International Journal of Research in Medical Sciences
Khalikar A et al. Int J Res Med Sci. 2026 Jun;14(6):2345-2351
www.msjonline.org

pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20261471

Original Research Article

Use of ultrasonography as a novel tool of airway assessment in patients undergoing general anesthesia and surgery and its comparison with Cormack-Lehane classification: a prospective observational study

Ankita Khalikar, Harmeen Singh Chhabda*

Department of Anaesthesiology, MGM Medical College and Hospital, Chhatrapati Sambhajinagar, Maharashtra, India

Received: 17 March 2026
Revised: 08 May 2026
Accepted: 11 May 2026

***Correspondence:**
Dr. Harmeen Singh Chhabda,
E-mail: drharmeensingh@gmail.com

ABSTRACT

Background: Accurate preoperative prediction of difficult airway remains a challenge in anesthetic practice. Conventional bedside airway assessment tests have limited sensitivity and specificity. Ultrasonography has emerged as a non-invasive, bedside tool for airway evaluation. This study aimed to assess the role of ultrasonography in predicting difficult laryngoscopy and to compare ultrasonographic airway parameters with the Cormack-Lehane (CL) classification obtained during direct laryngoscopy.

Methods: This prospective observational study was conducted in adult patients undergoing elective surgery under general anesthesia. Preoperative airway assessment included ultrasonographic measurement of airway parameters. After induction of anesthesia, direct laryngoscopy was performed and the laryngeal view was graded according to the CL classification. The correlation between ultrasonographic findings and laryngoscopic grades was analyzed to evaluate the predictive value of ultrasound in identifying difficult laryngoscopy.

Results: Ultrasonographic airway measurements demonstrated a significant correlation with laryngoscopic grading. Patients with increased ultrasonographic airway parameters were more likely to have higher CL grades (Grade III-IV), indicating difficult laryngoscopy. Ultrasonography showed good sensitivity and specificity in predicting difficult airway when compared with conventional airway assessment methods.

Conclusions: Preoperative airway ultrasonography is a simple, non-invasive, and reliable tool for predicting difficult laryngoscopy. It can serve as a valuable adjunct to conventional clinical airway assessment and may improve perioperative airway management strategies.

Keywords: Ultrasonography, Airway assessment, Difficult laryngoscopy, Cormack-Lehane classification, General anaesthesia, Endotracheal intubation

INTRODUCTION

Implementation of anesthesia begins with preoperative assessment and proper planning. Maintenance of patent airway is a primary responsibility of the anesthesiologist. Interruption of gas exchange for even a few minutes can result in catastrophic outcomes such as brain damage or death. Almost one third of deaths attributable to anesthesia have been related to inability to maintain a patent airway and majority (85%) of airway-related events involve brain damage or death. A closed claims analysis of adverse respiratory events in anesthesia shows that 17% of cases were of difficult tracheal intubation with the incidence of inadequate ventilation being 38% and esophageal intubation being 18%. The unanticipated difficult airway occurs with a low but consistent incidence in anesthesia practice. Difficult direct laryngoscopy occurs in 1.5-8% of general anesthetics and failed intubation occurs in 0.3-1.3% of general anesthetics.[1,2]

Various clinical criteria are used which are modified Mallampati classification, interincisor distance, hyomental distance, thyromental distance (TMD), neck circumference, Wilson's score etc. Sensitivity and specificity of these criteria are low and hence after much assessment, unexpected difficulty may still be encountered. A meta-analysis of 55 studies identified that only 35% of difficult intubations had Mallampati class III or IV.[2]

Several imaging techniques such as X-ray and CT scan have been proposed to increase the accuracy of prediction.[1] Ultrasonography, an imaging modality once reserved for radiologists, has been adopted by other medical specialties. It provides high-resolution images that are rapidly obtainable, portable and non-invasive.[3] It can be utilized to determine airway size and also to judge what size endotracheal tube can be passed through the laryngeal inlet.

To visualize pharyngeal and laryngeal structures, both sublingual and transcutaneous approaches can be used. Sublingual scanning can be done by curvilinear probe for imaging oropharyngeal structures, while laryngeal structures can be visualized by linear probe transcutaneously.[4] Ultrasonic measurement of anterior neck soft tissue has been used to predict difficult intubation. Increased thickness of anterior neck soft tissue may impair the forward mobility of pharyngeal structures during laryngoscopy. Neck ultrasound measurements are found to be as accurate as MRI for quantification of fat depth.[5] The potential use of ultrasound to evaluate airway was recognized as early as three decades ago.[6]

Endotracheal intubation is one of the most important skills for anesthesiologists in securing the airway during general anesthesia and resuscitation. Difficulties in handling airways optimally can lead to severe adverse effects and failure can also lead to mortality.[7] Many clinical screening tests have been used to classify patients at risk of difficult laryngoscopy, but none have been shown to predict this complication with adequate sensitivity and specificity.[8] Neck ultrasound can accurately localize the cricothyroid membrane, epiglottis and vocal cord movements.[9,10]

Ultrasound can also be used to localize airway masses, evaluate vocal cord paralysis, detect cystic lesions or abscesses, predict endotracheal tube size, confirm placement of endotracheal tube, and assist in airway planning before intubation.[9,11,12] It decreases complications as it provides real-time dynamic assessment.

Aims and objectives

Primary aim and objectives were to evaluate accuracy of ultrasonic parameters in prediction of difficult intubation. Secondary aim and objectives were to determine the incidence of difficult intubations and to compare the accuracy of ultrasonic parameters vs clinical tests in difficult airway prediction

METHODS

Study type

It was a prospective observational study.

Study place

Study conducted at SMT. Kashibai Navale Medical college and general hospital, Narhe, Pune.

Study period

Study carried out for 1 year from the date of approval from ethics committee.

Ethical consideration

Ethics committee approval was taken from institutional ethics committee and scientific advisory committee of the SMT. Kashibai Navale Medical college and general hospital, Pune, Maharashtra, India (JULY2021-JULY2022).

The 100 patients posted for surgery requiring general anesthesia with endotracheal intubation would be included in this prospective observational study. Informed written consent will be taken from all patients.

Selection criteria

Patients with ASA I and II, age 18 to 65 years with BMI<30 were included in the study.

Patients with head and neck anatomical pathology like tumor, abscess, ASA III and IV, BMI>29.9 and age <18 and >65 years were excluded from the study.

Preoperative assessment

This will be done in the pre-anesthetic visit and will include-Detailed history, thorough general and systemic examination and review of investigations.

After explaining the procedure and the nature of safety of the procedure, a written, valid, informed consent will be obtained and adequate starvation confirmed.

The routine airway assessment including mouth opening, modified Mallampati scoring, TMD, and neck circumference will be performed during the pre-anesthetic assessment. In the preoperative room, with the patients lying supine andhead and neck in neutral position, the sonographic assessment will be conducted using the high-frequency linear probe (SonoSite® MicroMaxx® US system, SonoSite INC, Bothell, WA).

Details of the procedure

The following distances will be measured in transverse axis-Distance from hyoid bone to skin surface (HSD), distance between anterior commissure of vocal cords to skin surface (ACSD), distance from thyroid isthmus to skin surface (TISD) and distance from the skin to the point of the epiglottis corresponding to half the distance between the hyoid bone and the thyroid cartilage (ESD).

Anaesthesia will be induced with propofol 2 to 2.5 mg/kg, fentanyl 2 mcg/kg and suxamethonium 1.5 mg/kg. After adequate relaxation has been achieved, tracheal intubation will be attempted by direct laryngoscopy using anappropriately sized Macintosh blade. Tracheal intubation will be performed by an experienced anesthetist (>5 years of clinical practice).

The grade of DMV will be evaluated using the four level Han scale: first, ventilated by mask; second, ventilated by mask with oral airway/adjuvant, with or without muscle relaxant; third, difficult ventilation (inadequate, unstable or requiring two providers) with or without muscle relaxant; fourth, unable to mask ventilate, with or without muscle relaxant.

The CL classification is as follows: Grade 1: visualization of the entire laryngeal aperture, Grade 2: visualization ofparts of the laryngeal aperture or the arytenoids, grade 3: visualization of only the epiglottis and grade 4: visualization of only the soft palate.

The laryngoscopy will be classified as easy (CL Grade 1 and 2) or difficult (CL grade 3 and 4). The trachea will be intubated with appropriately sized endotracheal tube and anesthesia will be maintained on oxygen, nitrous oxide and isoflurane.

The number of attempts of intubation need for alternative difficult intubation approaches or inability to secure the airway will also be noted.

Statistical analysis

All analyses will be performed by SPSS version 13.0 for windows. The results will be averaged (mean±standard deviation [SD]) for each parameter for continuous data. The Chi-square test will be used to determine the statistical difference between the easy and difficult laryngoscopies. The predictive value of the tests will be assessed by calculating the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). To assess the optimal cut-off scores, receiver operating characteristic (ROC) graphs will be plotted and area under curve will be calculated to assess the prognostic accuracy.

Facilities and equipment

Ultrasound machine, Multipara monitor, equipment for general anesthesia. Emergency equipment, defibrillator and emergency drugs are available in operating room. All of these will be provided by the hospital.

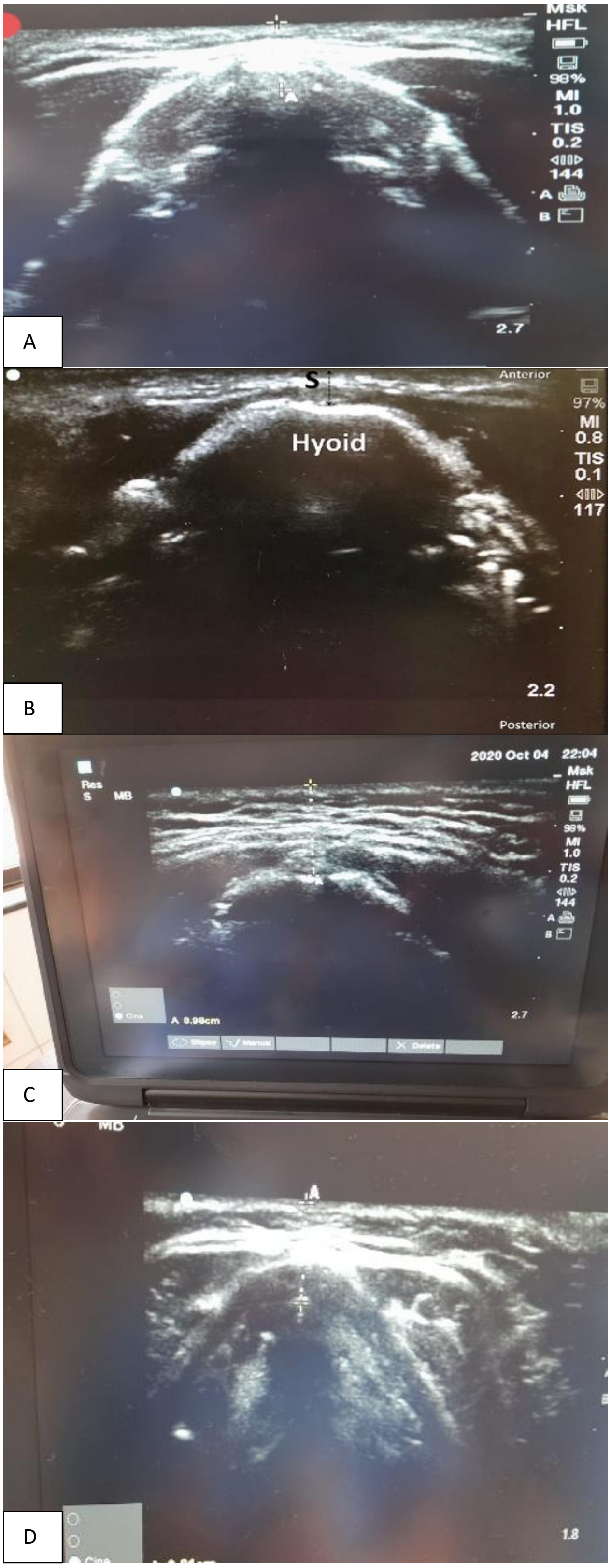

Figure 1: (A) Distance between ACSD, (B) distance from HSD, (C) distance from TISD and (D) distance from the skin to the point of the epiglottis corresponding to half the distance between ESD.

RESULTS

One hundred adult patients undergoing elective surgery under general anesthesia with endotracheal intubation were included in study the study population included indiviuals in the age group of 18-70 years with 62% males and 38% females.

It was found that 40% of the patient had CL grade 1, 34% had CL grade 2, 22% of the patient had CL grade 3 and 4%had CL grade 4.

Table 1 is showing distribution of demographic data in relation to CL grading. demographic variables like age, gender and BMI are not found to be statistically significant (p>0.05).

Table 2 show distribution of the CL grade in comparison with USG parameters, TMD and neck circumference. In the present study, it was found that correlation of HSD, ACSD, TISD, ESD with CL grading was found to be statistically significant. Correlation of TMD with CL grading was not found to be statically significant (p>0.05).

Table 5 show correlation gradient between CL grading and TMD, neck circumference, US parameters (HSD, ACSD, TISD and ESD). In present study, it is found that All US parameters (HSD, ACSD, TISD and ESD) had positive correlation with CL grading. Whereas TMD showed negative correlation to CL grading.

Sensitivity, specificity, PPV, NPV of parameters included in study were calculated and are shows in Table 6.

Amongst all USG parameters TISD parameter found to be more reliable parameter in terms of sensitivity specificity and accuracy as compared to TMD and neck circumference.

Figure 2 shows using ROC curve cut off values of each US parameters calculated. TISD of >0.49 cm was associated with difficult intubation (area under the curve 0.92).

Table 1: Demographic profile of the patient in relation to the CL grading.

Variables	CL grading				P value (>0.05)
	Easy intubation		Difficult intubation		
	Grade 1	Grade 2	Grade 3	Grade 4	
Age (in years)	31.3±9.7	41.5±10.5	32.8±9.0	40.6±10.2	NS
Gender					
Male-62/ Female-38	25/15	20/14	15/7	2/2	NS
BMI (kg/m^2)	25.5±1.96	26.3±1.8	25.7±1.3	26.9±0.82	NS

Table 2: Distribution of the CL grade in comparison with USG parameters, TMD and neck circumference.

CL grade		TMD	Neck circumference	HSD	ACSD	TISD	ESD
1	Mean	6.8925	34.4700	0.4342	0.3962	0.4072	0.4740
	N	40	40	40	40	40	40
	SD	0.22914	1.17390	0.13193	0.09181	0.10286	0.10330
	Minimum	6.50	31.80	0.24	0.25	0.25	0.24
	Maximum	7.40	36.70	0.76	0.59	0.69	0.70
2	Mean	6.5971	34.8471	0.5997	0.5653	0.5333	0.6847
	N	34	34	34	34	33	34
	SD	0.29897	1.61512	0.20069	0.14387	0.15838	0.16725
	Minimum	6.20	31.20	0.28	0.26	0.28	0.42
	Maximum	7.60	37.80	1.09	0.91	0.94	1.10
3	Mean	6.3636	35.8136	0.9150	0.8082	0.7655	0.8950
	N	22	22	22	22	22	22
	SD	0.22792	1.22990	0.16495	0.19155	0.16916	0.18358
	Minimum	5.90	32.40	0.32	0.42	0.49	0.47
	Maximum	6.60	38.20	1.10	1.12	1.08	1.12
4	Mean	6.2000	35.9000	1.0350	0.9300	0.9500	1.0250
	N	4	4	4	4	4	4
	SD	0.08165	1.24900	0.08888	0.21494	0.06164	0.09983
	Minimum	6.10	34.20	0.91	0.68	0.86	0.89
	Maximum	6.30	37.20	1.12	1.19	1.00	1.11
	P value	0.06	0.013	0.02	0.03	0.03	0.045

Table 3: Distribution of CL grade according to Mallampati classification.

Counts		CL grade no. of patients (%)				Total	X^2	P value
		1	2	3	4			
MM grade	1	21 (70)	9 (30)	0	0	30	12.40	0.0004
	2	18 (32.14)	21 (37.5)	17 (30.3)	0	56		
	3	1 (8.3)	4 (33.3)	3 (25)	4 (33.3)	12		
	4	0	0	2	0	2		
Total		40	34	22	4	100		

*Mallampati classification has found to be statistically significant (p value <0.05) in relation to CL grading.

Table 4: TMD distribution according to CL grading.

Counts		CL grade				Total	P value
		1	2	3	4		
TMDGP	6-6.5	4	18	14	4	40	0.06
	Less than 6	0	0	1	0	1	
	More than 6.5	36	16	7	0	59	
Total		40	34	22	4	100	

*Results were found to be statistically insignificant (p>0.05)

Table 5: Correlation gradient between CL grading and TMD, neck circumference, US parameters (HSD, ACSD, TISD and ESD).

Correlations		Age (in years)	BMI (kg/m^2)	TMD	Neck circum-ference	HSD	ACSD	TISD	ESD	CL grade
Age (in years)	Pearson correlation	1	0.436**	-0.392**	0.217*	0.404**	0.423**	0.435**	0.403**	0.430**
	Sig. (2-tailed)		0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000
	N	100	100	100	100	100	100	99	100	100
BMI (kg/m^2)	Pearson correlation	0.436**	1	-0.675**	0.552**	0.517**	0.509**	0.445**	0.609**	0.584**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	100	100	100	100	100	100	99	100	100
TMD	Pearson correlation	-0.392**	-0.675**	1	-.417**	-0.553**	-0.594**	-0.531**	-0.576**	-0.669**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
	N	100	100	100	100	100	100	99	100	100
Neck circumference	Pearson correlation	0.217*	0.552**	-0.417**	1	0.418**	0.346**	0.351**	0.411**	0.364**
	Sig. (2-tailed)	0.030	0.000	0.000		0.000	0.000	0.000	0.000	0.000
	N	100	100	100	100	100	100	99	100	100
HSD	Pearson correlation	0.404**	0.517**	-0.553**	0.418**	1	0.729**	0.735**	0.711**	0.765**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
	N	100	100	100	100	100	100	99	100	100
ACSD	Pearson correlation	0.423**	0.509**	-0.594**	0.346**	0.729**	1	0.746**	0.661**	0.774**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000
	N	100	100	100	100	100	100	99	100	100
TISD	Pearson correlation	0.435**	0.445**	-0.531**	0.351**	0.735**	0.746**	1	0.709**	0.750**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
	N	99	99	99	99	99	99	99	99	99
ESD	Pearson correlation	0.403**	0.609**	-0.576**	0.411**	0.711**	0.661**	0.709**	1	0.774**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
	N	100	100	100	100	100	100	99	100	100
CL grade	Pearson correlation	0.430**	0.584**	-0.669**	0.364**	0.765**	0.774**	0.750**	0.774**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	N	100	100	100	100	100	100	99	100	100

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table 6: Sensitivity, specificity, PPV, NPV of parameters included in study were calculated and are represented.

Variables	Cut off values	Sensitivity	Specificity	NPV	PPV	Accuracy
TMD	6.25	0.65	0.05	0.30	0.19	21%
Neck circumference	32.4	0.96	0.13	0.28	0.90	35%
HSD	0.33	0.96	0.13	0.90	0.28	35%
ACSD	0.42	0.96	0.40	0.96	0.36	55%
TISD	0.49	0.96	0.66	0.98	0.50	74%
ESD	0.47	0.96	0.29	0.32	0.95	45%

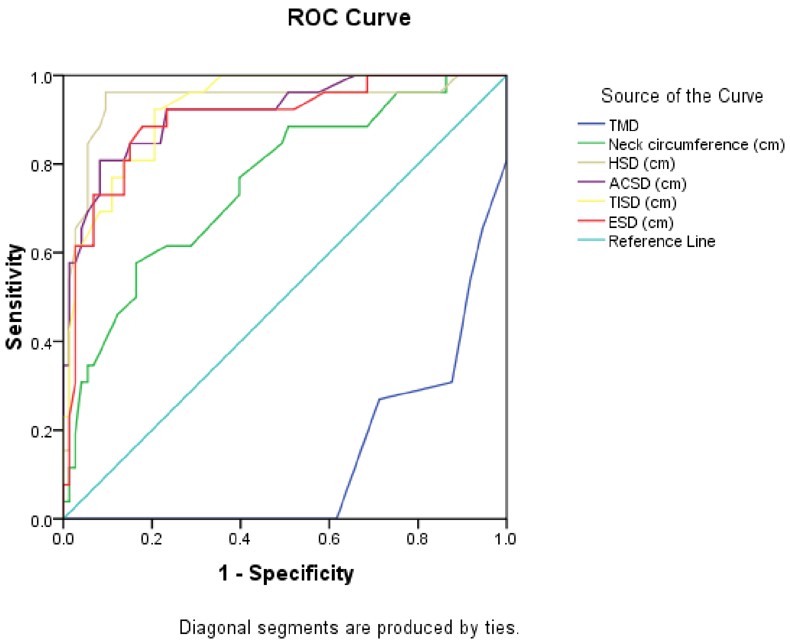

Figure 2: ROC curve for US parameters (HSD, ACSD, TISD and ESD), clinical parameters.

DISCUSSION

Airway-related morbidity, as a result of inability to anticipate difficult airway, remains the primary concern for anesthesiologists.[1] The incidence of difficult laryngoscopy and tracheal intubation still ranges between 1.5%-13%.[2,3] The inability to predict difficult airway is probably due to high inter-observer variability and low predictability of commonly used airway assessment tests.

Sonographic assessment of upper airway is an emerging tool for prediction of difficult airway, particularly in cases where anatomical landmarks are difficult to palpate, such as in emergency situations or unconscious patients, although literature is still limited. Our study demonstrates that sonographic parameters of the upper airway such as HSD, ACSD, TISD, and ESD are helpful in predicting difficult airway when compared with CL grading as well as clinical predictors like TMD and neck circumference.

TMD, though widely used, was not statistically significant in our study. Similar findings have been reported in previous studies, where ultrasound parameters demonstrated better predictive value than TMD.[4,5]

Adhikari et al demonstrated that sonographic measurements of anterior neck soft tissue at the level of the hyoid bone and thyrohyoid membrane could distinguish easy from difficult laryngoscopy.[10] In our study, skin-to-hyoid distance showed lower sensitivity compared to other ultrasound parameters like ACSD, TISD, and ESD.

Parameswari et al also reported that skin-to-epiglottis distance was superior to skin-to-hyoid distance in predicting difficult laryngoscopy, which is consistent with our findings.[13]

Our results show that ESD, TISD, ACSD, and HSD were significantly greater in difficult laryngoscopy cases and were strongly correlated. These findings are comparable to previous studies showing that anterior neck soft tissue thickness is an independent predictor of difficult airway.[4,6]

Strong positive correlations were observed among ultrasound parameters. The area under curve (AUC) values of TISD, ACSD, HSD, and ESD were all above 0.7, indicating good predictive accuracy. In contrast, TMD showed poor predictive value, which is consistent with findings reported by Kajekar et al.[7]

Sensitivity, specificity, and accuracy of ultrasound parameters were higher than clinical parameters like neck circumference and TMD, suggesting that ultrasound can serve as a valuable non-invasive adjunct in airway assessment.[9,11,12]

Limitations

Present study was conducted in a single center with a relatively small sample size, which may limit generalizability of findings. Patients with obesity (BMI>30), head and neck pathology, and higher ASA grades were excluded; therefore, applicability of results to these populations remains uncertain. Additionally, ultrasonographic airway assessment is operator-dependent and may vary with the experience of examiner. Further multicentric studies with larger sample sizes are required to validate predictive value of ultrasonographic airway parameters in difficult airway assessment.

CONCLUSION

In summary, our study shows that ultrasound can be used to assess the airway preoperatively, and several sonographic parameters can be measured. Ultrasound guidance can predict difficulty in laryngoscopy. Because of its simplicity, less inter-observer variation and more accuracy, airway ultrasound may be considered as an important tool during pre-operative airway assessment.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee of SMT. Kashibai Navale Medical College and General Hospital, Pune, Maharashtra, India (July 2021-July 2022)

REFERENCES

1. Benumof JL. Definition and incidence of difficult airway. In: Benumof JL, editor. Airway Management: Principles and Practice. St Louis: Mosby. 1996;121-5.
2. Wajekar AS, Chellam S, Toal PV. Prediction of ease of laryngoscopy and intubation: Role of upper lip bite test, modified Mallampati classification, and thyromental distance in various combination. J Family Med Prim Care. 2015;4(1):101-5.
3. Hall EA, Showaihi I, Shofer FS, Panebianco NL, Dean AJ. Ultrasound evaluation of the airway in the ED: A feasibility study. Crit Ultrasound J. 2018;10(1):3.
4. Ezri T, Gewürtz G, Sessler DI, Medalion B, Szmuk P, Hagberg C, et al. Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue. Anaesthesia. 2003;58(11):1111-4.
5. Rana S, Verma V, Bhandari S, Sharma S, Koundal V, Chaudhary SK. Point-of-care ultrasound in airway assessment: A correlation of ultrasonography-guided parameters to the Cormack-Lehane classification. Saudi J Anaesth. 2018;12(2):292-6.
6. Alessandri F, Antenucci G, Piervincenzi E, Buonopane C, Bellucci R, Andreoli C, et al. Ultrasound as a new tool in the assessment of airway difficulties: An observational study. Eur J Anaesthesiol. 2019;36(7):509-15.
7. Kajekar P, Mendonca C, Gaur V. Role of ultrasound in airway assessment and management. Int J Ultrasound Appl Technol Perioper Care. 2010;1(2):97-100.
8. Jain PN, Ranganathan P. Ultrasound in anesthesia. Indian J Anaesth. 2007;51(3):176-83.
9. Reddy AV, Asim SA, Reddy BS, Rao MV. Utility of ultrasound in preanaesthetic airway assessment. Asian Pac J Health Sci. 2017;4(2):90-2.
10. Adhikari S, Zeger W, Schmier C, Crum T, Craven A, Frrokaj I, et al. Pilot study to determine the utility of point-of-care ultrasound in the assessment of difficult laryngoscopy. Acad Emerg Med. 2011;18(7):754-8.
11. Kristensen MS, Teoh WH, Graumann O, Laursen CB. Ultrasonography for clinical decision-making and intervention in airway management: From the mouth to the lungs and pleurae. Insights Imaging. 2014;5(2):253-79.
12. Reddy PB, Punetha P, Chalam KS. Ultrasonography-A viable tool for airway assessment. Indian J Anaesth. 2016;60(11):807-13.
13. Parameswari A, Govind M, Vakamudi M. Correlation between preoperative ultrasonographic airway assessment and laryngoscopic view in adult patients: A prospective study. J Anaesthesiol Clin Pharmacol. 2017;33(3):353-8.

Cite this article as: Khalikar A, Chhabda HS. Use of ultrasonography as a novel tool of airway assessment in patients undergoing general anesthesia and surgery and its comparison with Cormack-Lehane classification: a prospective observational study. Int J Res Med Sci 2026;14:2345-51.