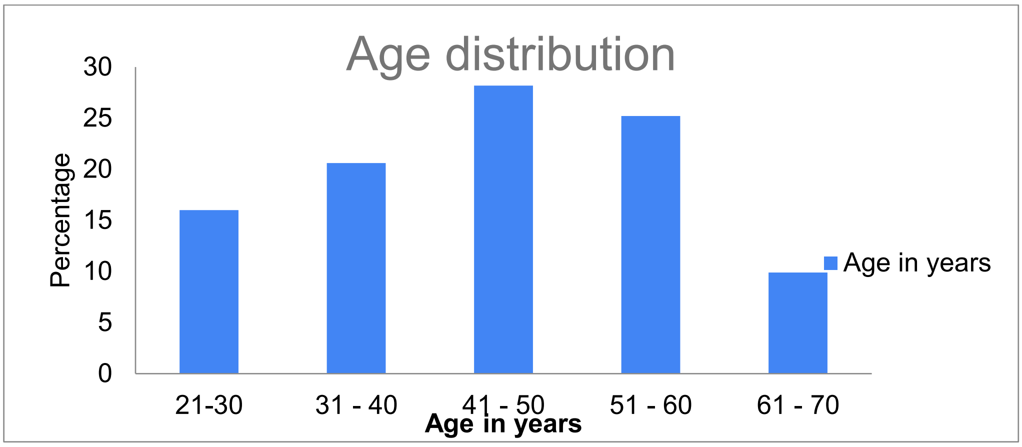

Fig 2: Age distribution

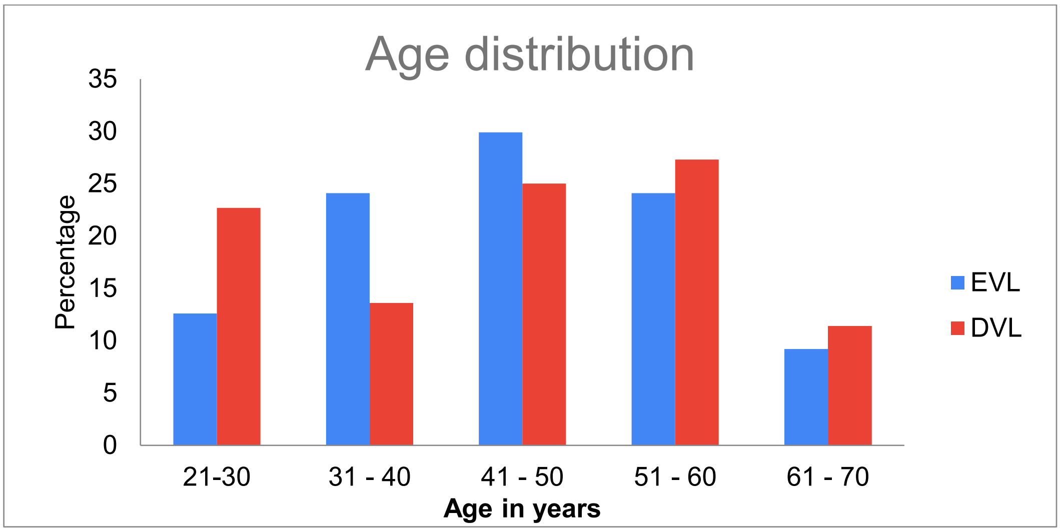

Fig 3: Age v/s DVL , EVL

Table 2: Age v/s DVL , EVL

Age	EVL		DVL		Total		χ^2	df	p
	N	%	N	%	N	%			
21-30	11	12.6	10	22.7	21	16			
31 - 40	21	24.1	6	13.6	27	20.6			
41 - 50	26	29.9	11	25	37	28.2			

51 - 60	21	24.1	12	27.3	33	25.2			
61 - 70	8	9.2	5	11.4	13	9.9	3.916	4	0.417
Total	87	100	44	100	131	100			

<u>Gender distribution</u>

Out of 131 patients in total, 63 (48.1%) were females and 68 (51.9%) were males. Our study is consistent with other studies which state that the incidence of difficult airway is more in males than in females. In this study incidence of DVL in males was 39% and in females was 26%.

Table 3: Gender distribution

Gender	Frequency	Percent
Female	63	48.1
Male	68	51.9
Total	131	100

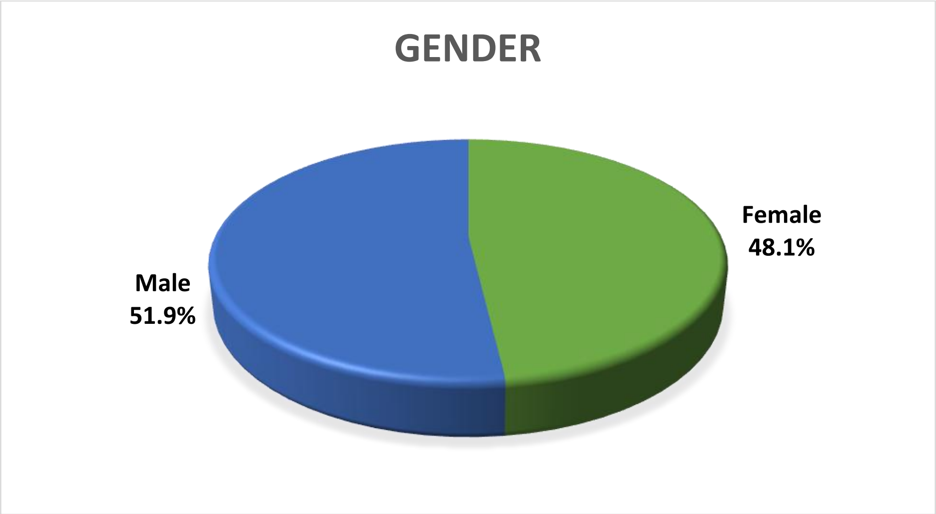

Fig 4: Gender distribution

Table 4: Gender v/s EVL, DVL

	EVL		DVL		Total		χ^2	df	p
Gender	N	%	N	%	N	%			
Female	46	52.9	17	38.6	63	48.1			
Male	41	47.1	27	61.4	68	51.9	2.373	1	0.123
Total	87	100	44	100	131	100			

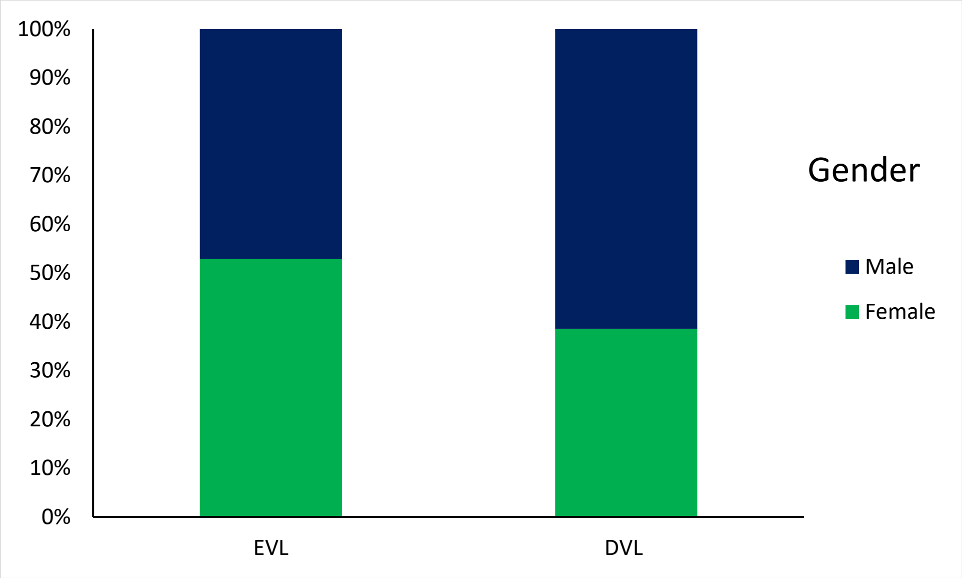

Fig 5: Gender v/s EVL, DVL

<u>BMI Distribution</u>
BMI of the patients ranged from 18 to 29.1. BMI > 30 were not included in the study since obesity in itself is a predictor of difficult airway. None of the patients were underweight (BMI < 18). 86 patients(65%) were found to have normal weight. 45 patients (34%) were overweight. We studied BMI in these patients and do not see much increase in DVL with increase in BMI. This is probably because the effects of BMI on DVL is more apparent in the Obese (BMI >30)

Table 5: BMI distribution

BMI	Frequency	Percent
Normal	86	65.6
Over weight	45	34.4
Total	131	100

Table 6: BMI v/s DVL. EVL

	EVL		DVL		Total				
BMI	N	%	N	%	N	%	χ^2	df	P
Normal	57	65.5	29	65.9	86	65.6			
Over weight	30	34.5	15	34.1	45	34.4	.002	1	0.964
Total	87	100	44	100	131	100			

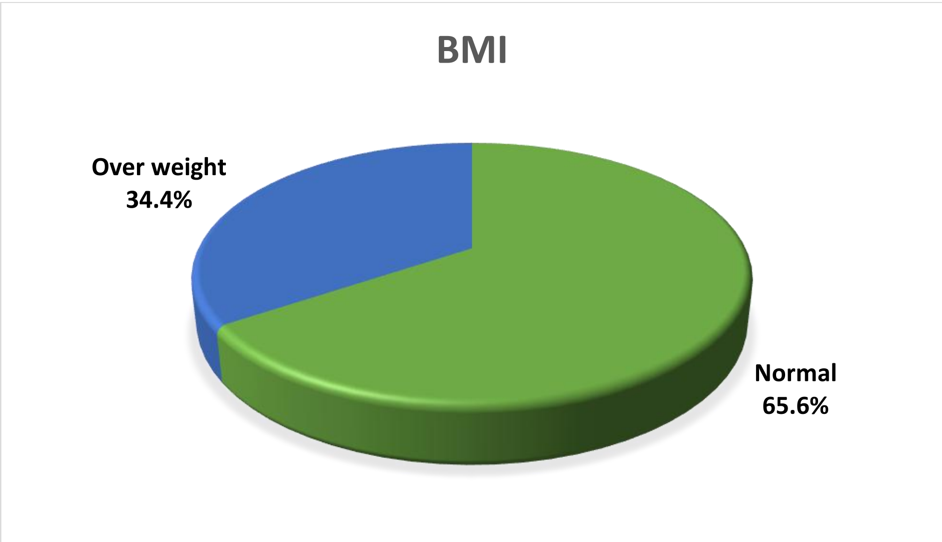

Fig 6: BMI distribution

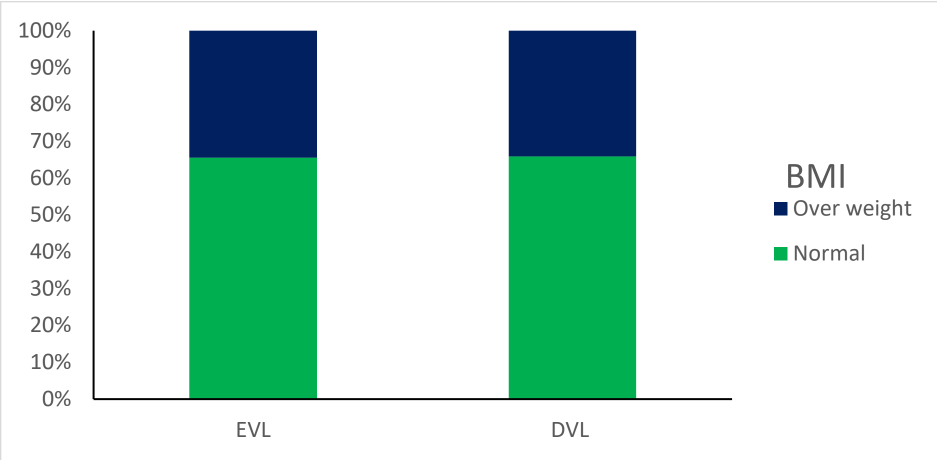

Fig 7: BMI v/s DVL. EVL

ASA status distribution

ASA physical status I and II were included in the study. 48 patients were ASA I (36.6%) and 83 patients were ASA II (63.4%). We do not see any evident co-relation between ASA physical status and DVL,
37.5 % of ASA I had DVL while 31.3 % of ASA II patients had DVL.

Table 7: ASA distribution

ASA	Frequency	Percent
1	48	36.6
2	83	63.4
Total	131	100

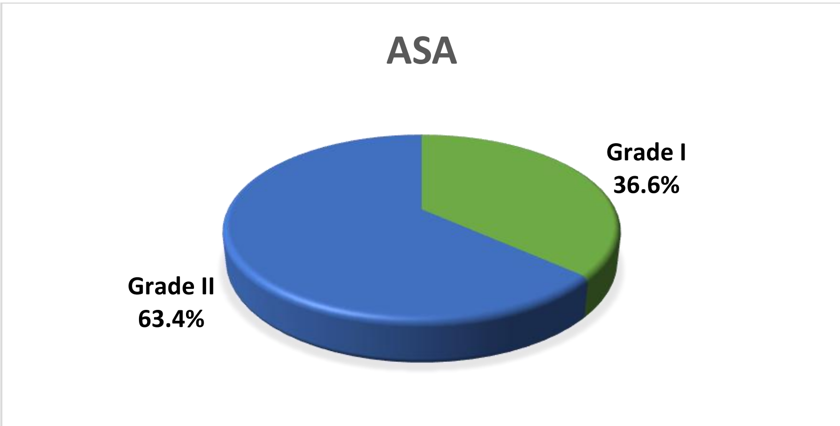

Fig 8: ASA distribution

Table 8: ASA v/s DVL, EVL

	EVL		DVL		Total		χ^2	df	P
ASA	N	%	N	%	N	%			
1	30	34.5	18	40.9	48	36.6			
2	57	65.5	26	59.1	83	63.4	.520	1	0.471
Total	87	100	44	100	131	100			

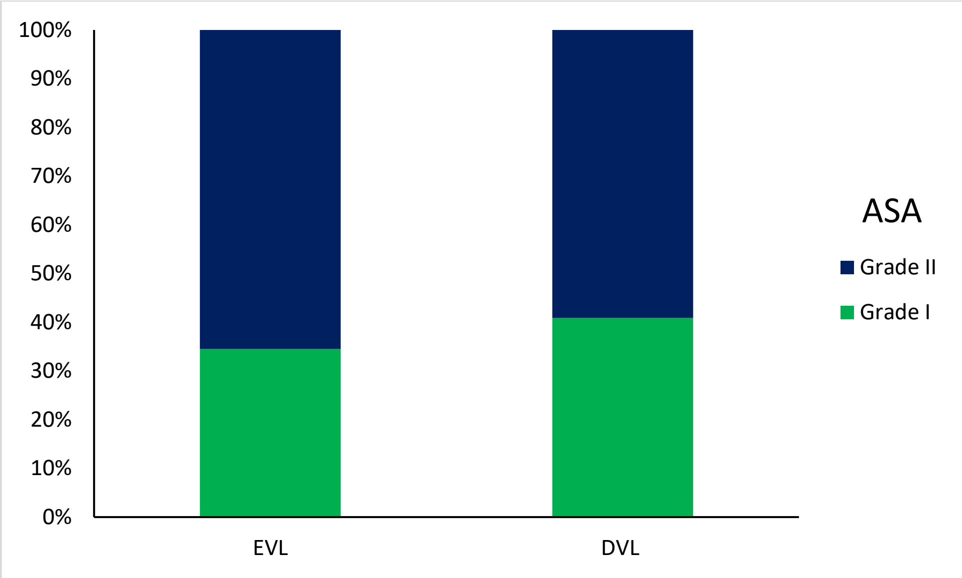

Fig 9 : ASA v/s DVL, EVL

Mallampatti class distribution

Modified Mallampatti classification revealed classes I,II,III and IV among the patients. 37 patients (28.2%) were class I, 65 (49.6%) were class II, 28 (21.4%) were class III and 1 patient was class IV. As expected MMC class I and II had high fraction of EVL .However only one patient was found to have MMC class IV .However a significant fraction of MMC I and II were found to have DVL

Table 9: MMC distribution

MMC	Frequency	Percent
1	37	28.2
2	65	49.6
3	28	21.4
4	1	0.8
Total	131	100

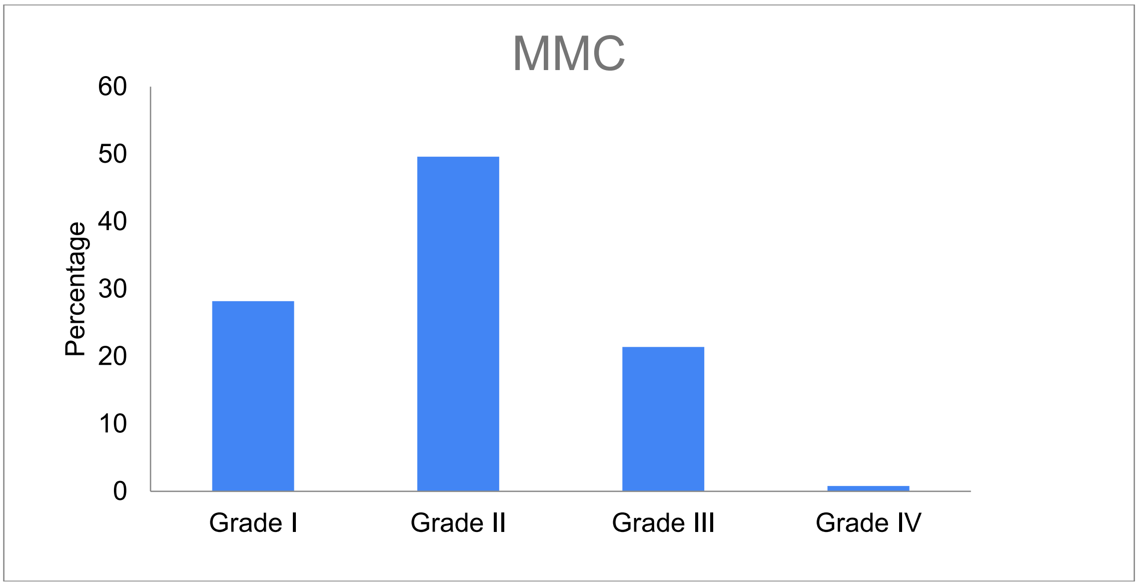

Fig 10: MMC distribution

Table 10: MMC v/s DVL, EVL

MMC	EVL N	EVL %	DVL N	DVL %	Total N	Total %	χ^2	df	p
1	23	26.4	14	31.8	37	28.2			
2	46	52.9	19	43.2	65	49.6			
3	17	19.5	11	25	28	21.4	1.766	3	0.622
4	1	1.1	0	0	1	0.8			
Total	87	100	44	100	131	100			

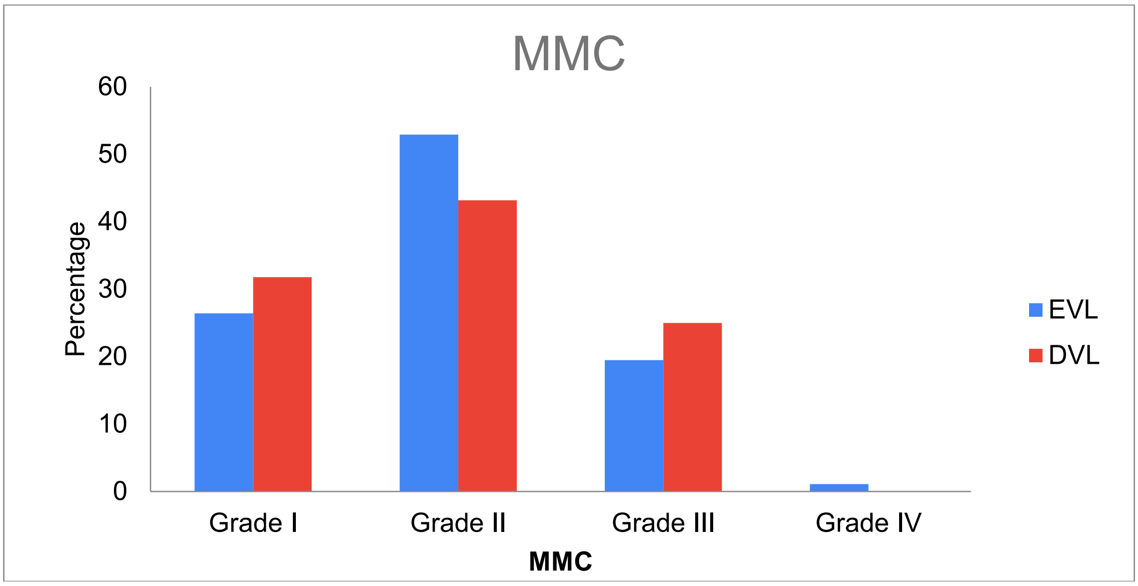

Fig 11: MMC v/s DVL, EVL

CL Grade distribution

Cormack Lehane grading on direct laryngoscopy was recorded as grade I, IIA,IIB, IIIA,IIIB and IV. 54 patients(41.2%) had grade I, 33 patients (25.2%) had grade II A, 14 patients (10.7%) had grade IIB, 19 patients (14.5 %) had grade IIIA and 6 patients (4.6%) had IIIB and 5 patients (3.8%) had grade IV. We see a steady decline in frequency of patients at higher CL grades. The main focus of this study is to establish the co-relation between Line C/A and CL grading. We calculate the average line C for each grade of CL. We see a clear co relation between CL grade and Line C. We see that the mean of Line C increases with the CL grade, starting with Grade II B, which is the grade where difficult air way starts. The difference between the mean line C of each grade and the previous grade, is significant compared to the standard deviation of the line C values. The AASI value increases steadily with increase in CL grade. Due to the positive correlation between the AASI value and the CL grade, the AASI value can be used to predict difficulty in airway in patients. Patients with AASI greater than 0.469 are classified as difficult airway patients, whereas those with AASI lesser than 0.469 are classified as easy airway patients. This is because an AASI value of 0.469 corresponds to a CL grade of II B, which is the onset of difficulty in airway, as per literature.

Table 11: CL grade distribution

CL GRADE	Frequency	Percent
Grade I	54	41.2
Grade II A	33	25.2
Grade II B	14	10.7
Grade III A	19	14.5
Grade III B	6	4.6
Grade IV	5	3.8
Total	131	100

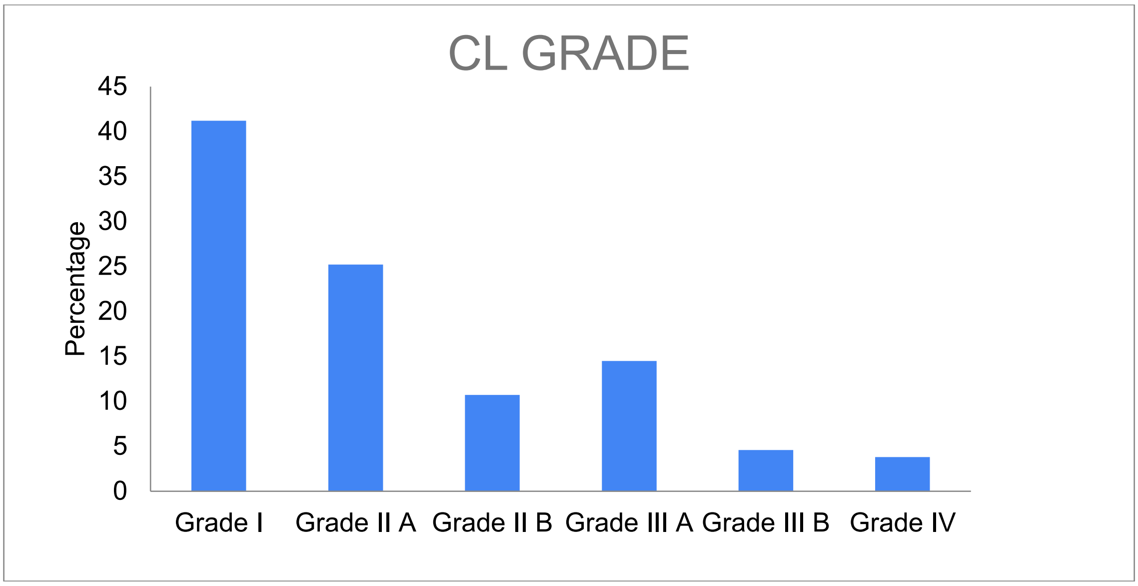

Fig 12: CL grade distribution

Table 12: CL grade v/s DVL, EVL

CL Grade	N	LINE C		ANOVA	
		Mean	sd	F	p
Grade I	54	3.62	0.91		
Grade II A	33	3.61	0.81		
Grade II B	14	4.60	1.61	25.54	<0.001
Grade III A	19	6.12	2.04		
Grade III B	6	6.92	1.53		
Grade IV	5	7.60	1.52		
Total	131	4.39	1.74		

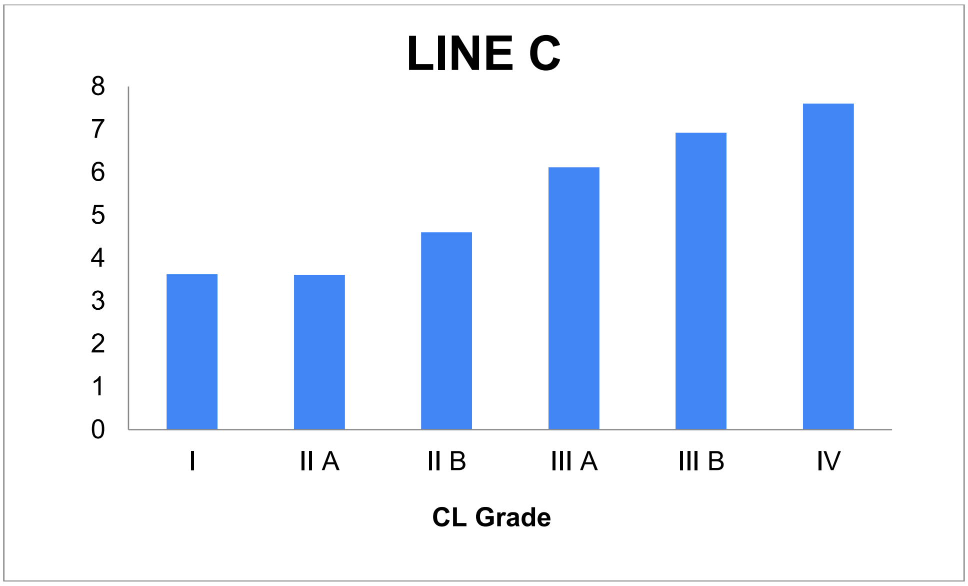

Fig 13: CL grade v/s DVL, EVL

Table 13: CL grade V/S AASI

CL Grade	N	AASI		ANOVA	
		Mean	sd	F	p
Grade I	54	0.361	0.093		
Grade II A	33	0.362	0.088		

Grade II B	14	0.469	0.138		
Grade III A	19	0.608	0.177	25.064	<0.001
Grade III B	6	0.645	0.125		
Grade IV	5	0.696	0.116		
Total	131	0.435	0.160		

AASI

AASI values ranged from 0.2 to 0.83. The mean AASI value was 0.43 and standard deviation was 0.1. AASI value increases steadily with increase in CL grade. Due to positive correlation between AASI and CL grade , AASI can be used to predict difficult airway in patients.

Patients with AASI > 0.469 are classified as difficult airway patients and AASI < 0.469 are classified as easy airway. This is because AASI value of 0.469 corresponds to CL grade II b, which is the onset of difficult airway.

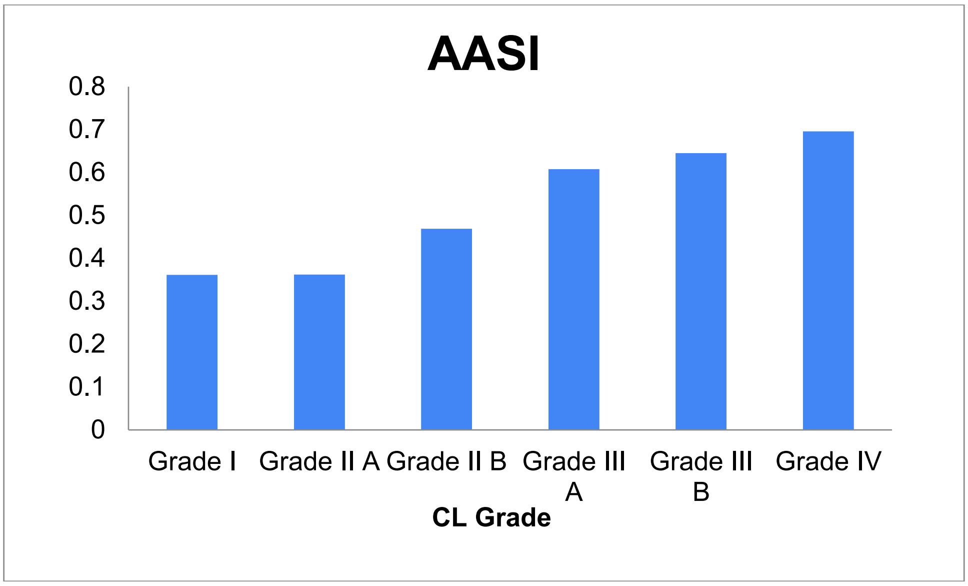

Fig 14: AASI v/s DVL, EVL

Table 14: AASI distribution

AASI	NUMBER	PERCENTAGE
<0.46	88	67.1
>0.46	43	32.9
TOTAL	131	100

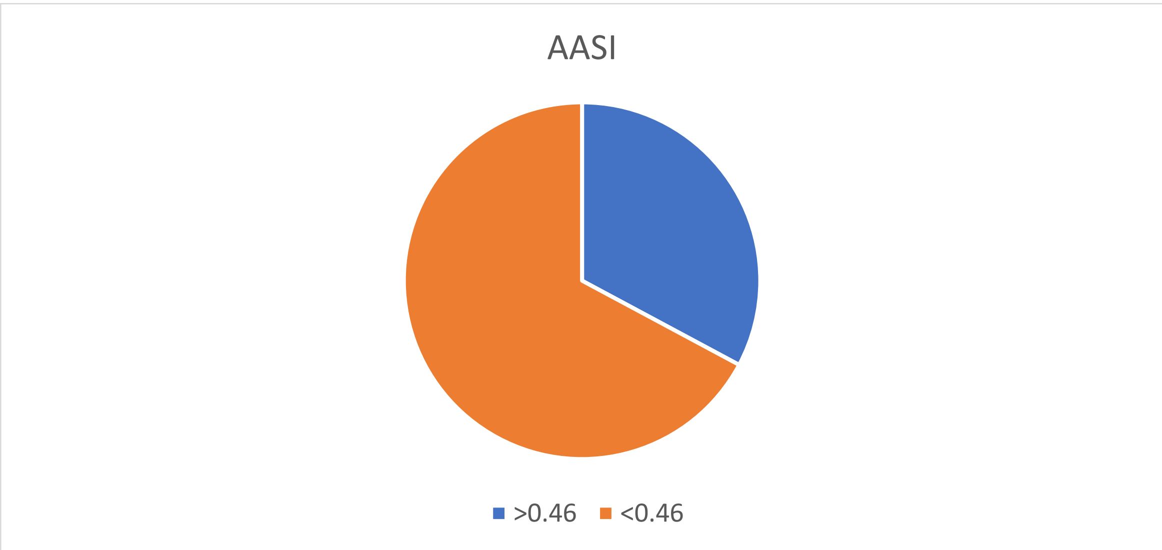

Fig 15: AASI distribution

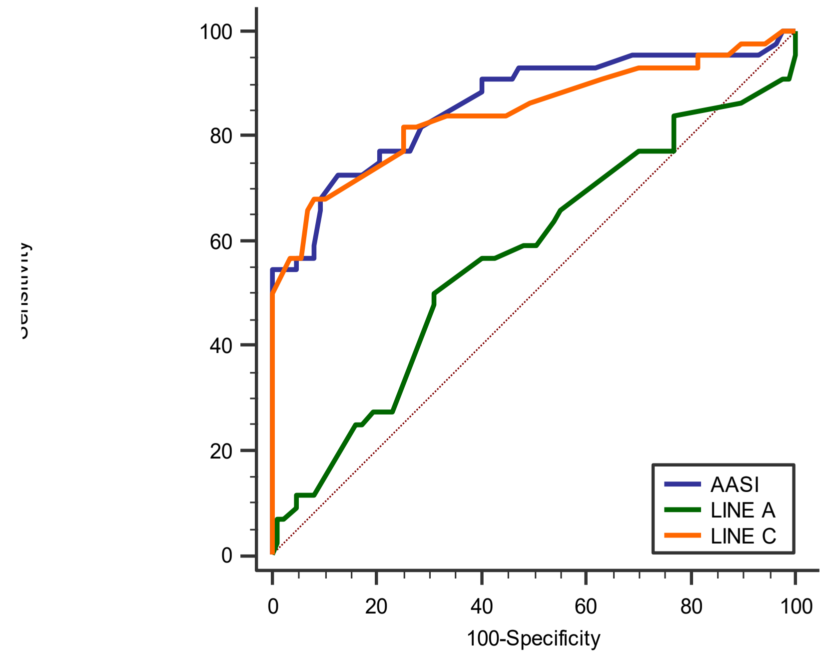

Fig 16: ROC curve of AASI, Line A , Line C for Difficult Visualization of Larynx.

Table 15: ROC curve of AASI, LINE A and LINE C for Difficult Visualization of Larynx.

ROC curve			
Variable	AASI	LINE A	LINE C
Classification variable			
Sample size	131		
Positive group : DVL	44		
Negative group : EVL	87		
Disease prevalence (%)	33.6	33.6	33.6
Area under the ROC curve (AUC)	0.861	0.568	0.845
Standard Error	0.0384	0.0552	0.0416
95% Confidence interval	0.790 to 0.915	0.479 to 0.654	0.771 to 0.902
z statistic	9.399	1.231	8.287
Significance level P (Area=0.5)	<0.001	0.218	<0.001
Youden index J	0.6008	0.1897	0.6014
Optimum cut off	>0.46	>10.5	>4.7
Sensitivity	72.73	50	68.18
Specificity	87.36	68.97	91.95
+LR	5.75	1.61	8.47
-LR	0.31	0.73	0.35
+PV	74.4	44.9	81.1
-PV	86.4	73.2	85.1

Prevalence of DVL was 33.6%- 44 out of 131 patients had DVL. Optimum cut off value of AASI for DVL is 0.469. AUC of AASI is 0.86. Sensitivity of AASI was 72.73. Specificity of AASI was 87.36. Positive predictive value was 74.4 .Negative predictive value was 86.4

Discussion

Accurate preoperative prediction of a difficult airway is essential for patient safety during anesthesia.[15,16,17,18] In this study, the Acromio–Axillary–Suprasternal Notch Index (AASI) demonstrated good diagnostic accuracy in predicting difficult visualization of the larynx (DVL), with an AUC of 0.86 and an optimal cutoff value of 0.46. Patients with higher AASI values were significantly more likely to experience DVL during direct laryngoscopy.

Our findings are consistent with those of Kamranmanesh *et al.*, who first proposed the AASI and reported high sensitivity and specificity for predicting difficult laryngoscopy.[7] Similar results were observed by Nasr and Anvari, who found an AUC of 0.857 and comparable predictive values.[11] The present study thus supports the reproducibility of AASI across populations and reinforces its potential as a reliable bedside screening tool. Unlike conventional predictors such as the Modified Mallampati classification (MPC), AASI does not depend on patient cooperation or sitting posture, making it particularly useful for evaluating critically ill or immobilized patients.

While the Mallampati and other bedside tests (e.g., thyromental distance, sternomental distance, upper lip bite test) remain valuable, their combined sensitivity and specificity are limited.[12,13,14] AASI, in contrast, provides an objective, measurable index that reflects the anatomical relationship of the thorax and neck — factors often contributing to difficult laryngoscopy. Its use in the supine position is an additional advantage, particularly in emergency and intensive care settings.

This study has certain limitations. Laryngoscopic grading may vary with operator technique, neck position, and laryngoscope size. The sample size, although adequate for primary analysis, was confined to ASA I–II patients, limiting generalizability to higher-risk populations. Future research should include larger, multicenter cohorts and assess the additive value of AASI when combined with existing predictive models.

Conclusion

The Acromio–Axillary–Suprasternal Notch Index (AASI) is a simple, reproducible, and position-independent predictor of difficult laryngoscopy. An AASI cutoff value of approximately 0.46 effectively distinguishes between easy and difficult visualization of the larynx. Given its ease of measurement in the supine position, AASI may complement traditional predictors such as the Modified Mallampati classification, especially when patient cooperation is limited. Further large-scale validation is recommended before routine clinical adoption.

Acknowledgements: The authors sincerely thank the patients who participated in the study, as well as the operation theatre staff and anesthesia technicians for their valuable support throughout the research.

Source of financial support: Nil

Conflict of interest: There are no conflicts of interest

Authors contribution: TAE concept, design, definition of intellectual content, literature search, clinical studies, experimental studies, data acquisition, data analysis, statistical analysis, manuscript preparation, manuscript editing and manuscript revision. LSM definition of intellectual content, literature search, clinical studies, experimental studies, data acquisition, data analysis, statistical analysis, manuscript preparation, manuscript editing and manuscript revision, manuscript review and is guarantor. SS literature search, clinical studies, experimental studies, data acquisition, data analysis, manuscript preparation, manuscript editing and manuscript revision, manuscript review .SUR definition of intellectual content ,overall supervision and guidance, manuscript review .

CTRI Number: CTRI/2024/02/062357

References

1. Ramadhani SAL, Mohamed LA, Rocke DA, Gouws E. Sternomental distance as sole predictor of difficult laryngoscopy in obstetric anaesthesia. *Br J Anaesth*. 1996;77(3):313-316. doi:10.1093/bja/77.3.313
2. Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. *Anaesthesia*. 1987;42(5):487-490. doi:10.1111/j.1365-2044.1987.tb11162.x
3. Kamranmanesh MR, Jafari AR, Gharaei B, Agha Mohammadi H, Poor Zamany NK, Kashi AH. Comparison of acromio-axillary suprasternal notch index (a new test) with modified Mallampati test in predicting difficult visualization of larynx. *Acta Anaesthesiol Taiwan*. 2013;51(4):141-144. doi:10.1016/j.aat.2013.10.002
4. Cook TM, Woodall N, Harper J, Benger J; Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments. *Br J Anaesth*. 2011;106(5):632-642. doi:10.1093/bja/aer043
5. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, *et al.* A clinical sign to predict difficult tracheal intubation: a prospective study. *Can J Anaesth*. 1985;32(4):429-434. doi:10.1007/BF03011253
6. Gupta S, Sharma KR, Jain D. Airway assessment: predictors of difficult airway. *Indian J Anaesth*. 2005;49(4):257-262. [No DOI available]
7. Moore KL, Dalley AF, Agur AMR. *Clinically Oriented Anatomy*. 7th ed. Wolters Kluwer Health/Lippincott Williams & Wilkins; 2013.
8. Mosier JM, Stolz U, Chiu S, Sakles JC. Difficult airway management in the emergency department: GlideScope video laryngoscopy compared to direct laryngoscopy. *J Emerg Med*. 2012;42(6):629-634. doi:10.1016/j.jemermed.2011.06.032

9. Walls RM. *Manual of Emergency Airway Management*. 3rd ed. Wolters Kluwer Health/Lippincott Williams & Wilkins; 2008.
10. Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Nickinovich DG, *et al.* Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology*. 2013;118(2):251-270. doi:10.1097/ALN.0b013e31827773b2
11. Nasr-Esfahani M, Honarmand A, Safavi SM, Anvari Tafti M. How to predict difficult tracheal intubation: the application of acromio-axillary-suprasternal notch index. *Adv Biomed Res*. 2020;9:19. doi:10.4103/abr.abr_228_19
12. Rajkhowa T, Saikia P, Das D. An observational prospective study of performance of acromio-axillary suprasternal notch index in predicting difficult visualisation of the larynx. *Indian J Anaesth*. 2018;62(12):945-950. doi:10.4103/ija.IJA_480_18
13. Law JA, Broemling N, Cooper RM, Drolet P, Duggan LV, Lalande M, *et al.* The difficult airway with recommendations for management—part 1—difficult tracheal intubation encountered in an unconscious/induced patient. *Can J Anaesth*. 2013;60(11):1089-1118. doi:10.1007/s12630-013-0036-9
14. Huitink JM, Bouwman RA. The myth of the difficult airway: airway management revisited. *Anaesthesia*. 2015;70(3):244-249. doi:10.1111/anae.12969
15. Nørskov AK, Rosenstock CV, Wetterslev J, Astrup G, Afshari A, Lundstrøm LH. Diagnostic accuracy of anaesthesiologists' prediction of difficult airway management in daily clinical practice: a cohort study of 188,064 patients registered in the Danish Anaesthesia Database. *Anaesthesia*. 2015;70(3):272-281. doi:10.1111/anae.12951
16. Bannister FB, Macbeth RG. Direct laryngoscopy and intubation. *Lancet*. 1944;2:651-654. [No DOI available]
17. Ahmad I, Onwochei DN, Muldoon S, Keane O, El-Boghdadly K. Airway management research: a systematic review. *Anaesthesia*. 2019;74(2):225-236. doi:10.1111/anae.14455
18. Chhina AK, Jain R, Gautam PL, Garg J, Singh N, Grewal A. Formulation of a multivariate predictive model for difficult intubation: a double-blinded prospective study. *J Anaesthesiol Clin Pharmacol*. 2018;34(1):62-67. doi:10.4103/joacp.JOACP_127_16