RESEARCH PAPER

A Study on Correlation of Ultrasound Guided Airway Parameters with Cormack Lehane Grading In Emergency Department-A Prospective Observational Study

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Received: 24th April, 2026; Revised: 20th May 2026; Accepted: 30th June, 2026; Available Online: 10th July, 2026

ABSTRACT

Background
Airway management is a critical component of emergency care, where timely and successful endotracheal intubation is essential for preventing hypoxia, aspiration, and cardiorespiratory deterioration. Unanticipated difficult laryngoscopy remains a major challenge in emergency settings and is associated with increased morbidity and mortality. Conventional bedside airway assessment methods such as Mallampati grading, thyromental distance, and mouth opening are often unreliable in emergency department patients due to lack of cooperation, altered consciousness, trauma, or anatomical distortion. Ultrasound has emerged as a rapid, non-invasive, and objective modality for airway assessment. Sonographic parameters such as tongue thickness, pre-epiglottic space to epiglottic vocal cord (PE/EVC) ratio, and hyomental distance may help predict difficult laryngoscopy before airway instrumentation.

Aim
To evaluate the correlation between ultrasound-guided airway parameters and Cormack–Lehane grading in predicting difficult endotracheal intubation in emergency department patients.

Methods
This prospective observational study was conducted in the Emergency Department of SRM Medical College Hospital and Research Centre. A total of 100 adult patients requiring endotracheal intubation were included. Prior to intubation, airway ultrasound was performed using a high-frequency linear probe to measure tongue thickness, PE/EVC ratio, and hyomental distance in standardized scanning planes. Following ultrasound assessment, endotracheal intubation was performed using standard direct laryngoscopy, and laryngoscopic view was graded according to the Cormack–Lehane classification. Easy laryngoscopy was defined as Grade I–II, while difficult laryngoscopy was defined as Grade III–IV. Statistical analysis was performed to determine correlation between ultrasound parameters and difficult intubation, with $p < 0.05$ considered statistically significant.

Results
The mean age of the study population was 50.94 ± 19.59 years, with 54% female participants. Difficult laryngoscopy was observed in 30% of cases, while difficult intubation occurred in 25% of patients. Increased tongue thickness (>6.5 cm) showed strong association with difficult intubation ($p < 0.001$). Reduced hyomental distance (≤5.5 cm) was significantly associated with higher Cormack–Lehane grades ($p < 0.001$). A higher PE/EVC ratio (>1.6) also demonstrated strong correlation with difficult laryngoscopy ($p < 0.001$). Ultrasound parameters showed stronger predictive value compared to demographic variables such as age, BMI, and neck circumference. Patients with difficult airways required more intubation attempts and longer intubation times.

Conclusion
Ultrasound-guided airway assessment is a reliable and objective method for predicting difficult laryngoscopy in emergency department patients. Tongue thickness, hyomental distance, and PE/EVC ratio showed strong correlation with Cormack–Lehane grading and intubation difficulty. Incorporating pre-intubation airway ultrasound into emergency airway assessment protocols may improve first-pass success, reduce complications, and enhance patient safety.

Keywords: *Airway ultrasound, Difficult intubation, Cormack–Lehane grading, Tongue thickness, Hyomental distance, Emergency airway management*

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How to cite this article: Balaji S, Umer AP, Prasad H, Rajarajeshwaran., A Study on Correlation of Ultrasound Guided Airway Parameters with Cormack Lehane Grading In Emergency Department-A Prospective Observational Study Int J Drug Deliv Technol. 2026;16(72s): 900-907. DOI: 10.25258/ijddt.16.72s.101
Source of support: Nil.
Conflict of interest: None

INTRODUCTION

Airway management remains one of the most critical and time-sensitive responsibilities in emergency medicine, where rapid decisions often determine patient survival and neurological outcomes. Securing a patent airway through endotracheal intubation is frequently required in patients presenting with trauma, respiratory failure, altered sensorium, or hemodynamic instability. [1] However, unanticipated difficult laryngoscopy and intubation continue to pose significant challenges, even for experienced clinicians. Failed or delayed intubation can result in hypoxia, aspiration, cardiovascular collapse, and increased mortality, particularly in the emergency department where patients are physiologically unstable and often inadequately optimized prior to the procedure. [2] Conventional bedside airway assessment tools such as Mallampati grading, thyromental distance, and mouth opening are less reliable in emergency settings because patients may be uncooperative, immobilized, or unconscious. These limitations have driven the search for objective, rapid, and non –invasive methods to predict difficult laryngoscopy more accurately.

The Cormack–Lehane (CL) grading system remains the most widely accepted method for describing laryngeal view during direct laryngoscopy. [3] It categorizes visualization of the glottis into four grades and is strongly associated with intubation difficulty and need for adjuncts. Despite its value, CL grading is determined only after laryngoscopy has already begun, meaning it does not serve as a pre - procedural predictive tool. [4] Therefore, there is a clear clinical need for methods that can estimate airway difficulty before instrumentation, allowing better preparation, equipment selection, and backup planning. In emergency scenarios, the ability to anticipate a difficult airway can significantly reduce complications and improve first-pass success rates. Ultrasound has emerged as a promising modality in airway evaluation due to its portability, safety, repeatability, and real-time visualization of soft tissue structures. Point-of-care ultrasound is already integrated into emergency practice for cardiac, abdominal, and vascular assessments, making its extension into airway evaluation a logical progression. [5] Airway ultrasound allows visualization of anatomical landmarks such as the tongue, hyoid bone, epiglottis, vocal cords, and anterior neck soft tissues. Unlike clinical examination, ultrasound is not dependent on patient cooperation and can be performed even in immobilized or unconscious patients [6]. This adaptability is particularly valuable in emergency departments where rapid, bedside imaging is essential.

One of the most studied ultrasound parameters is tongue thickness. The tongue occupies a substantial portion of the oral cavity, and increased tongue bulk relative to the oropharyngeal space can hinder alignment of airway axes during laryngoscopy [7]. Ultrasound measurement of tongue thickness provides a quantitative representation of soft tissue volume that may predict limited glottis visualization. Several investigations have demonstrated that greater tongue thickness correlates with higher CL grades and increased intubation difficulty, suggesting that ultrasound assessment may offer superior objectivity compared to subjective airway scores [8].

Another important parameter is the pre -epiglottic space to epiglottis-vocal cord distance ratio. This measurement reflects the relationship between anterior neck soft tissue and the depth of laryngeal structures [9]. A larger pre - epiglottic space may indicate increased tissue bulk between the skin and glottis, potentially obscuring the laryngoscopic view. Ultrasound enables precise identification of the epiglottis and vocal cords, allowing calculation of this ratio as a predictor of difficult laryngoscopy [10]. Studies have indicated that this sonographic ratio may correlate more consistently with CL grading than traditional anthropometric indices, particularly in obese or anatomically complex patients.

Hyomental distance is another ultrasound –guided measurement gaining attention. It represents the distance between the hyoid bone and mentum and is associated with mandibular space adequacy [11]. A shorter hyomental distance may reflect reduced submandibular space, limiting displacement of the tongue during laryngoscopy. Ultrasound allows dynamic assessment of this distance in different head positions, offering additional insight into airway flexibility [12]. Evidence suggests that decreased hyomental distance is linked to higher CL grades and difficulty in visualizing the glottis. The integration of these ultrasound parameters provides a multidimensional evaluation of airway anatomy, encompassing oral cavity volume, anterior neck soft tissue thickness, and mandibular space characteristics. Unlike isolated clinical measures, sonographic assessment captures structural relationships directly influencing laryngoscopic view [13]. This anatomical visualization bridges the gap between pre-assessment and intra-procedural findings, offering a more predictive approach. Emergency physicians, anaesthesiologists, and critical care clinicians increasingly recognize airway ultrasound as a valuable adjunct in pre - intubation planning, particularly in high-risk environments.

In the emergency department, where patient physio logy may deteriorate rapidly, a reliable pre -intubation predictor is essential [14]. Trauma patients, for example, often have cervical immobilization that limits airway alignment. Similarly, patients with facial edema, burns, or obesity may present distorted anatomy. Ultrasound can be

performed without moving the patient and can reveal hidden anatomical constraints not evident on external examination. This capability enhances preparedness by guiding decisions regarding use of video laryngoscopy, bougies, or advanced airway devices. The growing body of literature supporting sonographic airway assessment underscores its potential role in emergency airway algorithms [15].Despite promising findings, variability in technique, operator experience, and patient characteristics necessitates further prospective studies to validate the correlation between ultrasound parameters and CL grading specifically in emergency populations[16]. Most previous research has been conducted in elective surgical settings, where patient profiles differ significantly from emergency cases. Therefore, studying these correlations in the emergency department context is essential to establish practical applicability and reproducibility. Demonstrating a strong relationship between ultrasound-derived measurements and CL grading could transform pre-intubation assessment, shifting from subjective estimation to objective imaging-based prediction.

AIM AND OBJECTIVES

Aim

To study the sonographic assessment of airway parameters (tongue thickness, pre epiglottic to epiglottic vocal cord ratio, hyomental distance) in predicting difficult endotracheal intubation.

Primary Objectives

To assess the predictive value of ultrasound-guided airway parameters (tongue thickness, pre epiglottic to epiglottic vocal cord ratio, hyomental distance) in determining intubation difficulty compared to the Cormack –Lehane classification.

Secondary Objective

To reduce the number of attempts in difficult intubation by early prediction.

Methodology

This prospective observational study was conducted in the Emergency Department of **SRM Medical College Hospital and Research Centre** to evaluate the correlation between ultrasound-guided airway parameters and **Cormack–Lehane grading** during laryngoscopy. No intervention beyond standard emergency airway management was introduced.

The study was conducted over a defined period until the required sample size of 100 patients was achieved using consecutive sampling.

Inclusion Criteria

Patients aged above 18 years requiring airway management in the emergency department with:

- Inability to maintain airway patency
- Risk of aspiration
- Impending respiratory failure
- Expected decline in Glasgow Coma Scale

Exclusion Criteria

Patients with:

- Very low GCS precluding safe pre-intubation assessment
- Requirement for immediate crash intubation
- Prior intubation outside the hospital
- Pregnancy
- Tracheostomy
- Previous thyroid surgery
- Major head and neck surgery

Ultrasound airway parameters assessed included tongue thickness, pre-epiglottic space to epiglottis–vocal cord ratio, and hyomental distance. Measurements were obtained using a high-frequency linear probe before intubation in standardized planes: submental transverse, midline longitudinal, and transverse anterior neck scans.

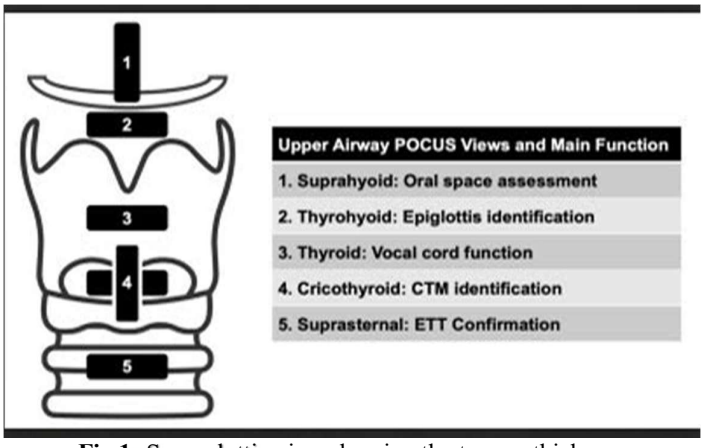

Fig 1: Supraglottic view showing the tongue thickness

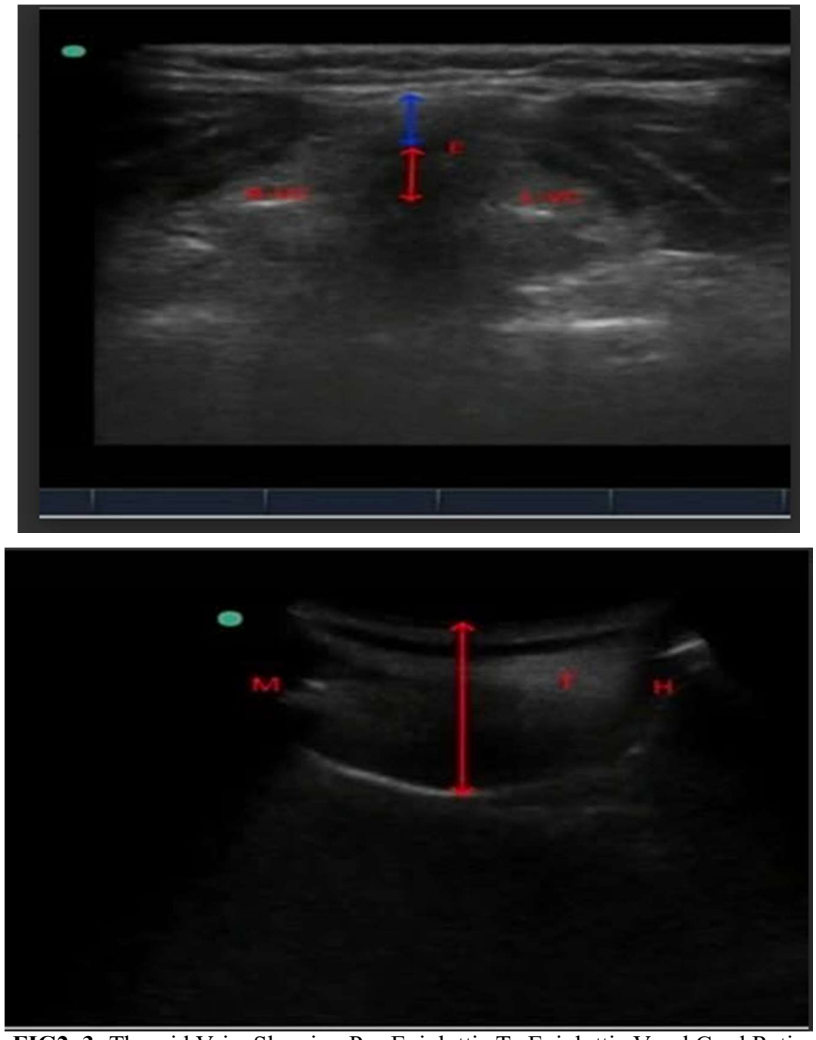

FIG2, 3: Thyroid Veiw Showing Pre-Epiglottic To Epiglottic Vocal Cord Ratio

Following ultrasound assessment, endotracheal intubation was performed using standard laryngoscopy. The laryngoscopic view was documented using Cormack–Lehane grading. For analysis, patients were classified as easy laryngoscopy (Grades I–II) or difficult laryngoscopy (Grades III–IV).

RESULTS

TABLE 1: Baseline Characteristics of Study Population

Variable	Value
Age (years)	50.94 ± 19.59
Sex (Male/Female)	46 / 54
BMI (kg/m²)	26.10 ± 4.59
Neck Circumference (cm)	38.21 ± 3.90
GCS Score	11.35 ± 1.74

The study included 100 emergency patients with a mean age of 50.94 years. Females constituted 54% of participants. Most patients were overweight with moderately increased neck circumference.

TABLE 2: BMI Category Distribution

BMI Category	Frequency	Percentage
Normal	45	45%
Overweight	35	35%
Obese	20	20%

More than half of patients (55%) were overweight or obese, indicating elevated airway difficulty risk.

TABLE 3: Association between Tongue Thickness and Difficult Intubation

Tongue Thickness (cm)	Difficult Intubation – Yes n (%)	Difficult Intubation – No n (%)	Chi-square value	p value
≤ 5.5	0 (0.0%)	47 (100.0%)	37.78	<0.001*
5.6 – 6.5	20 (41.7%)	28 (58.3%)		
> 6.5	5 (100.0%)	0 (0.0%)		

Table 4: Association between Hyomental Distance and Difficult Intubation

Hyomental Distance (cm)	Difficult Intubation Yes n (%)	Difficult Intubation No n (%)
≤ 5.5	15 (75.0)	5 (25.0)
5.6 – 6.5	8 (19.0)	34 (81.0)
> 6.5	2 (7.1)	26 (92.9)

Chi-square: 68.9, p-value: <0.001

Table 5: Association between PE/EVC Ratio and Difficult Intubation

PE/EVC Ratio	Difficult Intubation Yes n (%)	Difficult Intubation No n (%)
≤ 1.3	2 (4.7)	41 (95.3)
1.31 – 1.6	7 (20.6)	27 (79.4)
> 1.6	16 (80.0)	4 (20.0)

Chi-square: 52.3, p-value: <0.001

Table 6: Correlation of Clinical and Ultrasound Variables with Difficult Intubation

Variable	Correlation (r)	p-value
Age	0.09	0.37
BMI	-0.05	0.63
Neck Circumference	0.17	0.11
Tongue Thickness	0.81	<0.001
PE/EVC Ratio	0.75	<0.001
Hyomental Distance	-0.84	<0.001
Thyromental Distance	-0.87	<0.001
Time to Intubation	0.68	<0.001
Number of Attempts	0.71	<0.001

TABLE 7: Multivariable Logistic Regression Analysis for Predicting Difficult Intubation

Predictor Variable	β Coefficient	Odds Ratio (OR)	p-value
Tongue Thickness (cm)	+2.91	18.4	<0.001*
PE/EVC Ratio	+2.36	10.6	<0.001*
Hyomental Distance (cm)	–3.12	0.04	<0.001*
Thyromental Distance (cm)	–3.48	0.03	<0.001*
Neck Circumference (cm)	+0.21	1.23	<0.001*
BMI	–0.08	0.92	<0.001*

DISCUSSION

Airway management in the emergency department remains one of the most challenging and time-sensitive aspects of critical care. The ability to accurately predict difficult laryngoscopy before airway instrumentation can significantly improve first-pass success and reduce complications such as hypoxia, aspiration, and hemodynamic instability. In the present study, ultrasound-guided airway assessment demonstrated strong predictive value for difficult laryngoscopy and difficult intubation, with tongue thickness, hyomental distance, and pre-epiglottic space to epiglottic vocal cord (PE/EVC) ratio showing significant correlation with Cormack–Lehane grading.

Our study observed difficult laryngoscopy in 30% of patients and difficult intubation in 25%. These findings are clinically important because emergency patients often present with physiological instability, poor oxygen reserve, and altered anatomy, all of which increase airway-related risk. Compared with elective surgical populations, emergency department patients are more likely to have airway compromise due to trauma, edema, burns, obesity, or reduced consciousness. This makes pre-intubation prediction especially relevant. Similar observations have been reported in previous studies, where difficult airway incidence in emergency settings ranged from 10–30%, depending on patient population and criteria used. [16]

Tongue thickness emerged as one of the strongest predictors of difficult intubation in our study. Patients with tongue thickness >6.5 cm had significantly higher rates of difficult laryngoscopy and difficult intubation ($p < 0.001$). The correlation coefficient for tongue thickness was strongly positive ($r = 0.81$), indicating that increasing tongue thickness was associated with greater airway difficulty. This finding supports previous research suggesting that increased tongue bulk reduces available oropharyngeal space and interferes with alignment of oral, pharyngeal, and laryngeal axes during laryngoscopy. Adhikari et al. demonstrated that increased tongue thickness measured by ultrasound was significantly associated with difficult laryngoscopic view, emphasizing its role as an objective predictor. [17] Similarly, Parameswari et al. reported that tongue thickness was superior to traditional bedside tests in identifying difficult airways. [18]

Hyomental distance also showed strong predictive value in our study. Reduced hyomental distance (≤5.5 cm) was significantly associated with difficult intubation, with a strong negative correlation ($r = –0.84$, $p < 0.001$). Patients with shorter hyomental distance had higher Cormack–Lehane grades, suggesting reduced mandibular space and limited ability to displace the tongue during laryngoscopy. This is consistent with the anatomical basis of difficult laryngoscopy, where inadequate submandibular space restricts visualization of the glottis. Falcetta et al. reported similar findings, demonstrating that reduced hyomental distance ratio was strongly predictive of difficult laryngoscopy and could improve airway assessment accuracy. [19] The advantage of ultrasound measurement is that it provides more precise and reproducible values compared to manual bedside measurement.

The PE/EVC ratio was another important sonographic predictor in our study. Patients with PE/EVC ratio >1.6 had significantly increased incidence of difficult intubation (80%, $p < 0.001$), with a strong positive correlation ($r = 0.75$). This ratio reflects the relationship between anterior soft tissue thickness and depth of laryngeal structures. Increased soft tissue thickness can obscure laryngeal visualization and make direct laryngoscopy more difficult. Previous studies have shown that PE/EVC ratio correlates well with Cormack–Lehane grading and may outperform conventional airway assessment methods. Gupta et al. reported that this ultrasound parameter had high sensitivity and specificity in predicting difficult laryngoscopy, particularly in obese patients and patients with distorted neck anatomy. [20]

Interestingly, demographic variables such as age, BMI, and neck circumference showed weak or statistically insignificant correlations with difficult intubation in our study. Age had minimal correlation ($r = 0.09$), BMI showed no significant association ($r = –0.05$), and neck circumference demonstrated only weak correlation ($r = 0.17$). These findings suggest that conventional anthropometric measures alone may not reliably predict airway difficulty in emergency settings. Although obesity and increased neck circumference have traditionally been associated with difficult airway, these factors may not directly reflect internal airway anatomy. Ultrasound provides real-time visualization of anatomical structures, making it more clinically relevant than external measurements. Ezri et al. similarly reported that neck circumference and BMI alone were insufficient predictors of difficult laryngoscopy without accompanying anatomical assessment. [21]

Our multivariable logistic regression analysis further reinforced the predictive value of ultrasound parameters. Tongue thickness had an odds ratio of 18.4, while PE/EVC ratio showed an odds ratio of 10.6, indicating strong independent association with difficult intubation. Hyomental distance demonstrated a protective effect with odds ratio 0.04, indicating that greater distance significantly reduced intubation difficulty. These findings highlight that ultrasound-derived measurements can independently predict airway difficulty even when adjusted for confounding variables. Such objective prediction can allow clinicians to plan airway management strategies proactively.

Another important finding in our study was the association between difficult laryngoscopy and procedural outcomes. Patients with difficult airways required more intubation attempts and longer intubation times, with both variables showing significant correlations ($p < 0.001$). Increased number of attempts is associated with higher risk of complications, including desaturation, aspiration, and

airway trauma. This emphasizes the practical value of pre-intubation ultrasound in improving first-pass success. Early recognition of a difficult airway enables preparation for advanced airway tools such as video laryngoscopy, bougies, supraglottic devices, or surgical airway backup. Kristensen et al. highlighted that integrating airway ultrasound into routine preoperative and emergency assessment improved preparedness and reduced failed intubation rates. [22]

The major strength of our study is its focus on emergency department patients rather than elective surgical populations. Most previous studies evaluating airway ultrasound were conducted in controlled operating room settings with relatively stable patients. Emergency patients present unique challenges, including hemodynamic instability, trauma-related anatomical distortion, and reduced time for assessment. Demonstrating significant correlation between ultrasound parameters and Cormack–Lehane grading in this setting strengthens the applicability of airway ultrasound in real-world emergency practice. Similar studies by Yao et al. and Pinto et al. support the expanding role of point-of-care ultrasound in emergency airway management. [23, 24]

However, our study has certain limitations. First, it was conducted in a single centre with a sample size of 100 patients, which may limit generalizability. Larger multicentre studies are required to validate these findings across diverse populations. Second, ultrasound measurements are operator-dependent and require training to ensure consistency and accuracy. Interobserver variability may influence results, particularly during early learning phases. Third, crash intubation cases and severely unstable patients were excluded, limiting evaluation in the most critical emergency scenarios. Future studies should focus on validating ultrasound protocols in larger emergency cohorts and establishing standardized cut-off values for difficult airway prediction. [25]

CONCLUSION

Our findings strongly support the use of ultrasound-guided airway assessment as a reliable, rapid, and objective method for predicting difficult laryngoscopy in emergency department patients. Tongue thickness, hyomental distance, and PE/EVC ratio showed significant correlation with Cormack–Lehane grading and intubation difficulty. Incorporating pre-intubation airway ultrasound into emergency airway assessment protocols may improve anticipation of difficult airway, enhance first-pass success, reduce complications, and ultimately improve patient safety. With increasing availability of point-of-care ultrasound in emergency medicine, sonographic airway assessment has the potential to become an essential component of modern airway management algorithms.

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