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A PROSPECTIVE RANDOMIZED STUDY OF THE CORRELATION BETWEEN PREOPERATIVE ULTRASONOGRAPHIC AIRWAY ASSESSMENT AND CLINICAL AIRWAY ASSESSMENT IN PREDICTING DIFFICULT AIRWAY

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ABSTRACT

Background: Accurate prediction of difficult airway remains a major challenge in anaesthetic practice. Conventional clinical airway assessment methods have limited sensitivity and specificity when used alone. Ultrasonography provides real-time visualization of airway structures and may improve preoperative airway evaluation. This study aimed to assess the correlation between preoperative ultrasonographic airway measurements and conventional clinical airway assessment parameters in predicting difficult airway.

Materials and Methods: This prospective, comparative, observational, double-blind study was conducted in the Department of Anaesthesiology at a tertiary care centre after approval from the Institutional Ethics Committee. A total of 93 adult patients aged 18–65 years, belonging to ASA physical status I–III, scheduled for elective surgery under general anaesthesia requiring endotracheal intubation were enrolled. Preoperative clinical airway assessment included Modified Mallampati grading, inter-incisor gap, thyromental distance, hyomental distance, sternomental distance, neck circumference, neck circumference-to-thyromental distance ratio, and body mass index. Ultrasonographic airway assessment was performed using predefined parameters including tongue width, tongue cross-sectional area, floor of mouth cross-sectional area, mentohyoid distance ratio, tongue volume, muscle volume, anterior neck soft tissue thickness at the hyoid and vocal cord levels, skin-to-epiglottis distance, and epiglottis-to-vocal cord distance. Direct laryngoscopy was performed by an experienced anaesthesiologist blinded to preoperative assessment findings, and difficult airway was assessed using Cormack–Lehane grading.

Results: The mean age of the study population was 34.69±7.07 years, with a mean BMI of 23.93±1.94 kg/m². Difficult airway was encountered in 22 patients (23.66%). Among ultrasonographic parameters, mentohyoid distance ratio (≥1.12) demonstrated the highest sensitivity (86.4%) and negative predictive value (86.4%), whereas tongue cross-sectional area (≥25.16 cm²) showed the highest specificity (73.2%) and diagnostic accuracy (63.4%). Epiglottis-to-vocal cord distance demonstrated a high negative predictive value (89.2%). The highest area under receiver operating characteristic curve was observed for mentohyoid distance ratio (AUC=0.5656). Ultrasonographic parameters showed variable diagnostic performance, and individual parameters demonstrated limited discriminatory ability. Significant correlations were observed between several ultrasound measurements and conventional airway assessment parameters and Cormack–Lehane grade.

Conclusion: Preoperative airway ultrasonography provides additional anatomical information and may serve as a useful adjunct to conventional clinical airway assessment. Although no single ultrasonographic parameter demonstrated sufficient accuracy to independently predict difficult airway, parameters such as mentohyoid distance ratio, anterior neck soft tissue thickness, and epiglottis-to-vocal cord distance showed potential value in identifying patients at risk of difficult laryngoscopy. Further large-scale studies are required to establish standardized ultrasound-based airway assessment protocols.
Keywords: Airway ultrasonography; Difficult airway; Difficult laryngoscopy; Cormack–Lehane grade; Modified Mallampati score; Preoperative airway assessment; Point-of-care ultrasound.

INTRODUCTION

Securing and maintaining a patent airway is one of the most fundamental responsibilities of an anesthesiologist. Failure to establish adequate ventilation and oxygenation because of an unanticipated difficult airway remains a significant cause of anesthesia-related morbidity and mortality. Difficult tracheal intubation can occur in both elective and emergency settings, and failure to achieve timely airway control may result in severe hypoxemia, aspiration, brain injury, cardiac arrest, or death. Consequently, accurate preoperative airway assessment is an essential component of anesthetic evaluation, enabling the anesthesiologist to anticipate airway difficulty and formulate an appropriate airway management strategy before induction of anesthesia.[1,2]

Despite the availability of several evidence-based guidelines for difficult airway management, unanticipated difficult laryngoscopy and tracheal intubation continue to occur in approximately 1.5–13% of patients undergoing general anesthesia.[3] This highlights the limitations of existing bedside airway assessment techniques and emphasizes the need for more reliable predictive methods. Early identification of patients at risk allows for appropriate preparation of advanced airway equipment, selection of suitable airway devices, and involvement of experienced personnel, thereby improving patient safety and clinical outcomes.[1,3]

Conventionally, preoperative airway evaluation relies on a combination of clinical history and physical examination. Commonly used bedside screening tests include the Modified Mallampati grading, thyromental distance, sternomental distance, inter-incisor gap, upper lip bite test, neck circumference, body mass index, assessment of cervical spine mobility, and history suggestive of obstructive sleep apnea or snoring.[4–7] Although these tests are simple, inexpensive, and routinely performed, each has limited sensitivity and specificity when used individually. Even when multiple clinical predictors are combined, their ability to accurately predict difficult laryngoscopy remains suboptimal, resulting in a substantial proportion of unexpectedly difficult airways during routine anesthesia practice.[7,8]

Point-of-care ultrasonography has emerged as a valuable diagnostic tool in perioperative medicine because of its portability, safety, non-invasive nature, and ability to provide real-time anatomical information. Ultrasound is now routinely used for vascular access, regional anesthesia, and various critical care applications.[9,10] More recently, interest has grown in the use of ultrasonography for airway assessment. Unlike conventional clinical examination, ultrasonography enables direct visualization and measurement of airway structures, including anterior neck soft tissue thickness, tongue dimensions, hyoid bone, epiglottis, and the distance from the skin to the epiglottis or vocal cords, which may influence the ease of laryngoscopy and intubation.[11,12]

Several studies have demonstrated that ultrasonographic measurements of anterior neck soft tissue at different anatomical levels are associated with difficult laryngoscopy. These objective measurements may complement conventional bedside airway assessment and improve the prediction of difficult airway by identifying anatomical features that cannot be accurately evaluated through physical examination alone.[11,12] Nevertheless, the available evidence remains heterogeneous, and there is no consensus regarding the most reliable ultrasonographic parameter or its superiority over traditional clinical assessment. Furthermore, studies evaluating the combined role of ultrasonographic airway assessment and conventional clinical predictors remain relatively limited.

Considering these gaps in current knowledge, the present study was designed to evaluate the correlation between preoperative ultrasonographic airway assessment and conventional clinical airway assessment in predicting difficult airway. The study also aimed to determine whether the addition of ultrasonographic parameters improves the accuracy of preoperative airway evaluation compared with conventional clinical assessment alone. Identification of a reliable, rapid, bedside, and non-invasive predictive tool may contribute to safer airway management and reduce the incidence of unanticipated difficult intubation.

MATERIALS AND METHODS

This prospective, comparative, observational, double-blind study was conducted in the Department of Anaesthesiology at Government Medical College (GMC), Nagpur, Maharashtra, after obtaining approval from the Institutional Ethics Committee (IEC No. GMC/Nagpur/Pharmacology/IEC/2164, dated 26/04/2024). The study was carried out over a period of 18 months.

A total of 93 patients of either sex, aged between 18 and 65 years, belonging to the American Society of Anesthesiologists (ASA) physical status I, II, and III, who were scheduled to undergo elective surgery under general anaesthesia requiring endotracheal intubation, were enrolled in the study. The study protocol was explained to all eligible patients, and written informed consent was obtained before participation.

Patients aged 18–65 years of either sex with ASA physical status I–III posted for elective surgery under general anaesthesia were included in the study. Patients who refused to participate, had obvious airway abnormalities or craniofacial deformities, morbid obesity (body mass index >35 kg/m²), restricted mouth opening, required rapid sequence induction due to a full stomach, had cervical spine pathology or restricted neck movement, were uncooperative, or were pregnant were excluded from the study.

All enrolled patients underwent a detailed preoperative airway evaluation one day before surgery by an anaesthesiologist who was blinded to the ultrasonographic findings. Conventional clinical airway assessment included measurement of the Modified Mallampati Grade (MPG), inter-incisor gap (IIG), thyromental distance (TMD), neck circumference (NC), neck circumference-to-thyromental distance ratio (NC/TMD), and body mass index (BMI). All measurements were performed according to standard clinical protocols and documented in the study proforma.

Following clinical assessment, all patients underwent ultrasonographic airway evaluation by another anaesthesiologist who was trained and experienced in airway ultrasonography and was blinded to the clinical airway assessment findings. Ultrasonographic examination was performed using a Sonosite M-Turbo ultrasound system (Fujifilm Sonosite, Washington, DC, USA) equipped with a high-frequency linear transducer (5–14 MHz) and a low-frequency curvilinear transducer (3–7 MHz). To ensure uniformity and minimize inter-observer variability, all ultrasound examinations were performed by the same investigator.

During ultrasonographic assessment, patients were positioned supine with the head and neck maintained in a neutral position without a pillow. The patients were instructed to keep their mouth closed while looking straight ahead throughout the examination. Both transverse and mid-sagittal scanning planes were used to obtain airway measurements. The ultrasonographic parameters evaluated included tongue width, cross-sectional area of the tongue, cross-sectional area of the floor of the mouth, mentohyoid distance, anteroposterior thickness of the geniohyoid muscle, skin-to-hyoid distance, and skin-to-epiglottis distance. The ultrasound probes, scanning views, and anatomical landmarks used for these measurements are summarized in [Table 1].

Following completion of the preoperative airway assessments, all patients underwent standard anaesthetic induction according to institutional protocol. Direct laryngoscopy was performed by an experienced anaesthesiologist who was blinded to both the clinical and ultrasonographic assessment results. Laryngoscopy was carried out using an appropriately sized Macintosh blade (No. 3 or No. 4) or a McCoy blade, depending on the patient's airway characteristics and the discretion of the anaesthesiologist. The laryngoscopic view obtained during the first attempt was graded according to the Cormack–Lehane classification, and the grade was recorded. Subsequently, tracheal intubation was performed using an appropriately sized cuffed endotracheal tube, and anaesthesia was maintained according to standard institutional practice.

Table 1: Ultrasonographic Airway Parameters Evaluated

Ultrasonographic Parameter	Ultrasound Probe	View	Measurement Description
Width of tongue	Curvilinear	Transverse	Maximum transverse width between the lateral borders of the tongue
Cross-sectional area of tongue	Curvilinear	Mid-sagittal	Cross-sectional area of the tongue measured in the mid-sagittal plane
Cross-sectional area of floor of mouth	Curvilinear	Transverse	Combined cross-sectional area of the geniohyoid and mylohyoid muscles
Mentohyoid distance	Curvilinear	Mid-sagittal	Distance between the mentum and hyoid bone
Anteroposterior thickness of geniohyoid	Linear	Transverse	Maximum anteroposterior thickness of the geniohyoid muscle
Skin-to-hyoid distance	Linear	Transverse	Distance from the skin surface to the hyoid bone
Skin-to-epiglottis distance	Linear	Transverse	Distance from the skin surface to the anterior surface of the epiglottis at the level of the thyrohyoid membrane

Abbreviations: USG = Ultrasonography; AP = Anteroposterior.

RESULTS

A total of 93 patients were included in the study, and all completed the study protocol. The baseline demographic characteristics, clinical airway assessment findings, incidence of difficult airway, Cormack–Lehane (CL) grading, and post-extubation complications are presented in [Table 2].

The mean age of the study population was 34.69 ± 7.07 years, with a mean BMI of 23.93 ± 1.94 kg/m². Males constituted 65.59% of the participants, and most patients belonged to ASA physical status II (47.31%). Modified Mallampati Grade II was the most common preoperative airway assessment finding (45.16%). Difficult airway was encountered in 22 patients (23.66%). On direct laryngoscopy, Cormack–Lehane Grade I was the most frequent finding (41.94%), followed by Grade II (35.48%). Post-extubation complications occurred in 23.66% of patients, with coughing (40.91%) being the most common complication among affected patients.

Table 2: Baseline demographic characteristics, airway assessment findings, incidence of difficult airway, Cormack–Lehane grading, and post-extubation complications among the study participants (N = 93)

Parameter	N=93
Age in years Mean ± SD	34.69± 7.07
Male (%): Female(%)	61(65.59 %): 32(34.41%)
ASA I:II:III	42(45.16 %):44(47.31%):7(7.53%)
BMI kg/m2 Mean ± SD	23.93 ±1.94
MP Grade 1 2 3 4	 24(25.81%) 42(45.16%) 24(25.81%) 3(3.23%)
Difficult airway Yes n(%) No n(%)	 22 (23.66%) 71(76.34%)
CL Grade 1 2 3 4	 39(41.94%) 33(35.48%) 19(20.43%) 2(2.15%)
Post Extubation complications Yes n(%) No n(%)	 22 (23.66%) 71(76.34%)
Post Extubation complications Coughing Laryngospasm Breath holding Hypoventilation Apnoea	 9(40.91%) 6(27.27%) 3(13.64%) 3(13.64%) 1(4.55%)

Values are presented as mean ± standard deviation (SD) or number (percentage), as appropriate. ASA = American Society of Anesthesiologists; BMI = Body Mass Index; CL = Cormack–Lehane; SD = Standard Deviation. Difficult airway was defined according to the study criteria based on laryngoscopic assessment.

The clinical and ultrasonographic airway assessment parameters of the study participants are presented in [Table 3]. The mean hyomental distance was 5.73 ± 0.39 cm, sternomental distance was 12.79 ± 0.21 cm, and thyromental distance was 6.75 ± 0.16 cm. The mean neck circumference was 39.48 ± 4.27 cm. On ultrasonographic evaluation, the mean tongue width was 5.69 ± 0.54 cm, while the mean mentohyoid distance ratio was 1.11 ± 0.05. The mean anterior neck soft tissue thickness at the level of the hyoid bone and vocal cords was 0.36 ± 0.06 cm and 0.29 ± 0.08 cm, respectively. The mean distance between the epiglottis and vocal cords was 0.90 ± 0.08 cm.

Table 3: Clinical and ultrasonographic airway assessment parameters among the study participants (N = 93).

Parameter	N=93 Mean+ SD (Range)
Hyomental Distance in cm	5.73 ± 0.39(4.8- 6.5)
Sternomental distance in cm	12.79±0.21(12-13.3)
Thyromental Distance in cm	6.75± 0.16 (6.2-7.0)
Neck Circumference in cm	39.48± 4.27(35-53)
Width of tongue in cm	5.69± 0.54(4-7.5)
Mentohyoid distance ratio	1.11± 0.05(1-1.16)
Anterior neck soft tissue thickness at the level of Hyoid	0.36 ±0.06(0.24-0.5)
Anterior neck soft tissue thickness at the level of Vocal Cord	0.29 ±0.08(0.14-0.48)
distance between Epiglottis and Vocal cord	0.9± 0.08(0.72-1.09)

Values are expressed as mean ± standard deviation (SD), with the observed range presented in parentheses.

The diagnostic performance of various ultrasonographic airway parameters for predicting difficult airway, using the clinical airway assessment as the reference standard, is presented in [Table 4].

Among the ultrasonographic variables evaluated, the mentohyoid distance ratio (≥1.12) demonstrated the highest sensitivity (86.4%) and negative predictive value (86.4%), although its specificity was low (26.8%). The distance between the epiglottis and vocal cord (EVC ≥0.87 cm) showed the highest negative predictive value (89.2%) with a sensitivity of 68.2% and specificity of 57.4%.

The cross-sectional area of the tongue (≥25.16 cm^2) exhibited the highest specificity (73.2%) and diagnostic accuracy (63.4%), followed closely by anterior neck soft tissue thickness at the level of the hyoid (61.3%). The area under the receiver operating characteristic (ROC) curve for all ultrasonographic parameters ranged from 0.39 to 0.57, indicating poor discriminatory ability. Furthermore, agreement between ultrasonographic and clinical airway assessment was poor for all parameters, as reflected by low kappa coefficients, and none of the associations reached statistical significance ($p > 0.05$).

Table 4: Diagnostic validity of ultrasonographic airway parameters for predicting difficult airway using clinical airway assessment as the reference standard (N = 93).

ROC cut-offs	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Diagnostic Accuracy (%)	Area under ROC	kappa (P value)
Width of tongue >=5.8 cm	36.4	62.0	22.9	75.9	55.9	0.4936	-0.014 (0.5560)
Cross section of tongue >=25.16 cm	31.8	73.2	26.9	77.6	63.4	0.5227	0.0476 (0.3221)
Cross section of floor of tongue >=5.09 cm	27.3	47.9	13.9	68.0	43.0	0.4098	-0.1869 (0.9794)
Mento-Hyoid distance ratio >=1.12	86.4	26.8	26.8	86,4	40.9	0.5656	0.0742 (0.1028)
Tongue volume >=139.59 ml	45.4	56.3	24.4	76.9	53.8	0.5066	0.0138 (0.4412)
Muscle volume >=28.77 ml	54.5	46.5	24.0	76.4	48.4	0.5037	0.0071 (0.4664)
ANS-HYOID >=0.39 cm	36.4	69.0	26.7	77.8	61.3	0.5222	0.0487 (0.3187)
ANS-VC >=0.28 cm	31.8	38.9	13.7	64.3	36.6	0.3901	-0.2073 (0.9935)
Pre-E >=1.0 cm	76.2	43.7	44.4	75.6	55.7	0.4934	-0.0122 (0.5588)
EVC >=0.87 cm	68.2	57.4	25.9	89.2	59.3	0.5293	0.0487 (0.2596)
PreE/EVC >=1.2	45.4	49.3	21.7	74.5	48.4	0.4810	-0.0381 (0.6665)

ROC = Receiver Operating Characteristic; PPV = Positive Predictive Value; NPV = Negative Predictive Value; ANS-HYOID = Anterior Neck Soft Tissue Thickness at the Hyoid Level; ANS-VC = Anterior Neck Soft Tissue Thickness at the Vocal Cord Level; Pre-E = Skin-to-Epiglottis Distance; EVC = Distance Between Epiglottis and Vocal Cord. Diagnostic performance was calculated using receiver operating characteristic (ROC)-derived cut-off values, with clinical airway assessment considered the reference (gold) standard. Values of $p < 0.05$ were considered statistically significant.

DISCUSSION

Accurate prediction of a difficult airway remains a critical component of safe anaesthetic practice, as unanticipated airway difficulty may lead to serious complications. Conventional bedside airway assessment methods, including mouth opening, modified Mallampati classification, thyromental distance, jaw protrusion, and upper lip bite test, are widely used during pre-anaesthetic evaluation; however, their ability to reliably predict difficult laryngoscopy remains limited due to variable diagnostic accuracy when used alone or in combination.[14] Therefore, there is a need for additional objective, non-invasive, and easily applicable assessment tools. In recent years, ultrasonography has gained importance in perioperative airway assessment due to its portability, real-time imaging capability, and ability to evaluate airway structures not accessible through routine clinical examination. Previous studies have demonstrated the potential role of ultrasonographic parameters such as hyomental distance, tongue size, floor of mouth musculature, and anterior neck soft tissue measurements in predicting difficult laryngoscopy.[15,16] The present study was undertaken to evaluate the correlation between preoperative ultrasonographic airway measurements and

conventional clinical airway assessment parameters in predicting difficulty during direct laryngoscopy.

Prediction of difficult airway remains one of the most challenging aspects of anaesthetic practice, as unanticipated difficulty in ventilation or intubation may result in significant morbidity and mortality. Conventional bedside airway assessment methods, including modified Mallampati classification, inter-incisor gap, thyromental distance, hyomental distance, neck circumference, and upper lip bite test, are routinely used for preoperative airway evaluation. However, these parameters have demonstrated variable diagnostic accuracy, particularly when applied individually, and unexpected difficult laryngoscopy continues to occur despite appropriate preoperative assessment.[1-3] Several studies have reported limitations of traditional airway assessment methods, with low sensitivity and inconsistent predictive value for difficult laryngoscopy.[8.9] Therefore, there is increasing interest in objective, non-invasive techniques that can supplement conventional airway evaluation. Ultrasonography has emerged as a promising bedside modality because of its portability, absence of radiation exposure, reproducibility, and ability to provide real-time visualization of airway soft tissue and anatomical relationships.[10-12]

The present study evaluated the correlation of preoperative ultrasonographic airway assessment with conventional clinical airway parameters and its ability to predict difficult laryngoscopy. In our study population of 93 patients, difficult airway was encountered in 22 patients (23.66%), while CL Grade III and IV views were observed in 20.43% and 2.15% of patients, respectively. Multiple ultrasound parameters were assessed, including tongue dimensions, mentohyoid distance ratio, tongue and muscle volume, anterior neck soft tissue thickness, pre-epiglottic distance, and epiglottis-to-vocal cord distance.

In the present study, significant positive correlations were observed between several ultrasonographic parameters and Cormack–Lehane grade. Anterior neck soft tissue thickness at the vocal cord level (ANS-VC) showed the strongest correlation with CL grade ($r = 0.5862$, $p < 0.0001$), followed by PreE/EVC ratio ($r = 0.5545$, $p < 0.0001$) and mentohyoid distance ratio ($r = 0.5108$, $p < 0.0001$). Other parameters including tongue width, tongue cross-sectional area, tongue volume, muscle volume, and pre-epiglottic distance also demonstrated significant positive associations with laryngoscopic difficulty. These findings suggest that increased anterior airway soft tissue and altered anatomical relationships may contribute to impaired glottic visualization during direct laryngoscopy.

Our findings are comparable with previous studies evaluating ultrasound-based airway assessment. Wu et al. demonstrated that quantification of anterior neck soft tissue thickness using ultrasound was associated with difficult laryngoscopy, supporting the concept that increased anterior soft tissue may limit glottic exposure.[12] Falcetta et al. evaluated two neck ultrasound measurements as predictors of difficult direct laryngoscopy in 301 patients and reported excellent predictive performance of the median distance from skin to epiglottis (mDSE) and pre-epiglottic area (PEA), with AUC values of 0.906 and 0.93, respectively. A mDSE cut-off value of 2.54 cm demonstrated 82% sensitivity and 91% specificity, whereas PEA >5.04 cm^2 showed 85% sensitivity and 88% specificity.[13] In contrast, our ROC analysis showed modest discriminatory ability for individual parameters, with the highest AUC observed for mentohyoid distance ratio (AUC 0.5656). This difference may be related to variations in sample size, patient characteristics, ultrasound methodology, and the criteria used for defining difficult airway.

Parameswari et al. evaluated the role of sonographic airway assessment in predicting difficult laryngoscopy and reported that skin-to-epiglottis distance had the highest predictive performance, with a sensitivity of 75%, specificity of 63.6%, and negative predictive value of 96.2%. Tongue volume also demonstrated moderate predictive ability, whereas skin-to-hyoid distance and floor of mouth volume showed lower diagnostic performance. In our study, pre-epiglottic distance showed a significant correlation with CL grade ($r = 0.4607$, $p < 0.0001$); however, the highest sensitivity was demonstrated by mentohyoid distance ratio (86.4%), while EVC distance showed the highest negative predictive value (89.2%). The differences between the studies may be attributed to variation in ultrasound parameters evaluated and differences in difficult airway definitions.[17]

Harjai et al. (2023) compared clinical and ultrasonographic airway parameters between easy (CL I–II) and difficult (CL III–IV) laryngoscopy groups. They reported significant differences in modified Mallampati grade, inter-incisor gap, skin-to-hyoid distance, and skin-to-thyroid isthmus distance between the two groups. Their study demonstrated that increased skin-to-hyoid distance and tongue-related measurements had moderate predictive value, although several ultrasound parameters did not significantly differentiate easy and difficult airways. In comparison, our study demonstrated significant correlations of multiple ultrasound parameters with CL grade, particularly ANS-VC, mentohyoid distance ratio, PreE/EVC ratio, tongue volume, and muscle volume. The difference may be due to differences in study design, sample size, ultrasound techniques, and the number of parameters evaluated.[18]

The relationship between ultrasonographic parameters and conventional airway predictors was also assessed in our study. Significant correlations were observed between ultrasound parameters and modified Mallampati grade, particularly with ANS-VC, muscle volume, mentohyoid distance ratio, and ANS-HYOID. Hyomental distance showed significant correlations with mentohyoid distance

ratio, muscle volume, and ANS-VC, while neck circumference showed strong correlations with tongue volume, tongue width, mentohyoid distance ratio, and ANS-VC. These findings indicate that ultrasound measurements reflect underlying airway anatomical characteristics assessed indirectly by conventional clinical methods.

The diagnostic performance of individual ultrasound parameters in our study showed variable results. The mentohyoid distance ratio ≥1.12 demonstrated the highest sensitivity (86.4%) and negative predictive value (86.4%), whereas tongue cross-sectional area ≥25.16 cm^2 demonstrated the highest specificity (73.2%) and diagnostic accuracy (63.4%). Although individual ultrasound parameters did not demonstrate sufficient accuracy as standalone predictors, their significant correlation with CL grade suggests that ultrasound can serve as a valuable adjunct to routine airway assessment.

Overall, the findings of our study support the role of airway ultrasonography as an additional objective tool for preoperative airway assessment. While ultrasound may not replace conventional clinical airway evaluation, combining sonographic parameters with established screening tests may improve identification of patients at risk of difficult laryngoscopy and facilitate better airway planning.

Limitations

The present study has certain limitations. First, it was conducted at a single centre with a relatively small sample size, which may limit the generalizability of the findings to a wider population. Second, difficult airway prediction was primarily based on direct laryngoscopic view assessed by Cormack–Lehane grading; other factors contributing to difficult airway management, such as difficult mask ventilation, number of intubation attempts, or need for alternative airway devices, were not included. Third, although ultrasonographic assessment was performed by an experienced operator, interobserver variability was not evaluated, and the reproducibility of measurements between different operators requires further validation. Fourth, only elective surgical patients without obvious airway abnormalities were included; therefore, the applicability of these findings in emergency situations, obese patients, or patients with known airway pathology remains uncertain. Finally, individual ultrasound parameters demonstrated variable predictive performance, and larger multicentric studies are required to establish standardized cut-off values and determine whether combining multiple ultrasound parameters with clinical airway assessment improves predictive accuracy.

CONCLUSION

Preoperative airway ultrasonography provides objective anatomical information and can serve as a valuable adjunct to conventional clinical airway assessment. In the present study, several ultrasonographic parameters showed significant correlations with Cormack–Lehane grade and traditional airway assessment parameters. Among the evaluated measurements, anterior neck soft tissue thickness at the vocal cord level, PreE/EVC ratio, and mentohyoid distance ratio demonstrated significant associations with difficult laryngoscopic views. Although no single ultrasonographic parameter demonstrated sufficient accuracy to replace conventional airway assessment, ultrasound-based evaluation may improve identification of patients at risk of difficult laryngoscopy when combined with established clinical screening methods. Further large-scale studies are required to validate these findings and develop a standardized ultrasonographic airway assessment protocol for routine clinical practice.

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