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Original Research Article

ULTRASOUND GUIDED MEASUREMENT OF ANTERIOR NECK TISSUE FOR THE PREDICTION OF DIFFICULT LARYNGOSCOPY IN ICU PATIENTS

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ABSTRACT

Background: Unanticipated difficult laryngoscopy remains a major concern in anesthetic practice, especially in critically ill ICU patients, where securing the airway is crucial. Conventional bedside airway assessment methods have limited predictive value. Ultrasound (USG) has recently gained attention as a non-invasive, real-time tool for evaluating anterior neck anatomy. Measurements such as the distance from the skin to the hyoid bone, thyrohyoid membrane, and anterior commissure may aid in identifying patients at risk for difficult laryngoscopy. The primary objective was to evaluate the utility of ultrasound-guided measurements of anterior neck soft tissue in predicting difficult laryngoscopy. Secondary objectives included assessing the sensitivity and specificity of three key sonographic parameters: distance from skin to hyoid bone (DSHB), thyrohyoid membrane (DSTM), and anterior commissure of vocal cords (DSAC).

Materials and Methods: This prospective observational study included 91 adult ICU patients requiring elective intubation. Pre-intubation USG measurements (DSHB, DSTM, DSAC) were obtained using a high-frequency linear probe with patient's head and neck in neutral position. Standard clinical airway assessments were also recorded. Laryngoscopy was performed post-induction, and Cormack-Lehane (CL) grades were noted. Grades III and IV were classified as difficult laryngoscopy. ROC analysis was used to evaluate diagnostic accuracy.

Results: The incidence of difficult laryngoscopy was 3.3%. Among sonographic parameters, DSTM demonstrated the highest sensitivity (100%) at a cut-off >0.53 cm (AUROC 0.727). DSHB showed excellent specificity (98.9%) but low sensitivity. DSAC had limited diagnostic value.

Conclusion: Ultrasound-guided anterior neck soft tissue measurements did not significantly differ between the easy and difficult laryngoscopy patients and were not good predictors for difficult laryngoscopy in the population studied.

Keywords: Ultrasound airway assessment; Difficult laryngoscopy; Anterior neck soft tissue; ICU intubation; Airway ultrasound; Critical care airway management.

INTRODUCTION

Airway management is one of the critical clinical skills that is required in the practice of emergency medicine, anesthesiology and intensive care. A number of critical incidents in the above fields has its roots in suboptimal airway management. Difficulties encountered in airway management can result in serious patient morbidity, including aspiration, neurologic impairment, hypoxic brain injury, and sometimes death.[1,2]

The results of the Fourth National Audit Project [NAP4] of the Royal College of Anesthetists and the Difficult Airway Society of the United Kingdom further confirms that inadequately managed airway

contributes significantly to patient morbidity and mortality.[3] Tracheal intubation is a vital component of the care provided to critically ill patients in intensive care unit (ICU). Compared to operating room, the intubation conditions are poorer and there is a higher risk of complications for tracheal intubation in ICU underscoring the gravity of the situation. The incidence of complications related to intubation has been reported to be 8–12%.[4-6] Cardiac arrest, severe hypoxemia, and cardiovascular instability are some of the serious complications that can be associated with this population and can sometimes be as high as 45.2% in certain cohorts.[7]

Difficult laryngoscopy and intubation remain one of the important concerns and challenges in patients in ICU. Unlike an intubation in the operation room in a controlled environment, the conditions in ICU can be sub-optimal in terms of patient positioning, availability of equipment, availability of experienced personnel, patients with significant residual gastric contents and patients with a compromised physiological status. In addition, the option of abandoning intubation / postponing surgery which is available for an elective surgical patient is not available for these patients.

Appropriate prediction of difficult airway can not only reduce the incidence of unanticipated difficult intubation, but also enables provider to prepare additional potential life-saving adjuncts and personnel, as well as enables suitable modification of the initial airway management plan. Presently clinical assessment for prediction of difficult airway is done by variety of screening tools, such as the modified Mallampatti score, hyomental distance, thyromental distance, sternomental distance, interincisor gap, upper lip bite test, neck movement and neck circumference. However, these tests lack satisfactory sensitivity and specificity, thus have a poor diagnostic accuracy in predicting difficult intubation when used alone or in combination.[2,8-11] In addition these tests typically require an awake cooperative patient, unlike patients in ICU who can be sedated, agitated, unstable leading to practical difficulties in their application. Thus, any tool or method that can be an alternative or an adjunct to the traditional assessment is always desirable.

Ultrasound is safe, non-invasive, portable, easily reproducible, gives real time images, and is a point-of-care device. Ultrasound is now widely available in intensive care units for vascular access and other examinations of patients at the bedside. Point of care airway ultrasound is now gaining attention for assessing airway anatomy to predict intubation difficulty. It requires less patient co-operation making it a promising tool in ICU. Ultrasonography has been used for airway assessment as its role has been evolving as a useful tool for this purpose. Encouraging results have been obtained in a few studies utilizing ultrasound parameters for airway assessment.[12-14] However, there are no established standard ultrasound parameters to predict difficult laryngoscopy, and limited literature is available of their application in ICU. Hence the present study was designed to evaluate ultrasound measured anterior neck soft tissue thickness for predicting difficult laryngoscopy.

Objectives

The primary objective is to predict difficult laryngoscopy by ultrasound guided measurement of anterior neck soft tissue thickness.

To determine the sensitivity and specificity of distance from the skin to hyoid bone (DSHB), distance from the skin to the anterior commissure of vocal cords (DSAC) and distance from skin to Thyrohyoid membrane (DSTM) in prediction of difficult laryngoscopy.

MATERIALS AND METHODS

This prospective observational study included adult ICU patients requiring elective endotracheal intubation for ventilatory support. Patients were enrolled consecutively after meeting eligibility criteria. Written informed consent was obtained from the patient or legal surrogate when appropriate.

Ultrasound Assessment of Anterior Neck Soft Tissue: Ultrasound-guided measurements of anterior neck soft-tissue thickness were performed prior to induction of anesthesia. All measurements were taken with the patient in the supine position and the head and neck in a neutral alignment. A high-frequency linear probe (8–13 MHz) was used in the transverse orientation to obtain the following parameters:

- Distance from Skin to Hyoid Bone (DSHB): Minimum vertical distance between the skin surface and the anterior aspect of the hyoid bone.
- Distance from Skin to Thyrohyoid Membrane (DSTM): Measured midway between the hyoid bone and thyroid cartilage.
- Distance from Skin to Anterior Commissure (DSAC): Minimum distance between the skin and anterior commissure of the vocal cords.

All ultrasound assessments were performed by an experienced operator to minimize interobserver variability.

Airway Assessment: Additional airway measurements were recorded:

- Thyromental Distance (TMD): Measured from the mentum to the thyroid cartilage with the neck fully extended.
- Hyomental Distance (HMD): Measured from the mentum to the hyoid bone with the neck in a neutral position.

Monitoring and Anesthetic Procedure: Standard ICU monitoring, including ECG, non-invasive blood pressure, and pulse oximetry (SpO_2), was applied. Following preoxygenation with 100% FiO_2 for 3 minutes, patients received:

- Sedation: Midazolam 0.02 mg/kg IV or Fentanyl 1.5–2.0 µg/kg IV
- Induction: Propofol 1.0–1.5 mg/kg IV

- Neuromuscular Blockade: Succinylcholine 1 mg/kg IV

Laryngoscopy was performed in the sniffing position using a Macintosh blade of appropriate size. The Cormack–Lehane (CL) grade was recorded. Grades I–II were classified as easy laryngoscopy, and Grades III–IV as difficult laryngoscopy. Following intubation, an appropriate-sized endotracheal tube was inserted and the patient was connected to mechanical ventilation.

Sample Size Determination: Based on Kanoujiya et al.15 (sensitivity: 93.7% for ultrasound-based anterior neck measurements; 95% CI; 5% marginal error), the calculated minimum required sample size was 91 participants.

Statistical Analysis: Data analysis was performed using SPSS version 22.0 and R version 3.2.2. Continuous variables were summarized as mean ± standard deviation (SD) and categorical variables as frequency and percentage. Group comparisons were conducted using: Student's t-test (two-tailed, independent): applied to continuous variables after confirming normal distribution and homogeneity of variance (Levene's test). Chi-square test or Fisher's exact test: applied to categorical variables; Fisher's test was used when expected frequencies were <5. Diagnostic performance of ultrasound parameters in predicting difficult laryngoscopy was evaluated using the Receiver Operating Characteristic (ROC) curve. The Area Under the Curve (AUC) with 95% confidence intervals and p-values were reported. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, and likelihood ratios (LR^+, LR^-) were calculated for optimal cut-off values. Interpretation of diagnostic indices followed standard criteria: AUC Interpretation: Excellent (0.9–1.0), Good (0.8–0.9), Fair (0.7–0.8), Poor (0.6–0.7), Fail (0.5–0.6). Likelihood Ratios: Interpreted according to Ebell's classification for clinical relevance. A two-sided p-value <0.05 was considered statistically significant. Microsoft Word and Excel were used to generate tables and graphical representations.

RESULTS

In the present study, the majority of subjects were aged above 50 years (34.1%), followed by those in the 31–40-year group (23.1%), 20–30 years (22.0%), and 41–50 years (20.9%). The mean age of the study population was 43.82 ± 13.8 years. Males accounted for 56.0%, while females comprised 44.0% of the sample. Based on BMI classification, most participants had a normal BMI (18.5–24.9 kg/m²; 53.8%), followed by those who were overweight (25.0–29.9 kg/m²; 33.0%), obese (>30 kg/m²; 11.0%), and underweight (<18.5 kg/m²; 2.2%) [Table 1].

Most subjects (78.0%) had a distance from skin to hyoid bone (DSHB) between 0.5–1.0 cm, while 22.0% measured <0.5 cm. For the distance from skin to anterior commissure (DSAC), the majority (81.3%) fell within 0.5–1.0 cm, 13.2% exceeded 1.0 cm, and 5.5% measured <0.5 cm. Regarding distance from skin to thyrohyoid membrane (DSTM), 73.6% had values >0.5 cm, while 26.4% had values <0.5 cm. For airway measurements, thyromental distance (TMD) was most frequently 6.5 cm (58.2%), followed by 6.7 cm (33.0%), whereas hyomental distance (HMD) was most commonly 3.5 cm (51.6%), followed by 3.6 cm (38.5%) [Table 2].

Table 1: Profile of subjects in the study

		No. of Patients (n = 91)	%
Age (Years)	20-30	20	22.0
	31-40	21	23.1
	41-50	19	20.9
	>50	31	34.1
Gender	Female	40	44.0
	Male	51	56.0
Body Mass Index(kg/m2)	<18.5	2	2.2
	18.5-24.9	49	53.8
	25.0-29.9	30	33.0
	>30.0	10	11.0

Table 2: Frequency distribution of outcome variables of patients studied.

		No. of Patients (n=91)	%
Distance from the skin to hyoid bone (cms)	<0.5	20	22.0
	0.5-1.0	71	78.0
	>1.0	0	0.0
Distance from the skin to the anterior commissure of vocal cords (cm)	<0.5	5	5.5
	0.5-1.0	74	81.3
	>1.0	12	13.2
Distance from skin to thyro hyoid membrane (cm)	<0.5	24	26.4
	>0.5	67	73.6
TMD (cm)	6.50	53	58.2
	6.60	7	7.7
	6.70	30	33.0
	6.80	1	1.1
HMD (cm)	3.40	4	4.4
	3.50	47	51.6

	3.60	35	38.5
	3.70	3	3.3
	3.80	2	2.2

Table 3: CL Grade, Difficult Laryngoscopy and Complications findings

		No. of Patients	%
CL Grade	1	50	54.9
	A	34	37.4
	2B	4	4.4
	3	3	3.3
Difficult laryngoscopy	No	88	96.7
	Yes	3	3.3
Complication	Nil	91	100.0
	Yes	0	0.0

More than half the patients had a CL Grade I view (54.9%), with Grade IIa in 37.4%, Grade IIb in 4.4%, and Grade III in 3.3% of cases. Difficult laryngoscopy was observed in 3.3%, while 96.7% of patients had easy laryngoscopy. No complications were reported during laryngoscopy, as 100% of subjects remained complication-free [Table 3].

Table 4: Comparison of clinical variables in relation to difficult laryngoscopy of patients studied.

Variables	Difficult Laryngoscopy		Total	P Value
	No	Yes		
Age in years	43.69±13.91	47.67±12.74	43.82±13.83	0.627
Height (cm)	163.49±10.65	162.67±3.79	163.46±10.49	0.895
Weight (kg)	65.23±13.93	76.23±17.95	65.59±14.09	0.185
Body Mass Index (kg/m2)	24.23±3.62	28.83±7	24.38±3.8	0.038*

Patients with and without difficult laryngoscopy did not differ significantly in terms of age (47.67 ± 12.74 vs. 43.69 ± 13.91 years; p = 0.627), height (162.67 ± 3.79 vs. 163.49 ± 10.65 cm; p = 0.895), or weight (76.23 ± 17.95 vs. 65.23 ± 13.93 kg; p = 0.185). However, BMI was significantly higher in patients with difficult laryngoscopy (28.83 ± 7 kg/m²) compared to those with easy laryngoscopy (24.23 ± 3.62 kg/m²), with p = 0.038, indicating a statistically significant association [Table 4].

Table 5: Comparison of outcome variables in relation to difficult laryngoscopy of patients studied

Variables	Difficult Laryngoscopy		Total	P Value
	No	Yes		
Distance from the skin to hyoid bone (cm)	0.57±0.11	0.64±0.21	0.58±0.11	0.307
Distance from the skin to the anterior commissure of vocal cords (cm)	0.72±0.2	0.77±0.37	0.72±0.2	0.679
Distance from skin to thyrohyoid membrane (cm)	0.53±0.06	0.61±0.1	0.54±0.06	0.051
TMD (cm)	6.58±0.1	6.57±0.12	6.58±0.1	0.851
HMD (cm)	3.55±0.07	3.53±0.06	3.55±0.07	0.741

There was no statistically significant difference between easy and difficult laryngoscopy groups for DSHB (0.64 ± 0.21 vs. 0.57 ± 0.11 cm; p = 0.307), DSAC (0.77 ± 0.37 vs. 0.72 ± 0.20 cm; p = 0.679), or TMD (6.57 ± 0.12 vs. 6.58 ± 0.10 cm; p = 0.851). Similarly, HMD did not differ significantly between groups (3.53 ± 0.06 vs. 3.55 ± 0.07 cm; p = 0.741). The DSTM showed a near-significant trend, being higher in the difficult laryngoscopy group (0.61 ± 0.10 cm) compared to the easy group (0.53 ± 0.06 cm), with p = 0.051, suggesting a possible association that did not reach statistical significance [Table 5].

Table 6, shows distance from skin to thyrohyoid membrane (DSTM) the best- performing parameter with an AUROC of 0.727, indicating fair diagnostic accuracy achieved 100% sensitivity, identifying all difficult cases correctly. Specificity was 52.27%, with positive likelihood ratio (LR+) of 2.10 and negative likelihood ratio (LR-) of 0.00. These values suggest DSTM is a strong screening tool to rule out difficult laryngoscopy when <0.53 cm, though moderate specificity limits its standalone confirmatory use. Distance from Skin to hyoid bone (DSHB) shows AUROC of 0.608, classified as a poor test overall despite low sensitivity (33.3%), it showed very high specificity (98.9%) and an excellent positive likelihood ratio (LR+) of 29.33, indicating it may be valuable as a confirmatory test when positive. Distance from Skin to anterior commissure (DSAC) shows AUROC was 0.506, close to 0.5, indicating no discriminative power, with moderate sensitivity and specificity, this parameter showed limited diagnostic value (LR+ve 1.96, LR-ve 0.51). Thyromental Distance (TMD) shows AUROC was 0.532, with modest sensitivity (66.7%) and low specificity (42.05%). The likelihood ratio values suggest TMD is not a reliable standalone predictor of difficult laryngoscopy. Hyomental distance (HMD) had an AUROC of 0.549, with limited sensitivity and specificity, and likelihood ratio values indicating minimal predictive value.

Table 6: ROC curve analysis showing validity of Outcome parameters

Variables	ROC results to predict difficult laryngoscopy				Cut- off	AUROC	SE	P-value
	Sensitivity	Specificity	LR+	LR-				
DSHB (cm)	33.3	98.9	29.33	0.67	>0.83	0.608	0.245	0.659
DSAC (cm)	66.67	65.91	1.96	0.51	<0.58	0.506	0.249	0.982
DSTM (cm)	100.00	52.27	2.10	0.00	>0.53	0.727	0.137	0.098
TMD (cm)	66.67	42.05	1.15	0.79	<6.5	0.532	0.180	0.857
HMD (cm)	66.67	44.32	1.20	0.75	<3.5	0.549	0.153	0.747

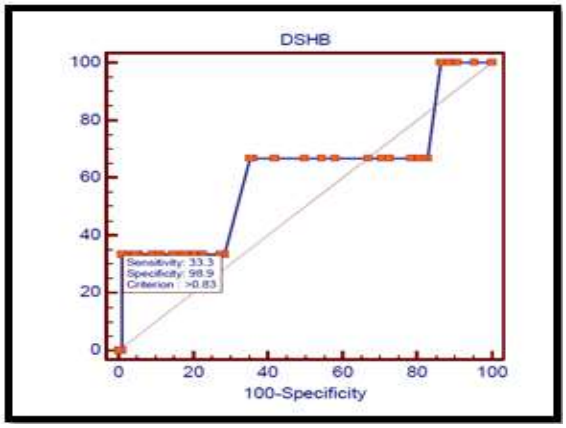

Figure 1: ROC Curve showing validity of DSHB in predicting Difficult laryngoscopy

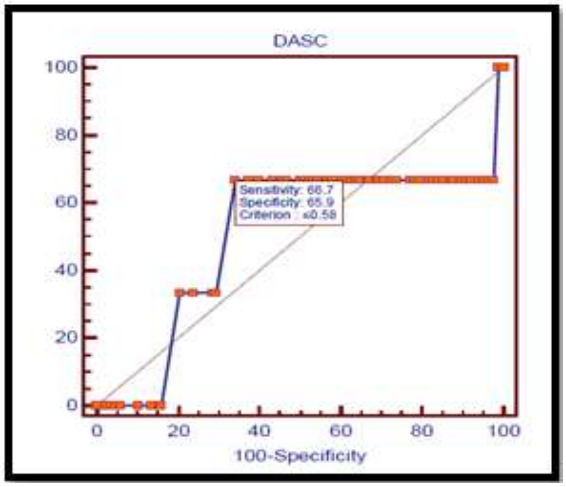

Figure 2: ROC Curve showing validity of DASC in predicting Difficult laryngoscopy

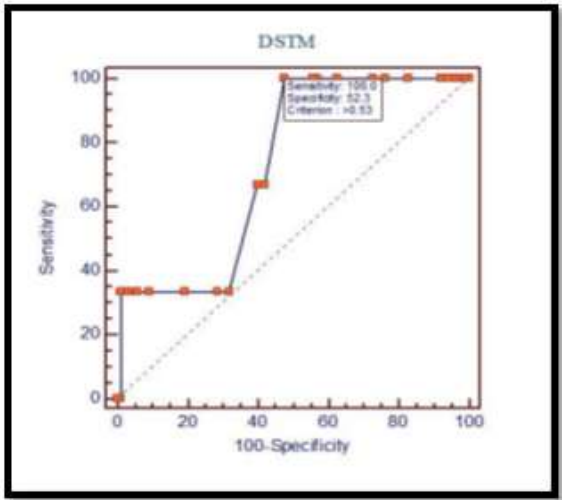

Figure 3: ROC Curve showing validity of DSTM in predicting Difficult laryngoscopy

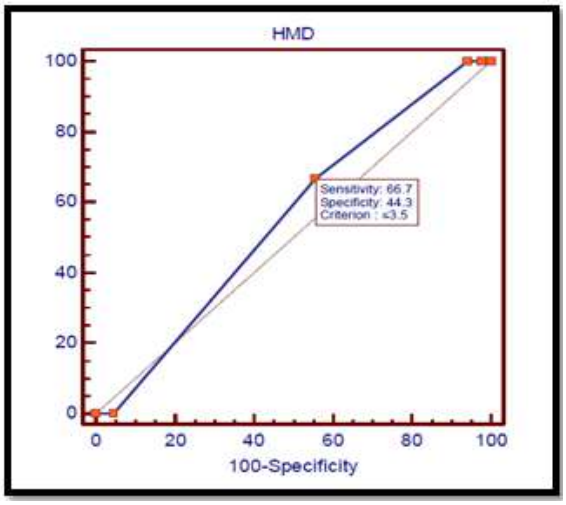

Figure 4: ROC Curve showing validity of HMD in predicting Difficult laryngoscopy

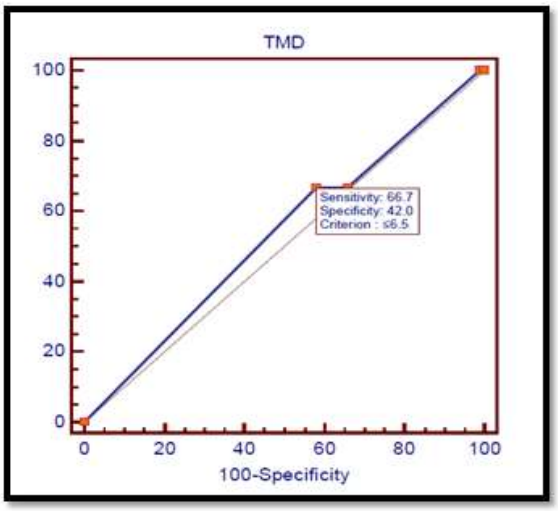

Figure 5: ROC Curve showing validity of TMD in predicting Difficult laryngoscopy.

In this study, ROC curve analysis showed that among all evaluated parameters, the distance from skin to thyrohyoid membrane (DSTM) had the highest diagnostic value for predicting difficult laryngoscopy, with an AUC of 0.727 and 100% sensitivity at a >0.53 cm cut-off, making it the most effective screening measure. The distance from skin to hyoid bone (DSHB) demonstrated excellent specificity (98.9%) and a very high positive likelihood ratio (29.33) at a >0.83 cm threshold, indicating usefulness as a confirmatory test despite its low sensitivity (33.3%). In contrast, the distance to anterior commissure (DSAC), thyromental distance (TMD), and hyomental distance (HMD) all showed AUC values close to 0.5 with low overall diagnostic

performance, reflecting limited value in predicting difficult laryngoscopy in this population.

DISCUSSION

Tracheal intubation is a potentially life-saving procedure for patients in intensive care unit. However, this can be associated with critical incidents in this physiologically compromised population when difficulties are encountered leading to serious morbidity and mortality. Endotracheal intubation is most often facilitated by direct laryngoscopy. Difficulty in visualizing the glottic inlet remains a major cause of difficult intubation.[16] Thus, predicting difficult intubation/laryngoscopy is important so as to institute a safe airway management plan. A number of clinical tests such as modified Mallampatti score, interincisor distance, hyomental distance, thyromental distance, neck circumference and neck movements have been traditionally used to assess difficulty in airway management. However, these parameters lack satisfactory sensitivity and specificity, thus lowering their diagnostic accuracy.

Ultrasound machines are now ubiquitously available in intensive care units for bedside evaluation of patients. Use of ultrasound for airway assessment is now evolving. Ultrasound can not only enable visualization of airway structures, but measurements of certain parameters can help predict difficult airway.[17,18] The term difficult airway encompasses a constellation of difficulties encountered with various aspects of airway management.

Difficulty encountered in glottic inlet visualization at direct laryngoscopy is one such difficulty during airway management. The Cormack-Lehane grading has become the standard for defining difficult laryngoscopy for purpose of airway related research. In the present study, CL grade 1 and 2 was defined as easy laryngoscopy and CL grade 3 and 4 was defined as difficult laryngoscopy in line with the existing literature. In the present study the anterior neck soft tissue related parameters, distance from skin to hyoid, distance from skin to thyrohyoid membrane and distance from skin to anterior commissure of vocal cords measured by ultrasound were evaluated for predicting difficult laryngoscopy.

The primary purpose of direct laryngoscopy is to obtain adequate view of glottic inlet to facilitate passage of an endotracheal tube. The incidence of difficult laryngoscopy has been reported to be 6% to 27% in western literature. Studies in Indian population have similarly reported difficult laryngoscopy ranging from 9% to 24%.[13,19,20-25] This wide variation may be related to age, gender, and ethnic difference among the population. In the present study the incidence of difficult laryngoscopy was 3.3% which is lower than that reported in literature.

In the present study, the mean distance from the skin to the hyoid bone was 0.57 ± 0.11 cm in the easy laryngoscopy group and 0.64 ± 0.21 cm in the difficult laryngoscopy group. These findings differ from most published studies, including those by Mallick S et al,[26] Sultan WA et al,[27] Kaul R et al,[28] Sotoodehnia M et al,[29] Wu J et al,[30] Yadav NK et al,[31] and Kanoujiya J et al,[15] which all reported significantly higher values in difficult laryngoscopy cases. Only Chhabra AR et al,[32] reported similar non-significant findings for this parameter, aligning more closely with the results of the present study.

For the distance from the skin to the anterior commissure of the vocal cords, values were 0.72 ± 0.20 cm and 0.77 ± 0.37 cm in the easy and difficult laryngoscopy groups respectively, with no significant difference between the two. This again contrasts with the majority of studies in the literature, where Sultan WA et al,[27] Kaul R et al,[28] Sotoodehnia M et al,[29] Wu J et al,[30] and Kanoujiya J et al,[15] found significantly elevated values among difficult laryngoscopy patients. Only Chhabra AR et al,[32] produced findings comparable to ours, reporting no significant difference in their cohort.

Similarly, the distance from the skin to the thyrohyoid membrane (DSTM) was 0.53 ± 0.06 cm in the easy group and 0.61 ± 0.10 cm in the difficult group, with a p-value of 0.051, showing a trend but not reaching statistical significance. This contrasts with the study by Mallick S et al,[26] who observed a significant difference between groups. Overall, and unlike most studies summarized, none of the ultrasound-based measurements evaluated in our study—DSHB, DSAC, or DSTM—were significantly associated with difficult laryngoscopy.

The lack of significant findings in the present study may be attributed to several factors. The incidence of difficult laryngoscopy was very low (3.3%), limiting comparative power. Study designs varied in the literature, including differences in ultrasonographic techniques, anatomical measurement points, and population characteristics, which may explain the discrepancies. Additionally, the mean ultrasound distances in our population were much lower than those reported in other studies, likely due to the predominance of subjects with normal BMI and potentially thinner anterior neck soft tissue. Neck circumference was not measured, which could have provided further insight into soft tissue distribution. As noted in the literature, mean parameter values tend to be higher in difficult laryngoscopy groups compared to easy groups, which our results also suggest, although without reaching significance.

Diagnostic validity measures in previous studies also show considerable variability. For DSHB, Mallick S et al,[26] Sultan WA et al,[27] Kaul R et al,[28] and Kanoujiya J et al,[15] reported sensitivities ranging from 68% to 93% and specificities between 56% and 81%. In contrast, our study demonstrated low sensitivity (33.3%) but very high specificity (98.9%) at the >0.83 cm cut-off. Similarly, DSAC showed excellent diagnostic accuracy in prior studies, with AUC values approaching 1.0 in work by Sultan WA et al,[27] Kaul R et al,[28] and Kanoujiya J et al,[15] whereas our AUC was only 0.506. For DSTM,

Mallick S et al,[26] reported high diagnostic performance, while our study yielded an AUC of 0.727 with perfect sensitivity but modest specificity. These wide variations likely stem from differences in cut-off values, population anatomy, operator technique, and measurement methodology.

Ideally, a difficult laryngoscopy predictor should offer both high sensitivity and specificity. However, in clinical airway practice, high sensitivity is more valuable as it minimizes false negatives, thereby reducing the risk of unanticipated difficult laryngoscopy and potential patient harm. False positives, while inconvenient, do not lead to adverse outcomes. Given the complexity of direct laryngoscopy—which depends on dynamic anatomical and functional factors—no single clinical or ultrasound parameter is sufficient as a stand-alone predictor.

Ultrasound does offer the advantage of identifying anatomical features that may not be apparent on clinical examination and can serve as a useful adjunct to traditional airway assessment. Its integration with established clinical predictors may therefore enhance diagnostic performance and improve airway management planning.

This study has several limitations. Ultrasound measurements were performed by a single operator, preventing assessment of inter-operator variability. Laryngoscopies were carried out by different physicians, though all had more than three years of experience. It is also important to note that difficult laryngoscopy is not synonymous with difficult intubation, as external laryngeal manipulation can improve visualization significantly. Furthermore, variability in training, lack of standardized sonographic protocols, and subjective factors such as operator skill and airway secretions may influence outcomes. Standardization of measurement techniques and combining ultrasound with clinical predictors may improve reproducibility and diagnostic accuracy in future research.

CONCLUSION

From the present study, it can be concluded that there was no statistically significant difference between the easy and difficult laryngoscopy groups across all three ultrasound-based anterior neck tissue measurements (DSHB, DSAC, and DSTM). Among these, DSTM demonstrated the highest sensitivity (100%) at a cut-off value of >0.53 cm, making it a useful screening tool for ruling out difficult laryngoscopy, whereas DSHB showed the highest specificity (98.9%) at a cut-off value of >0.83 cm, suggesting strong value as a confirmatory measure when positive. In contrast, DSAC exhibited only moderate sensitivity and specificity, limiting its diagnostic utility. Additionally, clinically assessed airway parameters such as thyromental distance and hyomental distance showed poor predictive performance when used in isolation in this study population.

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