Original Article

The usefulness of point of care ultrasound (POCUS) in preanaesthetic airway assessment

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ABSTRACT

Background and Aims: Point of care ultrasound has the potential to become reliable airway assessment tool by accurate prediction of difficult laryngoscopy. We aimed to determine the feasibility of ultrasound in preoperative airway assessment. **Methods:** This prospective, observational study was conducted on 200 patients requiring general anaesthesia and tracheal intubation. The thickness of anterior soft tissue neck at the level of hyoid bone (DSHB), epiglottis (DSEM), and Pre-E/E-VC[depth of the pre-epiglottic space (Pre-E)/distance from the epiglottis to the midpoint of the distance between the vocal cords (E-VC)] were measured sonographically. The hyomental distance ratio (HMDR) was measured utilising distances with head in neutral and extended position. The primary outcome was the efficacy of the parameters in predicting difficult laryngoscopy[Cormack Lehane 3,4]. The secondary outcome was to correlate the parameters to CL grading. **Results:** Utilising receiver operating curves, cutoff value of HMDR for predicting difficult laryngoscopy was ≤1.0870 with sensitivity of 65%, specificity of 77%. The cutoff value, sensitivity andspecificity for Pre-E/E-VC were ≥1.785, 82.8% and 83.8%., respectively. The cutoff value of DSHB was ≥0.99 with sensitivity of 48% and specificity of 82%. The cutoff, sensitivity and specificity for DSEM were ≥1.615, 89.7%, and 64.8%, respectively. There was moderate positive correlations of DSHB, DSEM, and Pre-E/E-VC (r = 0.551 and 0.701, 0.787: P = 0.00), whereas moderate negative correlation observed with HMDR (r = -.0671: P = 0.00). **Conclusion:** The strong positive correlation of Pre-E/E-VC, DSEM, and moderate negative correlation of HMDR makes these ultrasound parameters reliable predictors for difficult laryngoscopy.

Key words: Airway assessment, anaesthesia general, difficult intubation, hyomental distance ratio, intubation endotracheal, sonography

INTRODUCTION

Recognition of the difficult airway is a critical and most important element in the anaesthesiology practice. The preoperative airway evaluation using clinical predictors is mandatory step for the anaesthesiologist to predict difficult laryngoscopy.[1] However, in meta-analysis by Lundstrom *et al.*,[2] the low predictability of clinical indices has been observed. Thus reliable, accurate, and improved methods for airway evaluation prior to laryngoscopy is the need of the hour. In the recent years, there is growing evidence[3] regarding the usefulness of ultrasonography (USG)-guided preoperative predictors for identifying difficult laryngoscopy. Difficult laryngoscopy has been found to correlate with various sonography predicted parameters.[4-6] Despite the encouraging results, the studies are limited by the ethnic variation in population, small sample size, and unavailability of specified ultrasound scanning protocol.

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Therefore, this study was undertaken to observe the feasibility and reliability of point of care ultrasound (POCUS) in assessing the airway, utilising soft tissue neck measurements at the level of hyoid bone (DSHB), thyrohyoid membrane (DSEM), hyomental distance ratio (HMDR), depth of the pre-epiglottic space (Pre-E)/ distance from the epiglottis to the midpoint of the distance between the vocal cords (E-VC) (Pre-E/E-VC ratio) for predicting difficult intubation.

METHODS

After approval by the institutional ethics committee and obtaining informed consent, this prospective and observational study was carried out in 200 patients belonging to American Society of Anaesthesiologists I or II patients in the age group of 20–60 years of either gender, scheduled for elective surgery and requiring general anaesthesia with direct laryngoscopy and endotracheal intubation. The study was carried out over a period of 12 months from September 2017 to August 2018. The clinical trial registration number for the study is CTRI/2017/09/009917 and the study was conducted in strict accordance with the principles of declaration of Helinski.

Edentuolus patients, patients in whom the interincisor gap was less than 3 cm, patients with head and neck pathologies were excluded from the study. Patients having altered level of consciousness, inability to follow commands, the obese patients (BMI >30 kg/m^2), and parturients were not included in the study.

The routine airway assessment including mouth opening, modified Mallampati scoring, thyromental distance, and neck movements was done during the preanaesthetic assessment. The patients not meeting inclusion criteria were excluded from the study and the enrolled patients underwent sonographic assessment of airway by the anaesthesiologist in the preoperative holding area.

In the preoperative holding area, with the patients lying supine and active maximal head-tilt/chin lift, the sonographic assessment was done. The high-frequency linear probe (6–13 Hz) utilising (SonoSite® MicroMaxx® US system, SonoSite INC, Bothell, WA) was placed in the submandibular area in the midline. Without changing the position of the probe, the linear array of the US probe was slided in the transverse planes from cephalad to caudal, until simultaneous visualisation of the epiglottis was observed on the screen [Figure 1a]. Thereafter, following measurements were obtained with the oblique-transverse US view of the airway (a) E-VC, (b) Pre-E as described by Gupta *et al.*[7] Then by changing head and neck to neutral position, thickness of anterior neck soft tissue[8] were obtained with the transverse view at the following levels: (1) At the level of hyoid bone, that is, the minimal distance from the hyoid bone to the skin (DSHB) [Figure 1b]; (2) at the level of the thyrohyoid membrane, that is, the distance from skin to epiglottis midway between the hyoid bone and thyroid cartilage (DSEM) [Figure 1c].

Similarly, curved low-frequency (2–5 MHz) transducer was used to visualise the tongue and shadows of the hyoid bone and mandible with the patient in

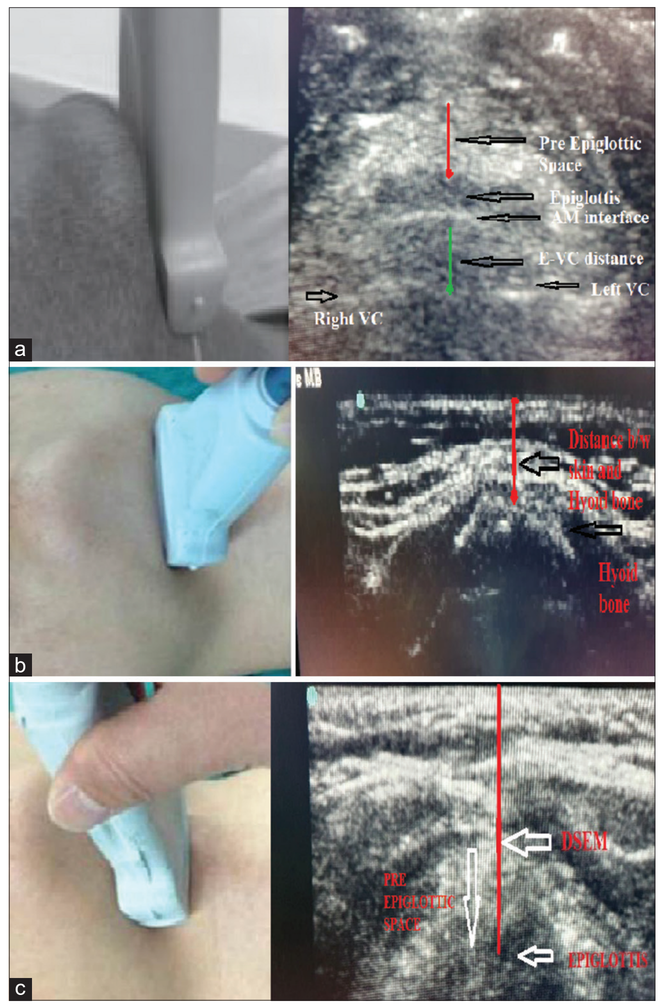

Figure 1: (a) Figure representing position of USG probe and corresponding image. AM interface: air mucosal interface. E-VC: distance from epiglottis to midway between vocal cords. VC: vocal cords. (b) Depicting the position of USG probe and corresponding image on screen. DSHB: distance from the skin to hyoid bone. (c) Depiction of USG probe position and corresponding image on USG screen. DSEM: distance from the skin to epiglottis at the level of thyrohyoid membrane

the supine position. The hyomental distances were measured from the upper border of the hyoid bone to the lower border of the mentum in the neutral and extended head positions, respectively.

The patients were then taken to the operating room and the standard general anaesthesia procedure was performed as per the discretion of the attending anaesthesiologist and as per standard of care. General anaesthesia was induced and the trachea intubated by a senior anaesthesiologist with >5 years of experience post-qualification who was blinded to the findings of preoperative ultrasonographic airway assessment. Direct laryngoscopy was performed using a Macintosh blade, and Cormack-Lehane (CL) grade noted without external laryngeal manipulation. The CL classification was as follows:[9] Grade 1: visualisation of the entire laryngeal aperture; Grade 2: visualisation of parts of the laryngeal aperture or the arytenoids; Grade 3: visualisation of only the epiglottis; Grade 4: visualisation of only the soft palate. The laryngoscopy was classified as easy (CL Grade 1 and 2) or difficult (CL Grade 3 and 4).

The trachea was intubated with appropriate sized endotracheal tube and anaesthesia was maintained. The number of attempts at intubation, need for alternative difficult intubation approaches, or inability to secure the airway was also noted.

The sample size was calculated according to the study by Rana *et al.*,[6] who found the incidence of difficult intubation to be 12.5%. Using Fisher's formula [$n = t^2 \times P\,(1 - P)/m^2$ where n = required sample size; t = confidence level at 95% (standard value of 1.96); P = 0.125; m = margin of error at 5% (standard value 0.05)]. The sample size was calculated to be 168. We enrolled 200 patients, to allow for probable dropouts .

The data was entered in MS Excel® and SPSS® ver.19 (SPSS Inc., Chicago, IL, USA) software was used for analysis. The results were presented as mean ± standard deviation [SD]) for each parameter for continuous data. The Chi-square test was used to determine the statistical difference between the easy and difficult laryngoscopies. The predictive value of the tests was assessed by calculating the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). To assess the optimal cutoff scores, receiver operating characteristic (ROC) graphs were plotted and the area under the curve (AUC) was calculated to assess the prognostic accuracy.

RESULTS

A total of 200 eligible patients (98 females, 102 males) scheduled for elective surgery under general anaesthesia requiring endotracheal intubation were included in this study, out of which 25 patients (12.5%) were categorised as difficult laryngoscopy (CL grade 3 and 4). The demographic profile including age, gender were comparable in the easy and difficult laryngoscopy group [Table 1], whereas significant difference was observed between the weight and BMI with difficult airway. The weight was significantly higher in the patients belonging to CL grade 3, 4 (mean ± SD: 59.61 ± 8.23 and 61.44 ± 10.9, P = 0.00) kg as compared to CL grade 1, 2 (54.63 ± 8.36, 61.44 ± 10.9; gr 1 and 3,4 = 0.021, gr 2 and 3, 4 = 0.015). The BMI was (mean ± SD:21.07 ± 3.07, 21.52 ± 3.13) in CL grade in 1, 2 in comparison to CL grade 3, 4 (mean ± SD: 23.03 ± 2.3 and 23.31 ± 3.36, P = 0.002 gr 1 and 3 = 0.005; gr 2 and 3, P = 0.024) [Table 1].

It was observed that 58 patients (29%) had CL Grade 1, and 117 patients had CL Grade 2 (58.5%), 22 patients had CL Grade 3 (11%), 3 patients belonged to CL grade 4 (1.5%). Therefore, the incidence of easy laryngoscopy was 87.5% and difficult 12.5%. In the study, 3 patients belonging to CL 4 required either more than a single attempt or additional equipment to achieve endotracheal intubation.

The distribution of CL grade as predicted by USG measured HMDR was (mean ± SD: 1.12 ± 0.033, 1.11 ± 0.035) for CL Grades 1 and 2, respectively,

Table 1: Demographic profile of the patients in relation to the Cormack-Lehane grading

Variables	Cormack-Lehane Grading				*P*
	Easy Intubation		Difficult Intubation		
	Grade 1	Grade 2	Grade 3	Grade 4	
Age (years)*	42.9±11.6	42.1±14.3	43.55±9.2	44.18±7.52	*P*=0.46
Gender (*n*)† M/F:105/95	32/26	59/58	12/10	2/1	*P*=0.33
Weight (kg)*	54.63±8.36	54.94±8.87	59.61±8.233	61.44±10.9	*P*=0.003, Gr: 1&3,4=0.021, Gr: 2&3,4=0.015
Body Mass Index (kg/m^2)*	21.07±3.07	21.52±3.13	23.03±2.3	23.31±3.36	*P*=0.002, Gr 1&3=0.005, Gr 2&3=0.024

The data presented as *mean±SD and †number as appropriate. M/F – Male/female patients; BMI – Body Mass Index and HMDR 1.09 ± 0.012 and 1.04 ± 0.018 for CL Grade 3 and 4 (P = 0.01; gr 1 and 4 = 0.007, gr 2 and 4, P = 0.010) [Figure 2].

The DSHB measured distribution was (mean ± SD: 0.837 ± 0.162 and 0.850 ± 0.171) cm for CL grade 1 and 2), while the measurement was 0.976 ± 0.23 and 1.15 ± 0.18 cm, respectively, for CL grade 3 and 4 (P = 0.00). The distribution of CL grade as predicted by USG measured DSEM was (mean ± SD: 1.42 ± 0.329,1.46 ± 0.358) cm for CL grades 1 and 2, respectively, and 1.89 ± 0.357 and 1.96 ± 0.211 for CL grade 3 and 4 (P = 0.00). The values of Pre-E/E-VC ratio were (mean ± SD: 1.22 ± 0.439 and 0.56 ± 0.27) for CL grade 1, 2, respectively, and 1.91 ± 0.25, 2.25 ± 0.31 corresponded to CL grade 3 and 4 (P = 0.00) [Figure 2].

A correlation was computed to assess the relation between USG-guided DSHB and DSEM, Pre E/E-VC and HMDR with CL grading. There was moderate positive correlation of DSHB (r = 0.551, P = 0.00), respectively, whereas DSEM had strong positive linear correlation with CL grading (r = 0.701, P = 0.00). The Pre-E/E-VC parameter had strong positive relationship (r = 0.787, P = 0.00), whereas moderate negative correlation was observed with HMDR (r = -0.671, P = 0.00) [Table 2].

Utilising receiver operating curves, the cutoff value of HMDR for predicting difficult laryngoscopy came out to be ≤1.0870 with sensitivity of 65% and specificity of 77%. The NPV of HMDR was 84.62% and PPV 54.29%. The AUC for HMDR was 0.762 (95% CI = 0.686–0.838), therefore the accuracy of this is fair [Figure 3 and Table 2], whereas Pre-E/E-VC had AUC of 0.871 (95% CI = 0.820–0.923) depicting good predictability in relation to CL grading. The cutoff value for Pre-E/E-VC was ≥1.785 with sensitivity of 82.8% and specificity of 83.8% for predicting difficult airway. The NPV of Pre-E/E-VC was 92.25% with PPV 67.61% (P = 0.00), whereas the cutoff value of DSHB for predicting difficult laryngoscopy came out to be ≥0.99 with sensitivity of 48% and specificity of 82%. The NPV of DSHB was 79.59% and PPV 52.83% [Figure 3 and Table 2].

The AUC for DSHB was 0.680 (95% CI = 0.594–0.767), therefore the accuracy for predicting difficult intubation is poor, whereas DSEM had AUC of 0.819 (95% CI = 0.758–0.880), depicting good predictability in relation to CL grading. The cutoff value for DSEM was ≥1.615 with sensitivity of 89.7% and specificity of 64.8% for predicting difficult airway. The NPV of DSEM was 93.88% with PPV 50.98% (P = 0.00) [Figure 3 and Table 2].

Table 2: Data depicting correlation of USG measured parameters with difficult laryngoscopy

Variables	Area Under Curve (CI)	Correlation Coefficient	*P*
HMDR	0.762 (0.686-0.838)	-0.671	0.000
DSHB	0.680 (0.594-0.767)	0.551	0.000
DSEM	0.819 (0.758-0.880)	0.701	0.000
Pre E/E-VC	0.871 (0.820-0.923)	0.787	0.000

HMDR – Hyomental distance ratio; DSHB – Distance from skin to hyoid bone; DSEM – Distance from skin to epiglottis b/w thyroid cartilage and hyoid bone; Pre E/E-VC – Ratio of depth of pre epiglottic space to the distance b/w epiglottis & midpoint of vocal cords

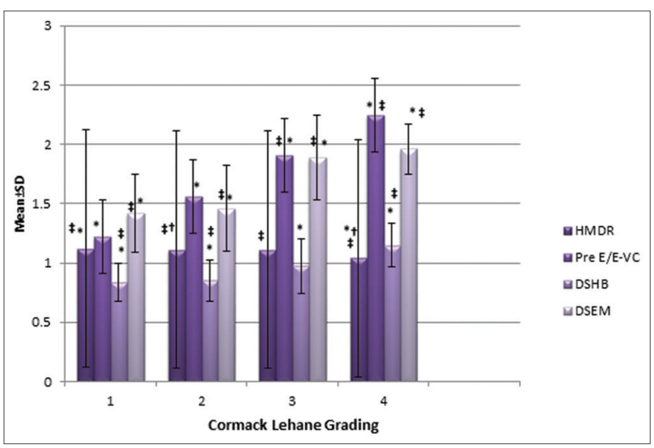

Figure 2: Graphical representation of sonographic predicted HMDR, Pre-E/E-VC, DSHB, and DSEM in relation to CL Grading. HMDR: hyomental distance ratio; Pre E/E-VC: ratio of depth of pre epiglottic space to the distance b/w epiglottis and midpoint of vocal cords. DSHB: distance from skin to hyoid bone, DSEM: distance from skin to epiglottis b/w thyroid cartilage and hyoid bone. (*P < 0.01,†P < 0.05, ‡P > 0.05)

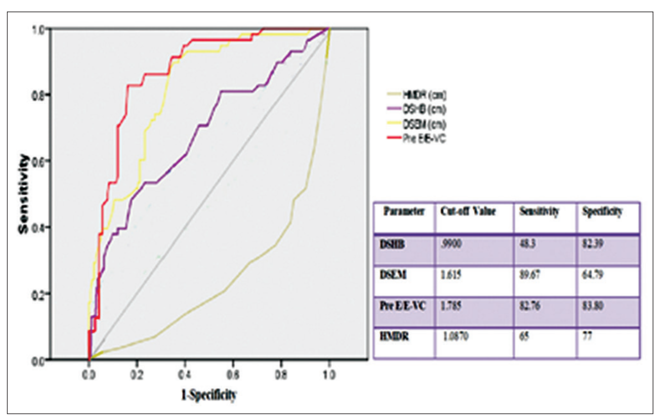

Figure 3: Graphical representation of predictive value of sonographic measured airway parameters in assessing difficult laryngoscopy utilising receivers operating curve. HMDR: hyomental distance ratio, Pre E/E-VC: ratio of depth of epiglottic space to the distance b/w epiglottis and midpoint of vocal cords, DSHB: distance from skin to hyoid bone, DSEM: distance from skin to epiglottis b/w thyroid cartilage and hyoid bone

DISCUSSION

Preoperative assessment of the airway utilising clinical indices is common practice in anaesthesiology, however the accuracy and predictability of the traditional indices is not satisfactory. Recently, there is much enthusiasm on the POCUS for assessment of the airway.

Despite the encouraging results, the studies are limited by the ethnic variation in population, small sample size, and unavailability of specified ultrasound scanning protocol. In the present study, the incidence of difficult intubation was 12.5%. The distribution of CL grade as predicted by ultrasonography measured HMDR was (mean ± SD: 1.12 ± 0.033, 1.11 ± 0.035) for CL Grades 1 and 2, respectively, and 1.09 ± 0.12 and 1.04 ± 0.018 for CL Grade 3 and 4 ($P = 0.01$, Gr 1 and 4 = 0.007, Gr 2 and 4 = 0.010), respectively. Whereas in the previous study[6] done in 120 patients, the distribution of CL grade as predicted by ultrasonography measured HMDR was (mean ± SD: 1.11 ± 0.35, 1.12 ± 0.29) for CL Grades 1 and 2, respectively, and HMDR 1.07 ± 0.39 and 1.04 ± 0.01 for CL Grade 3 and 4 ($P = 0.00$). The cutoff value of HMDR for predicting difficult laryngoscopy came out to be ≤ 1.0850 with sensitivity of 75% and specificity of 85.3% in this study as compared to the present study having cutoff value of ≤1.0870 with sensitivity of 65% and specificity of 77%. The results of both studies corroborates well.

Huh *et al*.[10] evaluated the predictive value of surface HMDR measurements in 213 non-obese adult patients scheduled for elective surgery under anaesthesia requiring tracheal intubation. The HMDR alone had the highest predictive validity for difficult laryngoscopy with an optimal cutoff point of 1.2 with sensitivity of 88% and specificity of 60%. The difference could be attributed to the use of USG for measuring HMDR in our study with precise calculation.

In another study by Wojtczak,[11] the USG-guided HMDR has been observed to be a good predictor of CL grading. The authors recruited 12 patients including seven morbidly obese adult patients with a history of either difficult or easy intubation, and submandibular sonographic examination was performed in the supine position. The mean HMDR in 6 patients who presented with a history of difficult intubation was 1.02 ± 0.01, and the ratio in 6 patients whose airway was easy to intubate was 1.14 ± 0.02 ($P = 0.002$). The difference with our study could be attributed to difference in the profile of the patients, as only 12 obese patients were recruited in comparison to the present study having 200 patients with body mass index <29 kg/m^2.

In another study by Petrisor *et al.*,[12] cutoff value of USG derived HMDR of 1.23 provides 100% [39.8–100.0] sensitivity and 90.5% [69.6–98.8] specificity and has superior diagnostic accuracy in predicting difficult laryngoscopy in the obese population. The higher value of HMDR in this study could be attributed to obese patient enrolled in the study.

In our study, USG-guided DSHB measured distribution was (mean ± SD: 0.837 ± 0.162, 0.850 ± 0.171) cm for CL grade 1 and 2, while the measurement was 0.976 ± 0.23 and 1.15 ± 0.18 cm, respectively, for CL grade 3 and 4 ($P = 0.00$). The distribution of CL grade as predicted by USG measured DSEM was (mean ± SD: 1.42 ± 0.329, 1.46 ± 0.358) cm for CL grades 1 and 2, respectively, and 1.89 ± 0.357 and 1.96 ± 0.211 for CL grade 3 and 4 ($P = 0.00$). In the similar study by Imran *et al.*,[13] the ultrasonographic measurements in difficult laryngoscopy group had a mean DSHB and DSEM of 14.48 ± 4.720 and 23.37 ± 2.159 mm, respectively, whereas easy laryngoscopy group had mean of 11.96 ± 3.839 and 16.44 ± 3.125 with P value of 0.071 and 0.001, respectively.

The authors observed that the optimal cutoff values of DSHB and DSEM with their sensitivity and specificity were 12.4 mm (63.2%, 76.1%) and 17.7 mm (78.9%, 76.3%), respectively. Whereas in our study, the cutoff value of DSHB for predicting difficult laryngoscopy came out to be ≥1.12 with sensitivity of 48% and specificity of 82%. The cutoff value for DSEM was ≥1.615 with sensitivity of 89.7% and specificity of 64.8% for predicting difficult airway.

There was also a weak positive and moderate positive correlation of DSHB and DSEM with CL grading with correlation coefficient of $r = 0.387$ ($P < 0.001$) and $r = 0.546$ ($P < 0.001$), respectively, in the study by Imran *et al*.[13] However in our study, there was moderate positive correlation of DSHB ($r = 0.551$, $P = 0.00$), whereas DSEM had strong positive linear correlation with CL grading ($r = 0.701$, $P = 0.00$).

If we compare the results, the USG-guided DSEM had better predictability in assessing difficult intubation in both studies having cutoff value 1.615 versus 1.7 and strong positive correlation, whereas the DSHB value difference in both studies could be due to difference in the demographic profile of patients. As in the study by Imran,[13] there is no mention of weight/BMI of patients, although the patients were comparable.

In a prospective observational study by Wu *et al.*,[8] 203 non-obese patients undergoing elective surgeries under general anaesthesia were taken and observed that 13.8% of patients had difficult laryngoscopy having greater thickness of anterior neck soft tissue measured by US at the level of the DSHB (1.51 ± 2.7 cm vs. 0.98 ± 0.26 cm; $P < 0.0001$), DSEM (2.39 ± 0.34 cm vs. 1.49 ± 0.39 cm; $P < 0.0001$). The optimal cutoff values with their sensitivity and specificity is as follows: DSHB [1.28 cm (85.7%, 85.1%)], DSEM [1.78 cm (100%, 66.3%)]. The results of present study correlates with our study.

In the study by Aruna *et al.*,[14] prospective, double-blinded study on 130 patients undergoing elective surgery under general anaesthesia, it was observed that patients with USG-guided skin to epiglottis distance (DSEM) <18 mm were predicted to be difficult and those with distance >18 mm were predicted to be easy. The higher cutoff value of DSEM in this study can be attributed to the recruitment of patients having BMI up to 39 kg/m^2, whereas in the present study the exclusion criteria was patient less than 30 kg/m^2.

In another study,[15] total of 301 patients of at least 18 years of age undergoing elective surgery under general anaesthesia with tracheal intubation were involved. The "pre-epiglottic space thickness" at the level of thyrohyoid membrane was measured as the median distance from skin to epiglottis with the mDSE cutoff value of 2.54 cm (sensitivity 82%, specificity 91%) as the best predictors of a CL grade.

Similarly, Adhikari[4] found anterior neck soft tissue at the level of thyrohyoid membrane anterior tissue as a significant predictor in 51 patients. CL Grade 3/4 have a 34.7 mm (95% CI 28.8–40.7) versus 23.7 mm (95% CI 22.9–24.4) in CL Grade 1/2. And at the level of hyoid bone it was (1.69, 95% CI = 1.19–2.19 vs. 1.37 95% CI = 1.27–1.46). However, in this, student *t*-test was used as compared to receiver operating curves in the present study to predict cutoff value.

However in the study by Pinto,[16] USG-derived anterior soft tissue measurement was taken at the level of midway between thyrohyoid, in 74 patients requiring endotracheal intubation. The authors concluded that DSEM 27.5 mm denotes a difficult laryngoscopy. The higher cutoff value might be contributed to ethnic variation.

In recent study,[17] ultrasound (US) measurement of depth of the pre-epiglottic space (Pre-E)/distance from the epiglottis to the midpoint of the distance between the vocal cords (E-VC) done in the preoperative period has been shown to correlate with the CL grading. In the study,[6] the values of Pre-E/E-VC ratio were (mean ± SD: 1.33 ± 0.335 and 1.62 ± 0.264) for CL Grade 1, 2, respectively, and 1.87 ± 0.243, 2.22 ± 0.29 corresponded to CL Grade 3 and 4 ($P = 0.00$). Whereas in the present study, pre-E/E-VC ratio was (mean ± SD: 1.22 ± 0.439 and 1.56 ± 0.27) for CL grade 1, 2, respectively, and 1.91 ± 0.25, 2.25 ± 0.31 corresponded to CL grade 3 and 4 ($P = 0.00$). The cutoff value of Pre-E/E-VC for predicting difficult laryngoscopy was ≥1.77 with sensitivity of 82% and specificity of 80% in the previous study, whereas in the present study, the cutoff value for Pre-E/E-VC was ≥1.785 with sensitivity of 82.8% and specificity of 83.8% for predicting difficult airway. The results of both studies are comparable. In the study by Reddy *et al.*,[18] the value of mean Pre-E/E-VC were 1.09 ± 0.38, 1.28 ± 0.37 for CL Grade 1 and 2, whereas for CL Grade 3, it was 1.29 ± 0.44. However, in the study, the authors did not encounter patient with CL 4.

In the review article by Justin *et al.*,[19] including 10 studies determining CL grade correlation with sonographic predictors of difficult airway, 114 of the 681 total subjects had difficult laryngoscopies (16.8%). The predictability and accuracy of sonographic parameters for difficult laryngoscopy was observed at three locations: hyomental distance [52.6 ± 5.8 mm ($P = 0.01$)], anterior tissue at the hyoid bone [16.9 mm (95% CI 11.9–21.9) and 15.9 ± 2.7 mm ($P = 0.0001$)], the thyrohyoid membrane [34.7 mm (95% CI 28.8–40.7) and 23.9 ± 3.4 mm ($P = 0.0001$).

Therefore, in our study, the highest sensitivity and negative predictive values were observed with the cutoff values of Pre–E/E-VC (≥1.785), DSEM (≥1.615), followed by HMDR (≤1.0870) and DSHB (≥0.99) for predicting difficult laryngoscopy. The strong positive correlation of Pre–E/E-VC, DSEM, and moderate negative correlation of HMDR makes these USG parameters reliable predictors for identifying difficult laryngoscopy.

There are few limitations of this study. We did not include patient with BMI >30 kg/m^2. Further studies can be done involving patient groups having factors associated with difficult intubation such as pregnancy, obesity. Second, the inter-subject variability and patient positioning and operators efficiency can be a limiting factor, particularly in relation with US-guided HMDR. Third, the difficult laryngoscopy does not necessarily result in difficult intubation, as external laryngeal manipulation tends to facilitate intubation most of the times.

There is need for evaluating the optimal combination of US-guided parameters including HMDR, Pre-E/E-VC, and anterior soft tissue neck thickness at the level of hyoid and vocal cord to formulate the specific USG-guided airway scanning protocols.

CONCLUSION

We conclude that POCUS should be incorporated in preanaesthetic evaluation of airway by virtue of its better accuracy and correlation in predicting CL grading. The good predictive value of USG measured parameters, that is, Pre-E/E-VC, DSEM, and HMDR ensure reliability of these variables in detecting difficult laryngoscopy.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

Institutional Ethics Committee

Attached.

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