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Original Research Article

A STUDY ON THE ROLE OF ULTRASONOGRAPHY AS A PREDICTOR OF DIFFICULT AIRWAY

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Abstract

Background: Airway management is critical in anaesthesia, emergency medicine, and critical care. Failure to predict a difficult airway is a major factor contributing to adverse outcomes. This study aimed to evaluate the correlation between ultrasonographic measurement of the distance from the skin to the epiglottis (USG-DSE) and the Cormack-Lehane (CL) classification in predicting difficult intubation. **Materials and Methods:** A single-blinded prospective observational study was conducted on 90 patients undergoing elective surgery under general anaesthesia at Stanley Medical College, Chennai. Preoperative airway assessment included Mallampati classification, thyromental distance, and USG-DSE measurements at the thyrohyoid membrane using a high-frequency ultrasound probe. Intubation was performed using a Macintosh blade, and the CL grade was documented. Patients were classified into easy (CL Grade I-II) and difficult (CL Grade III-IV) intubation groups. The predictive values of USG-DSE and Mallampati classification were compared. **Result:** The mean age of the patients was 42.08±15.64 years, and the mean BMI was 23.11±3.34 kg/m². Among the 90 patients, 85 (94.5%) had easy intubation (CL Grade I-II), whereas 5 (5.5%) had difficult intubation (CL Grade III-IV). USG-DSE >1.94 cm was observed in 47(55.3%) and 3(60%) of easy and difficult intubation cases. The sensitivity and specificity for predicting difficult intubation were 24.37% and 80.49% for USG-DSE and 19.23% and 80.25% for the Mallampati classification, respectively. The area under the ROC curve for USG-DSE was 0.679, indicating better predictive accuracy than that of the clinical methods. **Conclusion:** Ultrasound measurement of the pre-epiglottic space provides better specificity in predicting difficult intubation than conventional screening tests. Its role as an adjunctive airway assessment tool should be further validated in larger studies.

INTRODUCTION

Airway management is defined as the application of therapeutic interventions intended to affect gaseous exchange in patients who are unable to do so by themselves.[1] To achieve this, several devices and techniques are commonly employed in healthcare settings. These include the BMV (Bag and mask ventilation), SGD (supraglottic devices), oral/nasal ETI (endotracheal intubation) and invasive or surgical airway techniques.[2]

Failure to adequately manage the airway has been identified as the major factor leading to poor and adverse outcomes in anaesthesia, critical care, emergency medicine, hospital medicine and EMS (Emergency medical services) It is critically important to recognize that the single most important factor leading to failed airway is the failure to predict the difficult airway.[3,4] Therefore, accurate airway assessment should always be performed to provide appropriate planning and management of expected difficult intubation and to limit any unexpected difficulties.[5] However, the common clinical screening tests (Mallampati score, inter-incisor distance, thyrohyoid distance, thyromental distance, BMI, etc.) have shown low sensitivity and specificity with a limited predictive value, especially if only a single assessment method is used.[6]

Ultrasound-based airway assessment has recently been proposed as a useful, simple, non-invasive bedside tool as an adjunct to clinical methods; however, to date, few studies have been conducted on the potential role of ultrasound in difficult airway evaluation.[7] In this study, we attempted to analyse the usefulness of point-of-care ultrasound (POCUS) of the upper airway by considering a single parameter and its usefulness in predicting unanticipated difficult airway.

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Aim: This study assessed the correlation between ultrasonographic upper airway parameters (distance from skin to epiglottis) and the Cormack-Lehane (CL) classification.

MATERIALS AND METHODS

This single-blinded prospective observational study was conducted on 90 patients at the Department of Anaesthesiology, Stanley Medical College, Chennai for 6 months (2022). The study began after obtaining ethical clearance from the institutional ethics committee. Written informed consent was obtained preoperatively from each patient.

Inclusion criteria

Patients aged 18-60 years, classified under American Society of Anesthesiologists (ASA) physical status I–III, undergoing elective general surgeries under general anaesthesia requiring tracheal intubation with a BMI of 25.8 ± 5.3 kg/m² were included.

Exclusion criteria

Patients requiring rapid sequence induction, with a high BMI, uncooperative, pregnant, with a difficult intubation history, limited cervical spine mobility, maxillofacial anomalies, inter-incisor distance < 3 cm, emergency intubation in critical care and trauma wards, or tracheostomy were excluded.

Methods

During the pre-anaesthetic evaluation, demographic variables were collected, and clinical screening tests were performed to predict a difficult airway, including Mallampati score assessment, thyromental distance measurement, and ultrasonographic measurement of the distance from the skin to the epiglottis (DSE). For the Mallampati score assessment, the patients were seated with their heads in a neutral position, mouths wide open, and tongues maximally protruded without phonation. Thyromental distance (cm) was measured with the patient sitting, neck fully extended, and mouth closed, from the thyroid notch to the mentum tip using a measuring tape.

Patients underwent ultrasound airway assessment, focusing on USG-DSE performed at the thyrohyoid membrane level using a high-frequency linear ultrasound probe placed in the transverse plane. The patients were positioned supine with their head and neck in a neutral position, without a pillow, and instructed to keep their mouths closed and breathe slowly. The epiglottis was identified as a linear hypoechoic structure, with its posterior border marked by a brighter linear air-mucosa interface and its anterior border delineated by the hyperechoic pre-epiglottic space. The distance from the skin surface to the middle axis of the highest epiglottis was measured in centimetres.

Patients were monitored using ASA standard monitoring devices, and after preoxygenation with 100% O_2 for 3 min, intravenous (IV) midazolam (1 mg) and fentanyl (2 µg/kg) were administered. Anaesthesia was induced with IV thiopentone sodium (5 mg/kg), followed by muscle relaxation with IV atracurium (0.5 mg/kg). The patients were ventilated with oxygen and sevoflurane (2.0%) for 3 min before direct laryngoscopy.

Laryngoscopy was performed by an attending anaesthesiologist with at least two years of experience. Tracheal intubation was performed using an appropriately sized curved Macintosh blade, and the CL grade was recorded. Correct endotracheal tube placement was confirmed by capnography and five-point auscultation. The intubating anesthesiologist was blinded to the preoperative clinical and sonographic airway assessments.

Anaesthesia was maintained with sevoflurane and booster doses of atracurium and fentanyl as needed. At the end of the surgery, patients were reversed with intravenous (IV) glycopyrrolate (10 µg/kg) and neostigmine (50 µg/kg) and extubated following oral suctioning. Patients were classified into two groups based on the CL classification: Group A (easy intubation, Grade I–II) and Group B (difficult intubation, Grade III-IV).

Statistical analysis: Data were presented as mean, standard deviation, frequency, and percentage. The cut-off value was calculated using ROC, and cross tabs were created to determine the sensitivity and specificity. Data analysis was performed using IBM-SPSS version 21.0.

RESULTS

The mean age of the patients was 42.08±15.64 years, and the mean BMI was 23.11±3.34 kg/m². Regarding sex distribution, 54(60%) patients were male and 46 (40%) were female [Table 1].

Table 1: Demographic characteristics.

		Mean±SD
Age (years)		42.08±15.64
BMI (Kg/m2)		23.11±3.34
Gender N (%)	Male	54(60%)
	Female	46(40%)

According to the CL classification, 44 (48.9%) patients presented with Grade I intubation, while 41 (45.6%) presented with Grade II intubation, representing ease of intubation. However, 4 (4.4%) patients were in Grade III and 1 (1.1%) in Grade IV, representing difficult intubation [Table 2].

Table 2: Cormack-Lehane grading of patients

Cormack-Lehane grading		N (%)
Easy Intubation	Grade I	44(48.9%)
	Grade II	41(45.6%)
Difficult Intubation	Grade III	4(4.4%)

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	Grade IV	1(1.1%)

Among patients in Group A (easy intubation), 47(55.3%) had a USG-DSE measurement > 1.94 cm, while 38(44.7%) had < 1.94 cm. Similarly, in Group B (difficult intubation), 3(60%) patients had a USG-DSE >1.94 cm, whereas 2(40%) had a USG-DSE < 1.94.

According to the Mallampati classification (MPC), 24(28.2%) patients in Group A were categorised as difficult intubation, whereas 61(71.8%) were classified as easy intubation. In Group B, 1(20%) patients were classified as difficult intubation, while 4(80%) were categorised as easy intubation [Table 3].

Table 3: Comparison of USG-DSE and MPC to CL classification

		Cormack-Lehane	
		Group A	**Group B**
USG-DSE	> 1.94	47(55.3%)	3(60%)
	< 1.94	38(44.7%)	2(40%)
MPC	Difficult intubation	24(28.2%)	1(20%)
	Easy intubation	61(71.8%)	4(80%)

The sensitivity for predicting intubation using the CL classification was 24.37% for USG-DSE and 19.23% for MPC. The specificity values were 80.49% for USG-DSE and 80.25% for the MPC. The positive predictive value (PPV) was 52.94% for USG-DSE and 29.41% for MPC, whereas the negative predictive value (NPV) was 38.21% for USG-DSE and 71.23% for MPC [Table 4].

Table 4: Comparison of predictive values of USG-DSE and MPC with CL classification

	USG-DSE	**MPC**
Sensitivity	24.37%	19.23%
Specificity	80.49%	80.25%
PPV	52.94%	29.41%
NPV	38.21%	71.23%

The ROC curve found the area under the curve (AUC) to be 0.563 which is significant and denotes the predictive accuracy of thyromental distance [Figure 1].

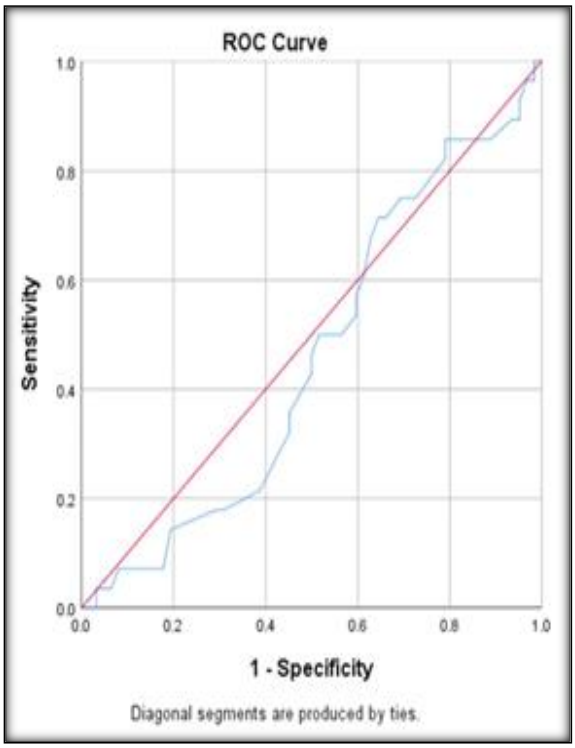

Figure 1: ROC curve of the thyromental distance

The above ROC curve reported an AUC of 0.679 which is significant and denotes the predictive accuracy of the distance from the skin to the epiglottis measured sonographically [Figure 2].

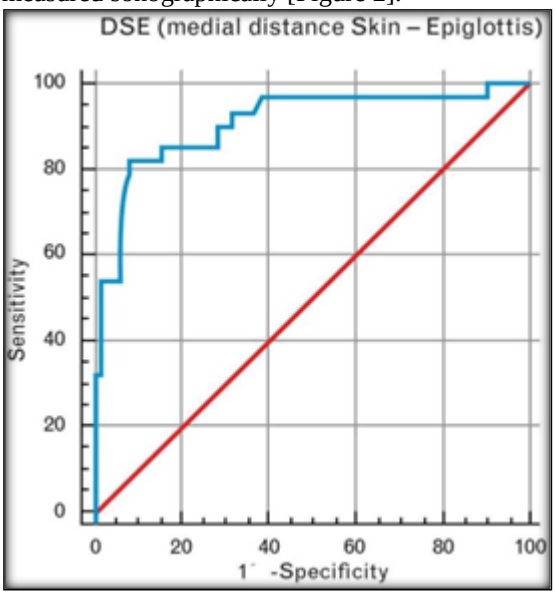

Figure 2: ROC curve of distance from skin to epiglottis

DISCUSSION

In our study, the demographic analysis showed a comparable distribution of age, gender, and BMI among the study population. This aligns with the findings of previous studies, such as those conducted by Abraham et al. and Koundal et al., in which patient demographics did not influence airway difficulty predictions.[8,9]

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Assessment of airway difficulty using ultrasound-based measurements showed that DSE provided better predictive accuracy than traditional clinical screening tests, such as TMD and MPC. This finding aligns with those of Rana et al. (sensitivity of 82% and specificity of 85%) and Falcetta et al., who reported that sonographic measurements of anterior cervical soft tissue thickness had superior sensitivity and specificity compared to conventional parameters.[10,11]

Our study found that USG-DSE had a higher specificity than TMD or MPC. Similar findings were observed in the study by Abdelhady et al., who reported that ultrasound-based airway assessment had a better correlation with difficult laryngoscopy than the MPC. While the MPC showed moderate specificity, its lower sensitivity makes it less dependable, as supported by studies such as those by Parameswari et al.[12,13]

Our study identified a cutoff value of 1.92 for USG-DSE sensitivity and specificity. The comparison of predictive values revealed that the PPV of USG-DSE was superior to both TMD and MPC, supporting the study hypothesis that ultrasound can enhance the detection of unanticipated difficult intubation. This aligns with a previous study by Chan et al. which explained the role of sonographic pre-epiglottic space measurement in airway assessment. Falcetta et al. reported that pre-epiglottic space assessment using ultrasound provided a high level of accuracy in predicting difficult airways and found that the median distance from the skin to the epiglottis and the pre-epiglottic area was 2.54 cm (cut-off) (sensitivity 82%, specificity 91%).[11,14]

CONCLUSION

Our study concluded that ultrasound measurement of the pre-epiglottic distance had better predictive accuracy for difficult airways than the thyromental distance, followed by the commonly used modified MPC. The increasing thickness at the level of the pre-epiglottic space could affect the ability to visualise the glottis with a Macintosh blade at direct laryngoscopy, especially when associated with a reduced distance between the skin and vocal cords. Our study was conducted with a relatively small sample size, which may limit the generalizability of the results.

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