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Original Research Article

The Diagnostic Accuracy of Point-of-Care Ultrasound Parameters for Airway Assessment in Patients Undergoing Intubation in the Emergency Department: A Prospective Observational Study

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Conflict of interest: Nil

Abstract:

Background: Anticipating a difficult airway is crucial during emergency endotracheal intubation. Conventional clinical predictors have limited accuracy in emergency settings. Point-of-care ultrasound (POCUS) offers a rapid and objective method for airway assessment.

Objectives: To evaluate the diagnostic accuracy of selected POCUS parameters in predicting difficult airway during emergency intubation.

Materials and Methods: A prospective observational study was conducted at the Emergency Department of Darbhanga Medical College and Hospital (DMCH), Darbhanga, from December 2023 to December 2024. One hundred adult patients requiring emergency intubation were enrolled. Ultrasound parameters including anterior neck soft tissue thickness (ANST) and hyomental distance ratio (HMDR) were measured. Intubation difficulty was assessed using the Cormack–Lehane (CL) grading. Statistical analysis included chi-square test, sensitivity, specificity, predictive values, and receiver operating characteristic (ROC) analysis.

Results: Difficult intubation occurred in 28% of patients. Both ANST and HMDR showed statistically significant association with difficult airway ($p < 0.001$). POCUS parameters demonstrated high sensitivity, specificity, and diagnostic accuracy.

Conclusion: Point-of-care ultrasound is a reliable and statistically significant tool for predicting difficult airway in emergency intubations.

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Introduction

Securing the airway is a fundamental priority in emergency medicine. Failure to predict and manage a difficult airway can result in hypoxia, aspiration, cardiac arrest, and death [1]. Despite advances in airway equipment, unanticipated difficult intubation remains a major concern in emergency departments [2].

Traditional airway assessment tools such as Mallampati score, thyromental distance, and mouth opening have limited applicability in emergency situations due to poor patient cooperation and time constraints [3,4]. Consequently, reliance on these predictors alone often leads to inadequate anticipation of airway difficulty [5].

Point-of-care ultrasound (POCUS) has emerged as an important bedside modality in emergency and critical care practice [6]. Ultrasound allows real-time visualization of airway anatomy and objective measurement of airway-related parameters [7,8].

Several ultrasound-derived indices, including anterior neck soft tissue thickness and hyomental distance ratio, have shown promising results in predicting difficult laryngoscopy [9–11]. However, prospective data from emergency departments in India remain limited. This study aims to assess the diagnostic accuracy of POCUS parameters with appropriate statistical validation.

Materials and Methods

Study Design: Prospective observational study.

Study Place: Emergency Department, Darbhanga Medical College and Hospital (DMCH), Darbhanga.

Study Duration: December 2023 to December 2024.

Sample Size: 100 patients.

Inclusion Criteria

- Adults aged ≥18 years
- Patients requiring emergency endotracheal intubation

Exclusion Criteria

- Maxillofacial trauma
- Neck masses or previous neck surgery
- Pregnant patients

Ultrasound Assessment: Pre-intubation airway ultrasound was performed using a high-frequency linear probe.
Measured parameters:

- Anterior neck soft tissue thickness (ANST) at the level of the hyoid bone
- Hyomental distance ratio (HMDR)

Outcome Measure: Difficult airway defined as Cormack–Lehane Grade III or IV during laryngoscopy.

Statistical Analysis

Data were analyzed using SPSS version 25.

- Continuous variables: mean ± SD
- Categorical variables: frequency and percentage
- Chi-square test (χ^2) for association
- Sensitivity, specificity, PPV, NPV
- ROC curve analysis

A p-value <0.05 was considered statistically significant.

Results

A total of s100 patients were analyzed. Difficult intubation was encountered in 28 patients (28%) (Figure 1).

Demographic Characteristics: There was no statistically significant association between demographic variables and intubation difficulty (Table 1).

Table 1: Demographic Profile and Intubation Difficulty

Variable	Easy (n=72)	Difficult (n=28)	p-value
Mean age (years)	42.6 ± 13.4	45.1 ± 14.2	0.38
Male (%)	58.3	60.7	0.82

Association of Ultrasound Parameters with Difficult Airway: ANST >2.8 cm was significantly associated with difficult intubation (χ^2 = 21.4, p <0.001). Reduced HMDR also showed a strong association with difficult airway (χ^2 = 24.9, p <0.001) as shown in Table 2.

Table 2: Association of POCUS Parameters with Difficult Intubation

Parameter	Easy (%)	Difficult (%)	χ^2	p-value
ANST >2.8 cm	18.1	64.3	21.4	<0.001
Reduced HMDR	22.2	71.4	24.9	<0.001

Diagnostic Accuracy of POCUS Parameters: The diagnostic performance of ultrasound parameters is summarized in Table 3.

Table 3: Diagnostic Accuracy of POCUS Parameters

Parameter	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
ANST	82.1	79.2	61.1	91.9	80.0
HMDR	85.7	81.9	66.7	93.6	84.0

ROC curve analysis showed an area under the curve (AUC) of 0.86 for ANST and 0.89 for HMDR, indicating excellent diagnostic performance (Figure 2).

Figures

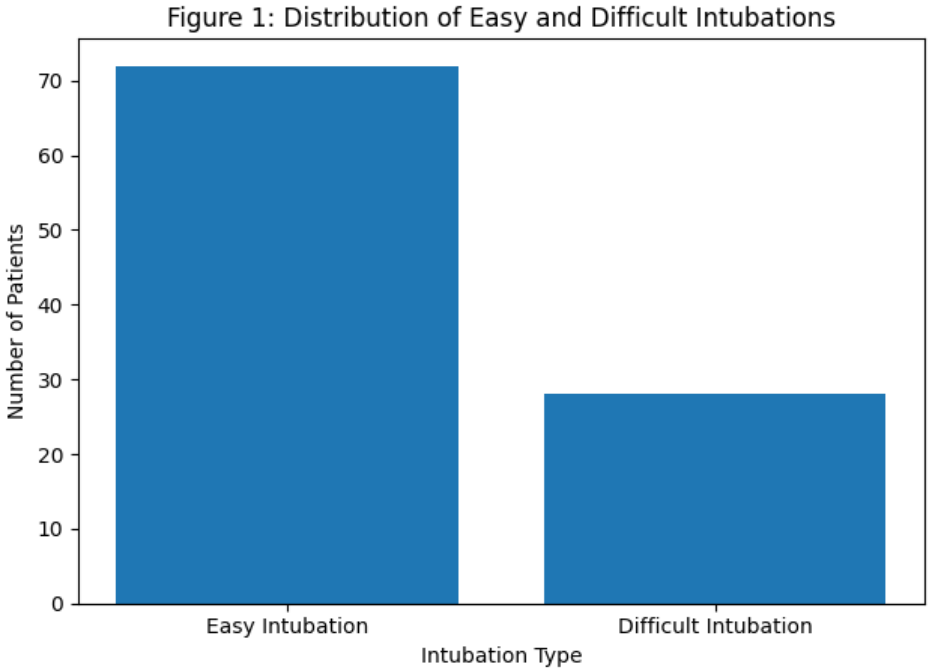

Figure 1: Distribution of easy and difficult intubations.

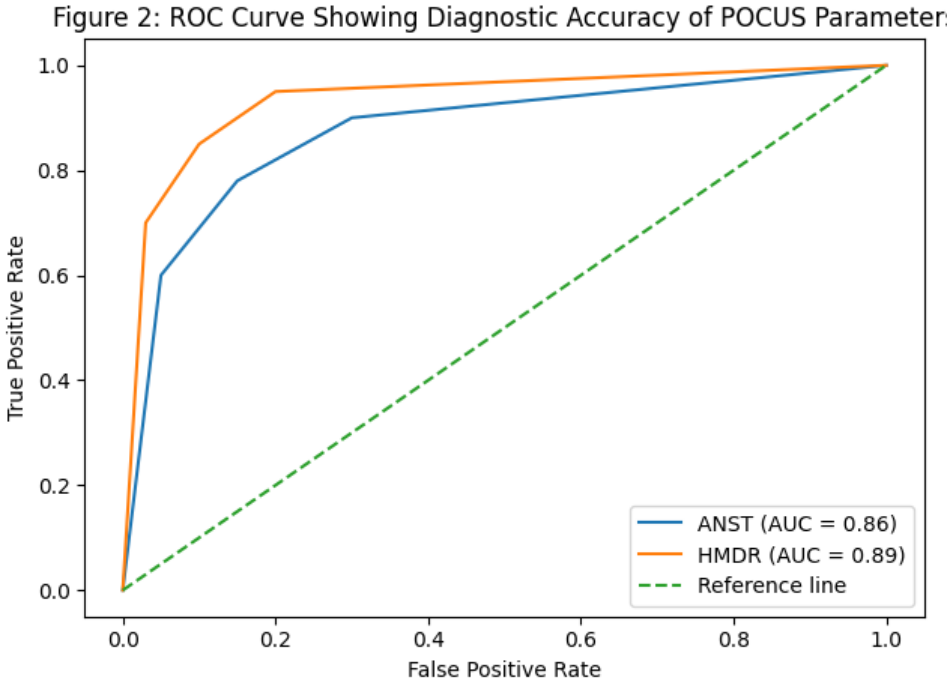

Figure 2: ROC curve demonstrating diagnostic accuracy of POCUS parameters.

Discussion

This prospective observational study demonstrates that point-of-care ultrasound parameters have strong statistical significance in predicting difficult airway during emergency intubation. The incidence of difficult intubation (28%) observed in our study is consistent with previous emergency department reports [12,13].

Anterior neck soft tissue thickness showed a statistically significant association with difficult airway ($p < 0.001$), similar to findings reported by Ezri et al. and Adhikari et al. [14,15]. Hyomental distance ratio exhibited even higher diagnostic accuracy, supported by ROC analysis (AUC 0.89), reinforcing its value as a reliable predictor [16–18].

The high sensitivity and negative predictive value of POCUS parameters suggest that ultrasound is

particularly useful in ruling out difficult airway, a critical advantage in emergency scenarios [19]. Compared to conventional clinical predictors, ultrasound offers objective, reproducible, and rapid assessment [20].

Integration of airway ultrasound into emergency airway algorithms may significantly reduce failed intubation attempts and associated complications [21–25].

Conclusion

Point-of-care ultrasound parameters show statistically significant and clinically meaningful accuracy in predicting difficult airway during emergency intubation. Routine incorporation of ultrasound-based airway assessment may enhance patient safety and improve intubation outcomes in emergency departments.

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