Innovations

Airway Evaluation Using Ultrasound for Predicting Difficult Intubation

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DOI: **10.54882/7420237416860**

Abstract

Difficult intubation is one of the main challenges in anaesthesiology . There are many clinical criteria that were introduced with regard to evaluation of the patient's airway before induction of anaesthesia, including Mallampati classification, mouth-opening, thyromental distance, neck extension, jaw protrusion, upper-lip bite test etc. Prospective Observational study conducted with 84 patients posted for elective surgical procedure. Airway was examined by both clinical and ultrasound. This study found that the correlation between the ultrasonographic parameters and Cormack-Lehane grade were weak or very weak, and can be assumed to have limited clinical significance.

Introduction

Endotracheal intubation is one of the most important skills for anaesthesiologists in securing the airway during general anaesthesia and resuscitation. Failure to secure the airway can cause anesthesia-related life-threatening morbidity and mortality. Therefore, unanticipated difficult intubation remains a primary concern for anesthesiologists.[1] Airway assessment is an essential aspect of pre-anaesthetic assessment. Presently, prediction of difficult airway is based on clinical assessment of airway.[2]

Various risk factors have been identified to help anticipate difficult airways. These include demographic variables (age, gender and race), history of obstructive sleep apnea (OSA), body mass index (BMI), abnormalities of upper teeth, ability to move the lower teeth in front of the upper teeth, inter-incisor gap, modified Mallampati score, thyromental distance, and ability to flex and extend the cervical spine and neck circumference.[3] A combination of airway assessment tests such as modified Mallampati classification, inter-incisor gap, sternomental distance, thyromental distance and neck mobility are often used to overcome their limited sensitivity to assess difficult laryngoscopy[2]

Despite the widespread adoption of these predictors by anesthesia providers, unexpected difficult ventilation and intubations still continue to occur, reflecting their poor sensitivity, specificity or reproducibility.[4]

The rate of difficult laryngoscopy and intubation ranges widely from 0.5% to 24% of patients undergoing general anaesthesia among difficult studies.[5,6] Patients with cervical spondylosis have a higher incidence of difficult laryngoscopy compared with patients without cervical spondylosis and in patients with cervical spondylosis, anaesthesiologists may encounter a large percentage of unexpected difficult airways, which are associated with increased morbidity and mortality[2].

To increase the accuracy of preoperative evaluation, recent studies have measured anterior neck soft tissue thickness using ultrasound. [7-9] CT, MRI, and other imaging techniques can accurately measure the thickness of anterior neck soft tissue, but they are expensive and unavailable in many operating rooms. Portable US is inexpensive, rapid, and convenient to perform in the operating room, and most importantly, it can quantify the neck fat thickness accurately.[10]

Ultrasonography (USG) of the upper airway is capable of providing detailed anatomic information and has numerous potential clinical applications. It can be used to identify airway pathology and may assist other methods in prediction of difficulty with airway management[11]

The basis for the use of USG can be understood by analyzing the view obtained during direct laryngoscopy. The process of laryngoscopy involves inserting the laryngoscope blade into the mouth and displacing the tongue, epiglottis and hyoid bone into the subglossal space. Authors hypothesized that increase in anterior neck soft tissue thickness may impair the forward mobility of the pharyngeal structures and that an increase in pre-epiglottic space or a decrease in the distance from the epiglottis to the vocal cords could be associated with increasingly difficult laryngoscopy and intubation. These variables can be measured by USG and therefore can be used to predict ease or difficulty of laryngoscopy[12]

Need for the study

Cormack-Lehane grading is a reliable method for prediction of difficult intubation, which is done at the time of direct laryngoscopy. However, laryngoscopy is an invasive procedure that is almost impossible to perform in an awake patient and it cannot be used to predict difficult tracheal intubation in patients undergoing general anaesthesia pre-operatively.

Airway ultrasonography is a non-invasive, safe and painless modality for evaluating the soft tissues

Different sonographic techniques for airway evaluation have been used and most Anaesthesiologists concluded that this technique was capable of providing detailed anatomic information with numerous potential clinical applications

Material and method

Prospective Observational study was done for a period of 1 year in a tertiary care centre with

sample size (n) 84 (if allowable error of 8%). It was calculated using the following formula. PES (pre egiglottic space) 2.8 mm (Easy: 1.00-3.90mm, difficult: 1.00-3.10mm, male : 1.00 to 3.90mm, Female: 1.00 to 3.50mm, sensitivity 21.1% and specificity 84.5%) and DSEM(distance from the skin to epiglottis midway between hyoid bone and thyroid cartilage)6.8 mm2 (Easy: 2.90-10.80mm, Difficult: 3.40-8.30mm, Male: 2.90-10.80mm, Female :3.50-9.00mm, sensitivity 21.1% and specificity 87.9%) according to Gagan Kumar Narula,et al(2019) study.

$$n = \frac{Z\alpha 2 \ (1\text{-Specificity})}{e2 \ \ X \ (1\text{-Prevalance})}$$

Zα= 1.96 at 95% confidence interval.

Specificity = 87.9%

Prevalence / occurrence = 24%

e = allowable error

purposive sampling method was used and it comprise of patients between age group of 18-60 years undergoing elective surgeries under general anaesthesia after written informed consent from patient and patient party.

Inclusion criteria :.

a) Age group 18-60 years
b) ASA I – III
c) Elective surgery patients requiring general anaesthesia with direct laryngoscopy and endotracheal intubation belonging to either gender.

Exclusion criteria:

a) Edentulous patients
b) Body mass index was >30 kg/m2
c) Patients undergoing Head and neck surgeries,
d) Patients with prior facial, cervical, pharyngeal and epiglottic surgery
e) Facial trauma patients ,history of trauma and difficult intubation
f) Head-and-neck pathologies, those with mouth opening <3 cm
g) Arthritis or diabetes mellitus of ≥10 years
h) Unable to extend their neck by ≥30°
i) Tracheostomy tube in situ

All patients the were seen the day before the surgery for pre-anaesthetic assessment and preparation for anaesthesia and surgery.Patientswere explained about the procedure and informed consent were taken.Blood investigations such as haemoglobin, total leucocyte count, platelet, bleeding time, clotting time, sent.

Nil per oral were kept overnight prior to surgery. T.Pantaprozole 40mg oral HS and T.Dizepam 5mg HS was given the night before surgery as premedication.

On the day of surgery patients were shifted to operation theatre where standard ASA monitors such as a pulse-oximeter, electrocardiogram, and non-invasive blood pressure (NIBP) was attached. The ultrasound measurements were taken in the pre-anaesthsia room before shifting to the OT using the a high-frequency linear probe (Probe HFL38x,13-6 MHz) of Phillips HD11 XE Ultrasound System with a scan depth of 6 cm will be used.In the preoperative room, the ultrasound view of the airway of all the study patients was obtained

Monitors were placed, IV cannula secured and then the patients were pre-oxygenated with oxygen for a minimum of 3min and InjGlycopyrolate 0.01mg/kg, and InjFentanyl 2mcg/kg will be given.patients were induced with InjPropofol 2mg/kg and paralyzed with InjSuccinylcholine 1mg/kg.

Laryngoscopy and endotracheal intubation was attempted with the patient’s head and neck in optimal intubating position during intubation, using an appropriate size Macintosh curved blade by an anaesthesiologist having minimum two years of experience in clinical anaesthesia and the same anaesthetist performed intubation for all patients in the study .

On the day of the surgery, the patients were explained about the procedure and after obtaining informed written consent, they will be shifted to the preoperative area in the operating theatre complex and patient’s demographic data will be collected and the following measurements were made and recorded.

Modified Mallampatti's classification of airway:

Modified Mallampatti is test similar to that used by Samsoon and Young. It is performed in patient sitting on chair with examiner sitting in front of him at the patient’s eye level, patient is asked to open his mouth as wide as he could and to protrude his tongue without phonation, the pharyngeal structures are inspected with pen torch and graded as listed below-

Grade I : Soft palate, fauces, uvula and pillars seen.

Grade II : Soft palate, fauces and uvula seen

Grade III : Soft palate and base of uvula seen.

Grade IV : soft palate not visible.

Inter incisor gap: Maximum distance between the upper and lower incisors when the patient's mouth is wide open. It is measured in centimeters using an inch tape.

Thyromental distance: Distance measured from the thyroid notch to the tip of the mentum with patient head extended fully, using an inch tape.

Ultrasound measurement of the thickness of anterior neck soft tissue:

The anterior neck soft tissue thickness was measured at 3 different levels

- At the level of epiglottis
- At the level of hyoid bone
- At the level of vocal cords

Patient position

Patient were made to lie down in supine position with pillow under the head, in neutral position, patient were instructed to keep mouth closed and to take slow breaths during measurements so as to minimise the errors with the movement during respiration.

Ultrasound machine control settings: The following controls were set in the ultrasound machine for obtaining the airway assessment measurements and images.

• Transducer - Linear High frequency transducer

• Axis/Plane - Short axis/Transverse plane

• Frequency - 11 MHz

• Depth - 3.0 cms - 4.0 cms

• Gain - 20 - 30.

Obtaining measurements: The measurements of anterior neck soft tissues will be measured at the above mentioned three levels in short axis view.

a) The hyoid bone is seen as an inverted U-shaped hyperechoic structure in the submandibular region. The image will be frozen on screen and measurement from skin to midpoint of hyoid bone is taken using the "measure" option in the ultrasound machine

b) The Epiglottis is identified in the Thyrohyoid membrane level as a linear hypoechoic shadow followed by hyperechoic shadow.

Measurement is taken from skin to epiglottis as mentioned previously.

c)The posterior most part of the vocal folds with arytenoids appear as hyperechoic lateral V-shaped structures facing away from each other. The identification of vocal cords is facilitated by observing their linear movement during quite breathing or phonation.

During the intraoperative direct laryngoscopy, the Cormack–Lehane grading was recorded as noted below:

1.Grade I – Visualisation of the entire laryngeal aperture

2.Grade II – Visualisation of parts of the laryngealaperture or the arytenoids

3.Grade III – Visualisation of only the epiglottis

4.Grade IV – Visualisation of only the soft palate

Cormack–Lehane Grades I and II was recorded as easy intubations. Grades III and IV as difficult

The first view of the glottis was recorded and used to grade Cormack–Lehane grade.

Number of attempts at intubation, external laryngeal pressure and use of any airway adjuncts were also be recorded.

If three or more attempts are required for successful intubation, they were included in difficult intubation group regardless of the Cormack–Lehane grade

Vital signs such as pulse rate, NIBP, respiratory rate, and oxygen saturation was monitored throughout. At the end of surgery patients were reversed with Inj. Glycopyrrolate 0.01 mg/kg and Inj. Neostigmine 0.05 mg/kg and extubated after thorough oral suctioning. After stabilization, patients will be shifted to the post anaesthesia care unit.

Statistical analysis

Data was entered in Microsoft Excel 2007 and analysed using SPSS version 22.0.

Collected data was analysed by Mean +/_ Standard deviation,Frequency, Percentage.

Significance were assessed using frequency, percentage, specificity, sensitivity, positive predictive value, negative predictive value, and Chi-square test.

Results

A prospective observational study was conducted to assess the usefulness of ultrasonogram in identifying difficult airway and to assess for any correlation between clinical airway assessment and ultrasound airway assessment. Sample size selected was 84 patients. 84 patients under this study were classified into 2 groups prospectively based on their Cormack Lehane grading.

Table 1,Cormack Lehane grading

	Frequency	Percentage
1	31	36.9%
2	22	26.2%
2A	10	11.9%
2B	7	8.3%
3	10	11.9%

3A	4	4.8%
Total	84	100%

Group E (Easy Airway)

Group D (Difficult Airway)

Of the 84 patients, 70 patients were classified into Group E and the rest 14 patients were classified in Group D.

The observations and results are as follows

Basic demographic features like age, sex BMI and heights are comparable between the groups.

In present study, Majority of the patients (80%) in group E had no co-morbidities and 50% of the participants in group D had co morbidities. The difference between co-morbidities among the study groups was statistically significant (P<0.05).

In present study, the mean MMG for conventional airway measurement was 1.74±0.60 in group E and 2.42±0.85 in group D. There was statistical significance between mean MMG among the study groups (P<0.05).The mean IIG for airway measurement in group E was 4.97±0.28 and in group D was 4.82±0.42. There was statistical significance between mean IIG among the study groups (P=0.04).

The mean TMD for airway measurement was 7.20±0.47 in group E and 6.91±0.34 in group D. The difference between mean TMD among the study groups was statistical significance (P=0.04).

In present study, the mean USG measurements from skin to epiglottis in group E was 16.27±2.89 and in group D was 19.76±1.47 which was found to be statistically significant among the study groups (P=0.0002).

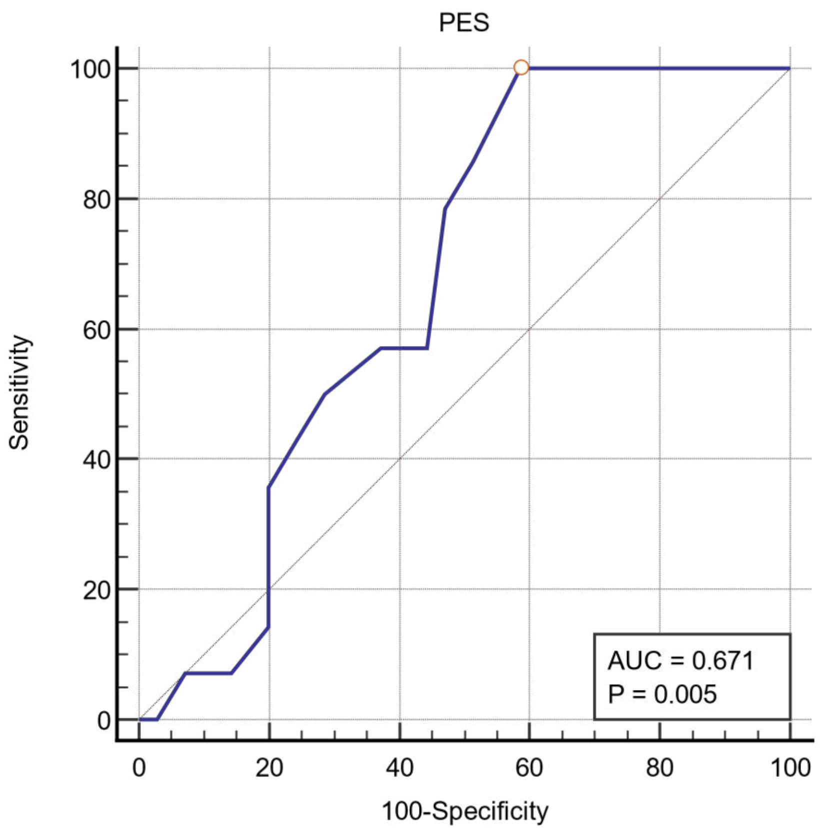
The mean USG measurements from skin to hyoid bone in group E was 8.77±0.95 and in group D was 9.50±1.48 which was found to be statistically significant among the study groups (P=0.03).

The mean USG measurements from skin to vocal cords in group E was 9.01±2.94 and in group D was 9.47±1.26 which was found statistically not significant among the study groups(P=0.42).

Table 2: predicting difficult intubation

	Group E	Group D	P value
PES	2.27 ± 0.63	1.95 ±0.35	0.06
EVL	6.93 ±2.10	8.01 ±2.98	0.10
DSHB	9.73 ±2.96	11.09 ±3.75	0.13
DSEM	6.02 ±1.42	5.53 ±1.41	0.24

ROC analysis – PES and prediction of difficult intubation [**Fig 1**]



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.671
Standard Error [a]	0.0616
95% Confidence interval [b]	0.560 to 0.770
z statistic	2.784

Significance level P (Area=0.5)	0.0054

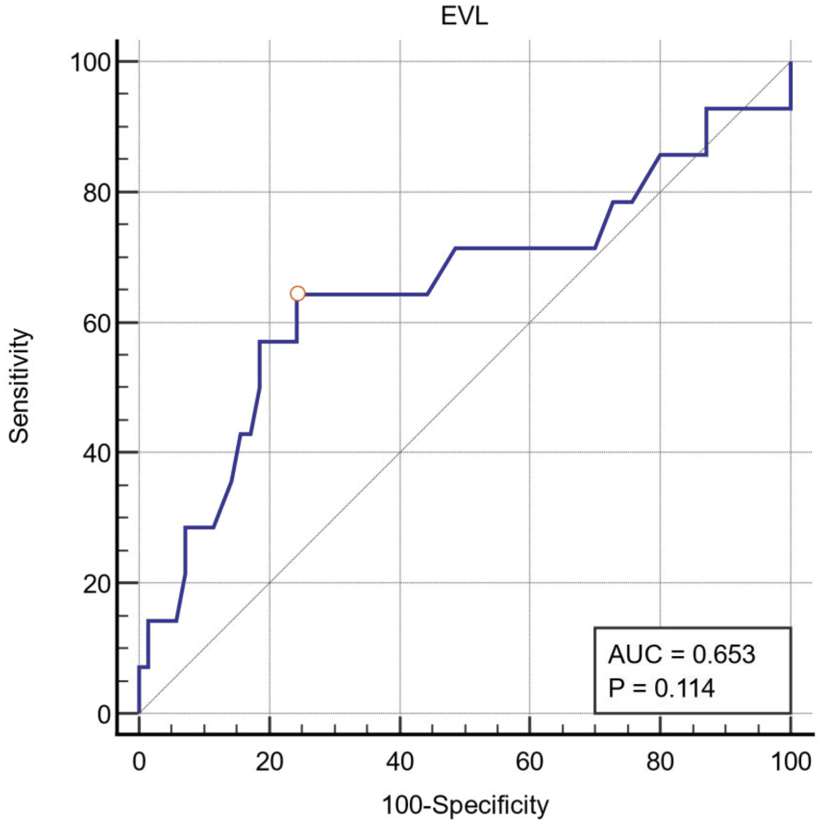
[a] DeLong et al., 1988
[b] Binomial exact

Youden index

Youden index J	0.4143
Associated criterion	≤2.4
Sensitivity	100.00
Specificity	41.43

In present study, based on ROC curve the cutoff point for PES was <2.4. At this cut off point, the sensitivity was 100% and specificity was 41.43% to predict difficult intubation

ROC analysis – EVL and prediction of difficult intubation.**Fig 2**



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.653
Standard Error [a]	0.0966
95% Confidence interval [b]	0.541 to 0.753

z statistic	1.580
Significance level P (Area=0.5)	0.1142

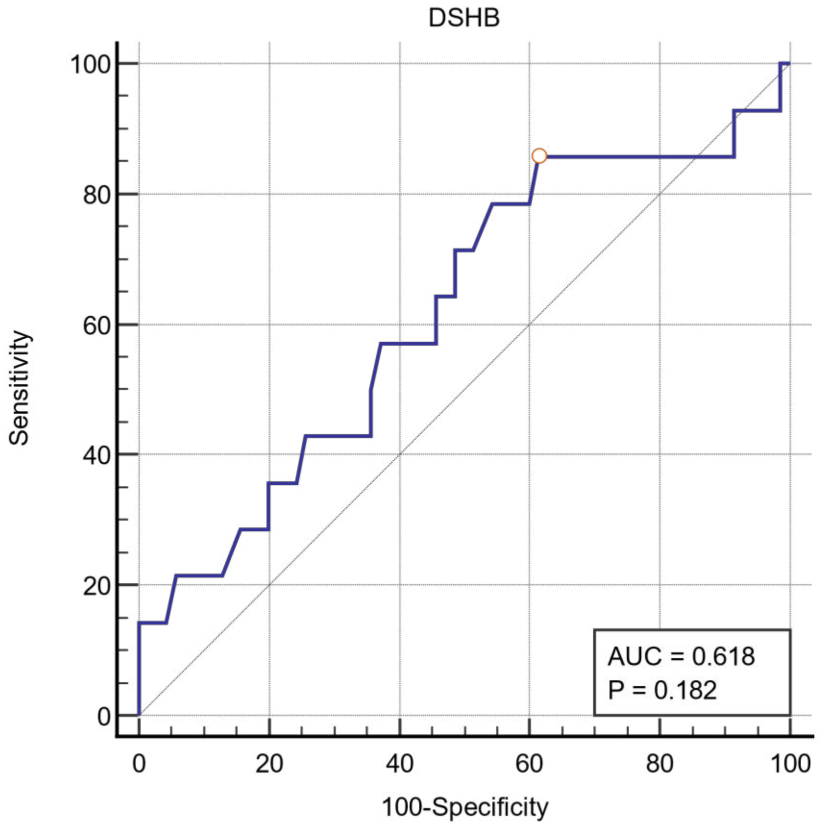
[a] DeLong et al., 1988
[b] Binomial exact

Youden index

Youden index J	0.4000
Associated criterion	>8.3
Sensitivity	64.29
Specificity	75.71

In present study, based on ROC curve the cutoff point for EVL was 8.3. At this cut off point, the sensitivity was 64.2% and specificity was 75.7% to predict difficult intubation

ROC analysis – DSHB and prediction of difficult intubation**[Fig 3]**



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.618
Standard Error [a]	0.0886
95% Confidence interval [b]	0.506 to 0.722
z statistic	1.335
Significance level P (Area=0.5)	0.1817

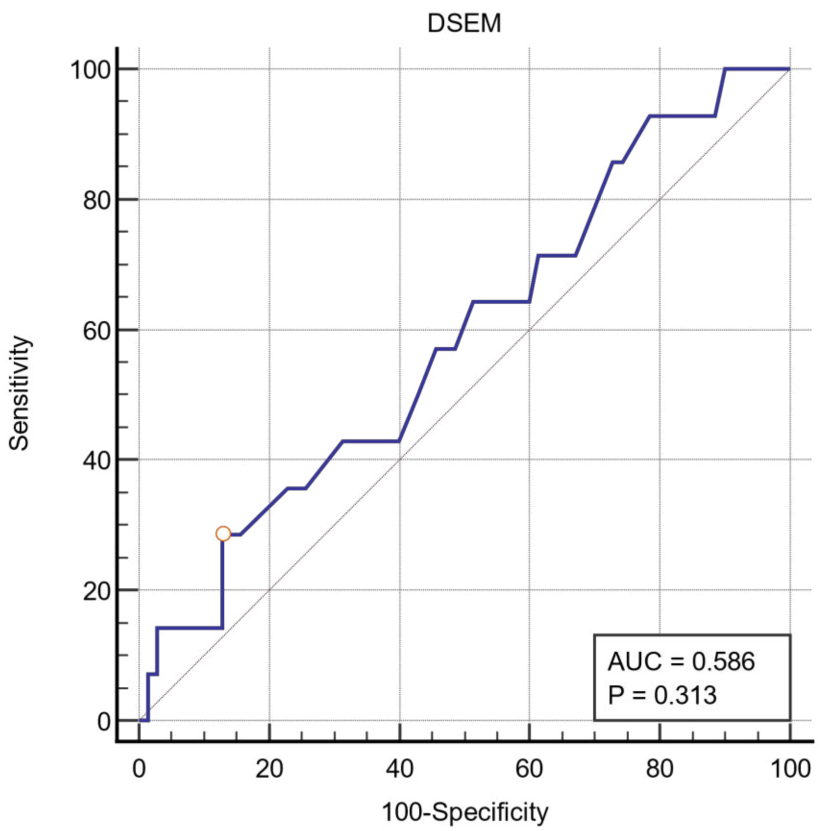
[a] DeLong et al., 1988
[b] Binomial exact

Youden index

Youden index J	0.2429
Associated criterion	>8.5
Sensitivity	85.71
Specificity	38.57

In present study, based on ROC curve the cutoff point for DSHB was 8.5. At this cut off point, the sensitivity was 85.7% and specificity was 38.5% to predict difficult intubation

ROC analysis – DSEM and prediction of difficult intubation**[Fig 4]**



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.586
Standard Error [a]	0.0850
95% Confidence interval [b]	0.473 to 0.692
z statistic	1.009
Significance level P (Area=0.5)	0.3130

[a] DeLong et al., 1988
[b] Binomial exact

Youden index

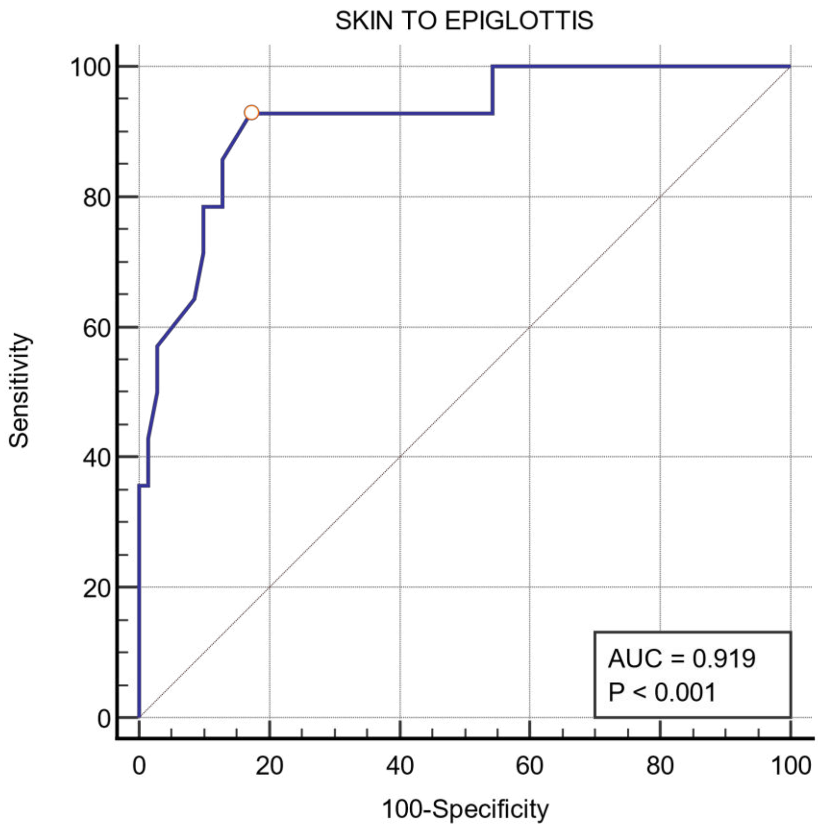
Youden index J	0.1571
Associated criterion	≤4.7
Sensitivity	28.57
Specificity	87.14

In present study, based on ROC curve the cutoff point for DSEM was <4.7. At this cut off point, the sensitivity was 28.5% and specificity was 87.1% to predict difficult intubation

In group E majority of intubations were done in first attempt (88.6%) followed by 2 attempts (11.4%) and in group D 78.6 % of patients had intubation in first attempt followed by 14.3% in two attempts and 7.1% in three attempts. The difference between number of attempts for intubation was statistically significant among the study groups ($P<0.05$).

In group E, BURP was used as an adjuvant maneuver in 5.7% of participants and in group D BURP and Bougie was used in 7.14% and 35.71% of participants respectively. The difference between adjuvant maneuvers used among the study groups was found statistically significant ($P<0.0001$).

Fig 5: Skin to epiglottis and prediction of difficult airway



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.919
Standard Error [a]	0.0413
95% Confidence interval [b]	0.839 to 0.967
z statistic	10.135
Significance level P (Area=0.5)	<0.0001

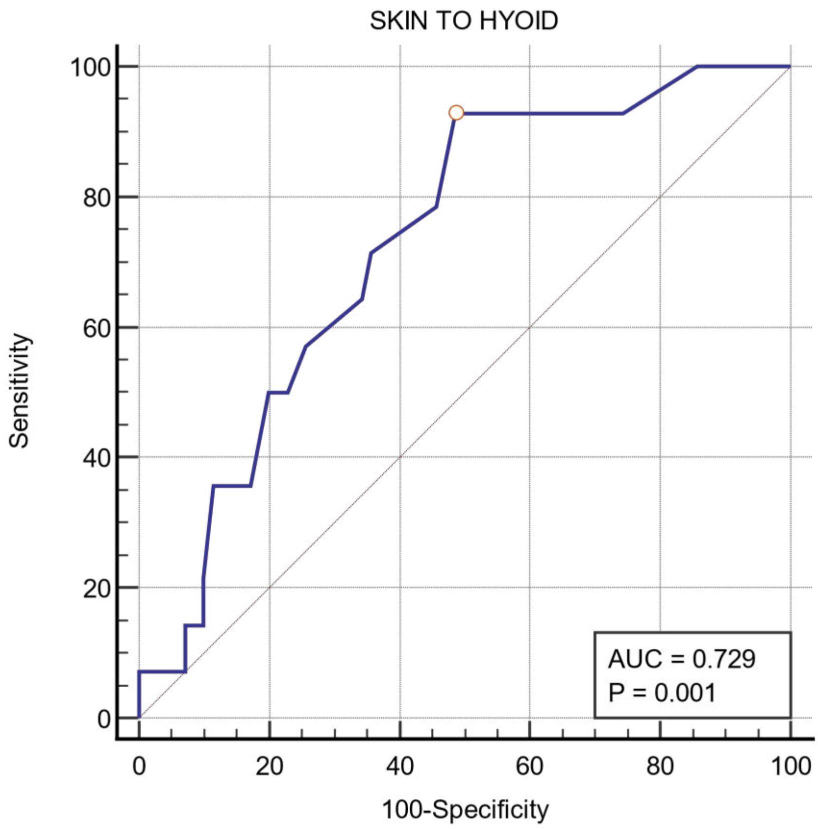
[a] DeLong et al., 1988
[b] Binomial exact

Youden index

Youden index J	0.7571
Associated criterion	>17.9
Sensitivity	92.86
Specificity	82.86

In present study, based on ROC curve the cutoff point for skin to epiglottis was >17.9. At this cut off point, the sensitivity of USG measurements skin to epiglottis was 92.86 and specificity was 82.42to predict difficult intubation

Fig 6; Skin to Hyoid to predict difficult airway



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.729
Standard Error [a]	0.0672
95% Confidence interval [b]	0.621 to 0.820
z statistic	3.400
Significance level P (Area=0.5)	0.0007

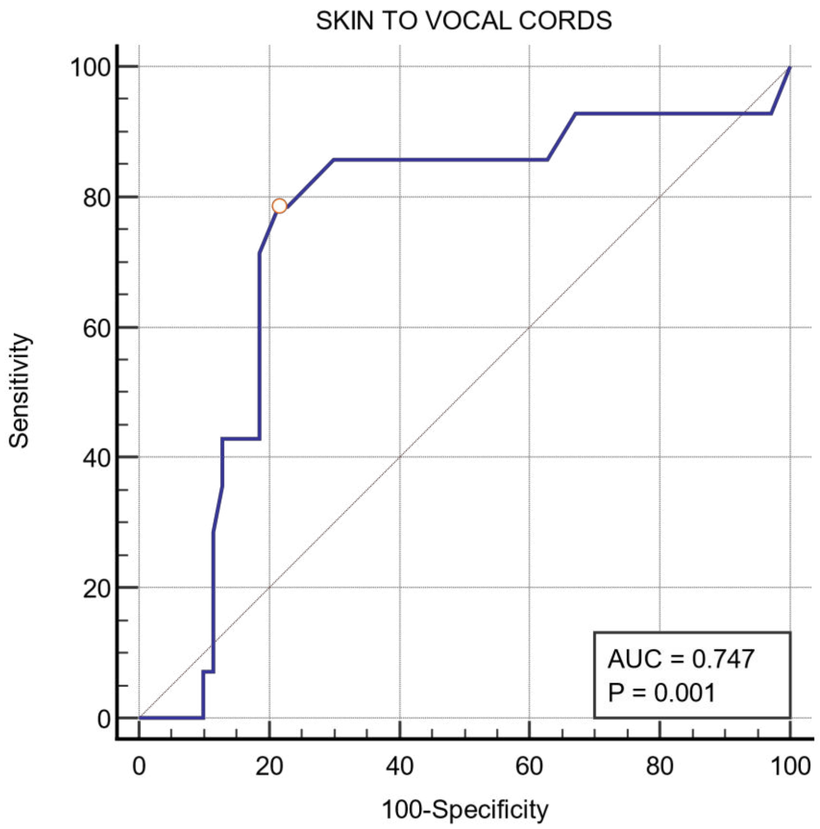
[a] DeLong et al., 1988
[b] Binomial exact

Youden index

Youden index J	0.4429
Associated criterion	>8.5
Sensitivity	92.86
Specificity	51.43

In present study, based on ROC curve the cutoff point for skin to hyoid bone was >8.5. At this cut off point , the sensitivity of USG measurements skin to hyoid bone was 92.86 and specificity was 58.24 to predict difficult intubation

Fig 7: Skin to vocal cords and prediction of difficult airway



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.747
Standard Error [a]	0.0763
95% Confidence interval [b]	0.641 to 0.836
z statistic	3.243
Significance level P (Area=0.5)	0.0012

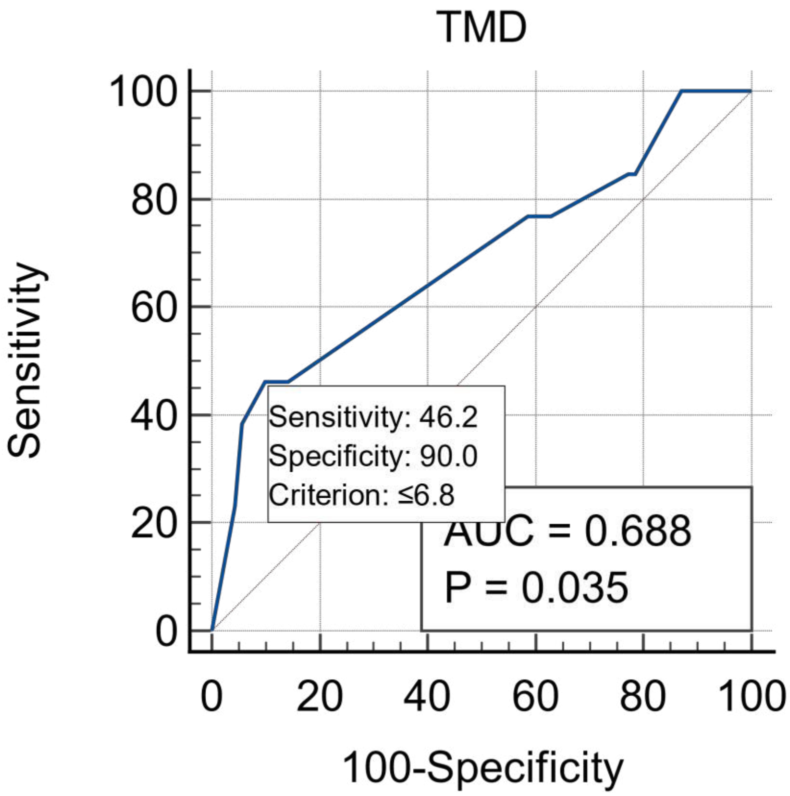
[a] DeLong et al., 1988
[b] Binomial exact

Youden index

Youden index J	0.5714
Associated criterion	>9
Sensitivity	78.57
Specificity	78.57

In present study, based on ROC curve the cutoff point for skin to vocal cords was >9. At this cut off point, the sensitivity of USG measurements skin to hyoid bone was 78.57 and specificity was 83.52 to predict difficult airway.

Fig 8: Thyromental distance and prediction of difficult airway



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.688
Standard Error [a]	0.0891
95% Confidence interval [b]	0.577 to 0.785
z statistic	2.109
Significance level P (Area=0.5)	0.0350

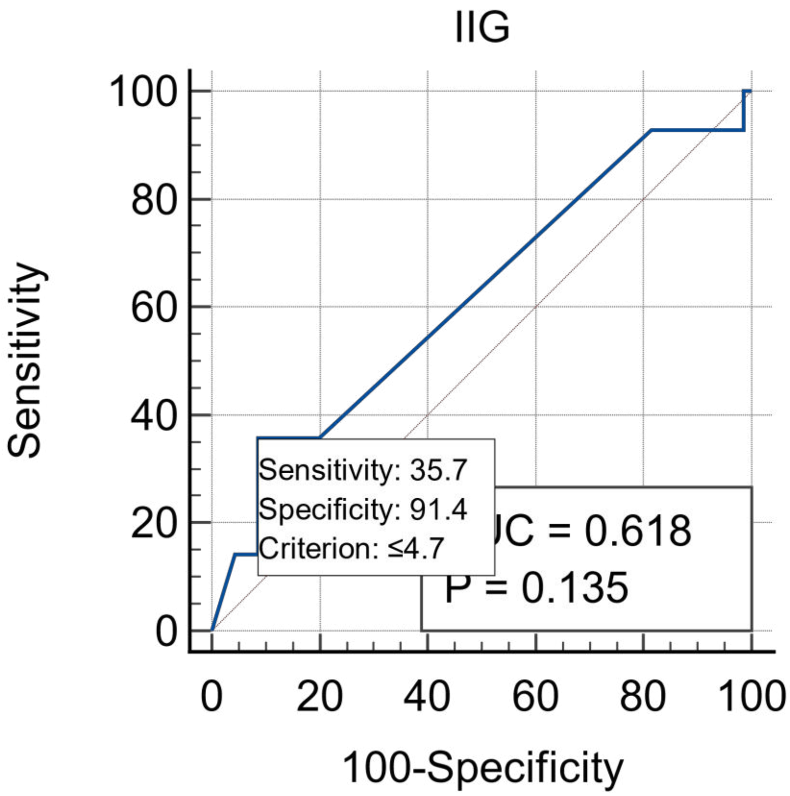
[a] DeLong et al., 1988
[b] Binomial exact

Youden index

Youden index J	0.3615
Associated criterion	≤6.8
Sensitivity	46.15
Specificity	90.00

In present study, based on ROC curve the cutoff point for Thyromental distance was 6.8. At this cut off point, the sensitivity of was 46.15% and specificity was 90% to predict difficult airway.

Fig 9: IIG and prediction of difficult airway



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.618
Standard Error [a]	0.0792
95% Confidence interval [b]	0.506 to 0.722
z statistic	1.494
Significance level P (Area=0.5)	0.1353

[a] DeLong et al., 1988
[b] Binomial exact

Youden index

Youden index J	0.2714
Associated criterion	≤4.7
Sensitivity	35.71
Specificity	91.43

In present study, based on ROC curve the cut off point for IIG was 4.7. At this cut off point, the sensitivity of was 35.71% and specificity was 91.43% to predict difficult airway.

Discussion

Airway assessment is an essential aspect of pre-anesthetic assessment for successful endotracheal intubation during general anesthesia and resuscitation. To increase the accuracy of pre-operative evaluation, many techniques such as Ultrasound, CT, MRI which can measure accurately the thickness of anterior neck soft tissue. But due to the cost and availability in many operating rooms, ultrasound is been used mostly. Ultrasonography of upper airway is capable of providing the accurate anatomic information and has many potential clinical applications.

In a study done by Arun Prasad et al[7] among 15 participants stated that USG as reliable for imaging as CT in comparision of sonography and computer tomography for the assessment of airway structures.

In a study done by Anusha et al[13] on ultrasound imaging of the airway and its applications showed that repeated dynamic evaluations can be carried out, and the accuracy was compared to the airway's CT and MRI with the added benefit of being real time. It can be used to assess airway anatomy immediately before induction of anaesthesia as well as to predict difficult airways. It enhances safety of percutaneous tracheostomies and circothyroidotomies.

The current study was done to assess the utility of pre-operative USG of anterior part of neck for the prediction of difficulty laryngoscopy and to compare the USG findings with Cormack-lehane grade during direct laryngoscopy at a tertiary care hospital, Karnataka.

In a study done by Parmar et al [14] on ultrasound, a tool for airway imaging in 100 participants stated that USG as a safe, fast, non-invasive, repeatable and bedside tool for assessing the airway and can provide dynamic images that were revelant for several aspects of airway management in real time.

A prospective observational study was conductedwhere. 84 patients undergoing general anaesthesia were included in the study after obtaining informed consent. 84patients were classified into 2 groups based on Cormack lehane grading as group E (Easy airway) and group D (Difficult airway).

In the present study, 21.4% belong to 18-30 years, 28.6% belong to 31-40 years., 21.4% belong to 41-50 years, 28.6% belong to 51-60 years. In Group E, 24.3% belong to 18-30 years, 305 belong to 31-40 years, 18.6% belong to 41-50 years, 27.1% belong to 51-60 years. In Group D, 7.1% belong to 18-30 years, 21.4% belong to 31-40 years, 35.7% belong to 41-50 years, 35.7% belong to 51-60 years.

There was no statistically significant difference observed with relation not gender as the p value calculated to be >0.05.

In contrast, a study was done by Lakhal et al[15] in 2007 on feasibility of ultrasound to assess subglottic diameter by comparing the transverse diameter of the cricoid lumen by

USG and MRI showed strong correlation between the two techniques (P<0.05). the study stated that among young healthy adults USG was a reliable tool to assess the diameter of the subglottic upper airway.

In present study, the mean height (meters) of participants in group E was 1.63 ± 0.07 and in group D was 1.65 ±0.08. The difference between mean height among the study groups was not statistically significant (P=0.62). The mean weight (Kg) of patients in group E was 67.32± 8.42 and in group D was 76.20± 9.09. The difference between mean weight among the study groups was statistically significant (P=0.0002). The mean BMI among patients in group E was 25.19 ±2.72 and in group D was 27.92 ±3.85. The difference between mean BMI among the study groups was statistically significant (P=0.0002).

In a study done by Komatsu et al[16] stated that ultrasound used to quantify the neck soft tissue from skin to anterior aspect of trachea at the vocal cords among 64 obese cases with BMI>35. The study assessed that thromental distance, mouth opening, jaw movment, limited neck mobility, modifies mallampti score, abnormal upper teeth, neck circumference, obstructive sleep apnoea, BMI, age, race and gender as predictors.

In present study, majority of patients had ASA grade I (75.7%) in group E and equal distribution of participants had ASA I & II among group D. the difference between ASA grading among the study groups was not statistically significant (P>0.05).

In present study, Majority of the patients (81.32%) in group E had no co-morbidities and 50% of the participants in group D had co morbidities. The difference between co-morbidities among the study groups was statistically significant (P<0.05).

In present study, Majority of the patients (80%) in group E had no co-morbidities and 50% of the participants in group D had co morbidities. The difference between co-morbidities among the study groups was statistically significant (P<0.05).

In present study, the mean MMG for conventional airway measurement was 1.74±0.60 in group E and 2.42±0.85 in group D. There was statistical significance between mean MMG among the study groups (P<0.05).

The mean IIG for airway measurement in group E was 4.97±0.28 and in group D was 4.82±0.42. There was statistical significance between mean IIG among the study groups (P=0.04).

The mean TMD for airway measurement was 7.20±0.47 in group E and 6.91±0.34 in group D. The difference between mean TMD among the study groups was statistical significance (P=0.04).

In present study, the mean USG measurements from skin to epiglottis in group E was 16.27±2.89 and in group D was 19.76±1.47 which was found to be statistically significant among the study groups (P=0.0002).

The mean USG measurements from skin to hyoid bone in group E was 8.77±0.95 and in group D was 9.50±1.48 which was found to be statistically significant among the study groups (P=0.03).

The mean USG measurements from skin to vocal cords in group E was 9.01±2.94 and in group D was 9.47±1.26 which was found statistically not significant among the study groups(P=0.42).

In a study done by Jinhong wu[8] among 203 participants to determine the role of anterior neck soft tissue quantifications by USG in predicting difficult laryngoscopy showed that 28 patients of 203 participants were grouped into difficult laryngoscopy. USG measurements of anterior neck soft tissue thickness at hyoid bone, thyrohyiod membrane and anterior commissure levels were higher in difficult group (P<0.0001) and act as independent predictors of difficult laryngoscopy. When combined these measurements might increase the ability to predict difficulty of intubation.

According to Cormac Lehane classification during laryngoscopy majority in group E had full view of glottis but in group D only epiglottis was seen none of glottis was seen in 83.3%. This finding was found to be statistically significant among the study groups (P<0.0001).

In group E majority of intubations were done in first attempt (88.6%) followed by 2 attempts (11.4%) and in group D 78.6 % of patients had intubation in first attempt followed by 14.3% in two attempts and 7.1% in three attempts. The difference between number of attempts for intubation was statistically significant among the study groups (P<0.05).

In group E, BURP was used as an adjuvant manoeuvre in 5.7% of participants and in group D BURP and Bougie was used in 7.14% and 35.71% of participants respectively. The difference between adjuvant maneuvers used among the study groups was found statistically significant (P<0.0001).

In a study done by Aruna P et al[7] in 2017 showed that the incidence of difficult intubation was 9.2%. Modified mallampati classification had maximum sensitivity and specificity and USG guided measurements of skin to epiglottis had maximum sensitivity and specificity for prediction of difficult intubation.

In present study, based on ROC curve the cutoff point for skin to epiglottis was >17.9. Out of 105 participants, number of patients above the cutoff point was 29 with difficult intubation but based on Cormack Lehane grading 14 patients were grouped as difficult intubation. Number of patients below the cutoff point was 76 with easy intubation but based on Cormack Lehane grading 91 cases were grouped as easy intubation. The sensitivity of USG measurements skin to epiglottis was 92.86 and specificity was 82.42.

In a study done by Sharma et al[17] among 70 obese patients of BMI >30 kg/m2 showed the USG distance between skin and hyoid bone cutoff point was ≥1.42 with sensitivity of 88.2% and specificity of 88.7%. The distance between skin and vocal cords cutoff was ≥1.23 with sensitivity of 82.4% and specificity of 92.5%. The study concludes that USG measured tissue thickness at the levels of hyoid bone and vocal cords had better correlation with difficult intubation.

In present study, based on ROC curve the cutoff point for skin to hyoid bone was >8.5. Out of 105 participants, number of patients above the cutoff point was 51 with difficult intubation but based on Cormack Lehane grading 14 patients were grouped as difficult intubation. Number of patients below the cutoff point was 54 with easy intubation but based on Cormack Lehane grading 91 cases were grouped as easy intubation. The sensitivity of USG measurements skin to hyoid bone was 92.86 and specificity was 58.24.

In a pilot study done among 51 participants by Adhikari et al[12] stated that USG measurements of anterior neck soft tissues at hyoid bone level could be used to distinguish between difficult and easy laryngoscopies. The USG measurements at hyoid bone level in difficult group was higher than in easy group (1.69, 95% CI=1.19 to 2.19 vs 1.37, 95% CI=1.27 to 1.46) but no statistical significance was found.

In present study, based on ROC curve the cutoff point for skin to vocal cords was >9. Out of 105 participants, number of patients above the cutoff point was 26 with difficult intubation but based on Cormack Lehane grading 14 patients were grouped as difficult intubation. Number of patients below the cutoff point was 79 with easy intubation but based on Cormack Lehane grading 91 cases were grouped as easy intubation. The sensitivity of USG measurements skin to hyoid bone was 78.57 and specificity was 83.52.

In a study done by Preethi et al[18] among 100 patients showed anterior neck soft tissue thickness at the level of vocal cords of cutoff point >0.23cm with sensitivity of 85.7% and specificity of 57.0%. The thyoromental distance with cutoff point <6.5cm, the sensitivity was 28.6% and specificity was 90.7%. The sternomental distance with cutoff point <12.5cm, sensitivity was 28.6% and specificity was 100.0%. The study stated that anterior neck soft tissue thickness USG measurements at the level of hyoid bone were potential predictor of difficult intubation.

In a study done by Yadav et al[19] among 310 participants divided into easy group with 279 patients and difficult group of 31 patients. Anterior neck soft tissue thickness at the level of hyoid bone with cutoff point 2.03mm, the sensitivity was 65% and specificity was 69%. The thyomental distance cutoff point was 0.77, the sensitivity was 68% and specificity was 72%. The study concluded that the measurements obtained using USG have greater predictor value of difficult intubation than the conventional methods.

In a study done by Kanoujiya Joti et al[11] in 2019 among 100 cases showed cutoff BMI of 24.8 kg/m2 with sensitivity of 68.7% and specificity of 76.2%. The cut off distance between skin and hyoid bone by USG was 0.81cm with sensitivity of 93.7% and specificity of 80.9%. The thyromental distance cutoff was 6.25cm and sensitivity was 50% and specificity was 40.5%. Cutoff modified mallampati classification was grade II with sensitivity of 81.2% and specificity of 60.7%. The study concluded that BMI, modified mallampati grade and neck circumference were good predictors of difficult intubation.

In a study done by Elizabeth Hall et al[20] among 39 participants showed a standard ultrasound protocol for measurement of airway in all but epiglottic thickness by emergency sonologists with good inter-operator reliability.

The current study concluded that the USG guided measurement of anterior soft tissue thickness of neck is more relevant than conventional methods in predicting difficult airway for intubation.

Conclusion

The present study was attempted to demonstrate the feasibility of using ultrasonography in predicting difficult intubation in the Indian subpopulation. This study found that the correlation between the ultrasonographic parameters and Cormack-Lehane grade were weak or very weak, and can be assumed to have limited clinical significance. Except for PES area under the curves of EVL, DSHB and DSEM were all below 0.6, suggesting that they are poor parameters in predicting difficult intubation. However, all the parameters were highly specific, suggesting that they can all be used to rule out difficult intubation.

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