

## USG guided indices as a tool for prediction of difficult airway in obese: an observational study

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### ABSTRACT

**Background:** Now a days, Ultrasound has been the gold standard and an invaluable tool in the field of regional anaesthesia, especially for upper limb and truncal blocks where general anesthesia is associated with high risk and also in patients posted for general anesthesia with anticipated difficult airway. Recently, few studies have published the importance of Ultrasound in the evaluation of airway and related procedures. Aim of this study is to evaluate the use of USG guided indices for prediction of difficult airway in obese patients and correlating them with clinical parameters.

**Methods:** This study was a prospective observational study done in a tertiary health care center, Government General hospital, Kakinada over a duration of two months from August 2022 to September 2022. Eight Ultrasound parameters like tongue thickness, skin to hyoid distance, pre-epiglottic space, skin to midpoint of vocal cords, skin to thyroid isthmus, anterior soft tissue thickness at suprasternal notch, hyomental distance and thyromental distance were correlated with clinical evaluation (Cormacke-lehane grading) in this study and conclusions were drawn.

**Results:** Out of 30 cases studied, 20 (70%) were predicted to be difficult with Ultrasound airway examination and 16 (53.3%) were found to have difficulty in intubation clinically.

**Conclusions:** The following USG indices like pre-epiglottic space, Skin to midpoint of vocal cords, Anterior soft tissue thickness at Suprasternal notch, Hyomental distance in mid-extended position and thyromental distance were found to be clinically correlated to predict difficult airway and intubation in obese patients.

**Keywords:** Difficult airway, Ultrasonography, Airway indices

### INTRODUCTION

Now a days, Ultrasound has been the gold standard and an invaluable tool in the field of regional anaesthesia, especially for upper limb and truncal blocks where General Anesthesia is associated with high risk and also in patients posted for general anesthesia with anticipated difficult airway.<sup>1</sup> Recently, few studies have published the importance of ultrasound in the evaluation of airway and

related procedures.<sup>2</sup> The studies highlighted the usage of Ultrasound not only in the prediction of difficult airway but also for confirmation of placement of Endotracheal tube/laryngeal mask airway, as an adjunct for percutaneous dilational tracheostomy, percutaneous cricothyroidotomy and for prediction of post-extubation stridor.<sup>3</sup> Other clinical applications of ultrasound in the airway management that have been published in the literature are prediction of appropriate Endotracheal tube and Double lumen tube sizes, confirmation of correct

Endotracheal Tube depth, detection of Endobronchial intubation, assessment of vocal cords, detection of tracheal stenosis, determination of tracheal wall thickening, etc.<sup>4</sup> Kinshuki Jain et al in their review article on ultrasonographic assessment of airway stated that in spite of its few limitations, Ultrasonography is a rapidly evolving modality in the field of anesthesiology finding application in the airway management.<sup>5</sup> Hence, the aim of this study is to evaluate the use of USG guided indices for prediction of difficult airway in obese patients and correlating them with clinical parameters.

## METHODS

The present study was a prospective observational study conducted in a tertiary health care center, Government General Hospital, Kakinada over a duration of two months from August 2022 to September 2022 after taking ethical committee approval and informed and written consent from the patients. Sample size was estimated based on the previous clinical study taking into consideration alpha value of 0.05, beta error of 80% and margin of error 5%. Total number of subjects included were 30 patients basing on the above. Blinding: The anesthesiologist who is involved in abstraction and collection of data for clinical assessment is blinded to Ultrasound evaluation and vice-versa.

All the 30 patients were thoroughly evaluated for pre-anesthetic checkup, necessary investigations done and optimised for the elective surgery. For each patient, correlation of airway and USG indices was done by principal anesthesiologist who is not involved in the observation and collection of airway data. Three investigators are involved in this study. All the surgeries were performed under standard General Anesthesia regimen consisting of drugs glycopyrrolate, ondansetron, opioids, propofol, atracurium, neostigmine. After adequate relaxation, tracheal intubation was attempted by direct laryngoscopy with a Macintosh blade of appropriate size. The laryngoscopic view was graded according to the Modified Cormack-Lehane grading as easy, mildly difficult and difficult. Patients were graded under easy category if intubated easily during first attempt without aids. The Laryngoscopic view was graded as Mildly Difficult if a Stylet was used for intubation or additionally pressure (BURP) was applied at cricoid cartilage during intubation. Patients were graded under Difficult category if an aid was used for intubation like Bougie and/or Cormacke-Lehane grade III, IV. All the patients were recovered uneventfully. All the 30 patients completed the study successfully.

### Inclusion criteria

Patients of ASA grade I and II, either gender, BMI more than 25 kg/m<sup>2</sup> and those posted for elective surgeries were included in this study.

### Exclusion criteria

Emergency cases, anterior neck masses, inter incisor distance <3 fingers, teeth pathology, temporo-mandibular joint movement restriction, neck movement restriction, gross clinical abnormalities that will predict difficult intubation externally were excluded.

During pre-anesthetic checkup, patient was examined and the following clinical airway indices were recorded: weight, inter incisor distance, mallampati grading, neck circumference, tmj mobility and neck movement restriction. In all the subjects during Pre - Anesthetic Checkup, following USG guided indices were recorded for assessment of airway by another anesthesiologist who is unaware of clinical assessment of airway: USG guided tongue thickness, USG guided Skin to Hyoid distance, USG guided Pre-Epiglottic space (Figure 1), USG guided Skin to midpoint of Vocal cords, USG guided Skin to Thyroid isthmus, USG guided anterior soft tissue thickness at suprasternal notch, USG guided hyomental distance in mid-extended position, USG guided thyromental distance. On the day of surgery, during direct laryngoscopy and intubation following clinical parameters were recorded: Modified Cormack - Lehane grading (Figure 2), Ease of intubation, Number of attempts for intubation, Use of any aids like Bougie or Stylet, Time taken for intubation (From direct laryngoscopy to cuff inflation time). After collection of data USG parameters were correlated with clinical parameters and statistical analysis was done for the following.

### Statistical analysis

Statistical correlation between Ultrasound parameters and clinical indices was done using SPSS software. Sensitivity, Specificity and cutoff values for a particular airway Ultrasound parameter was assessed by using ROC curve and Youden Index. Cut off were also compared with other observational studies on Ultrasound airway assessment in obese patients.

## RESULTS

Total number of cases studied were 30. Number of cases predicted for difficult intubation by Ultrasound evaluation were 21 (70%).

**Table 1: Ease of intubation.**

Easy	Mild difficulty	Difficult
14 (46.6)	4 (13.3)	12 (40)

Number of cases observed with difficult intubation clinically were 16 (53.3%). Subjects were categorised into easy, mildly difficult and difficult intubation clinically as shown in (Table 1). Cutoff values obtained in this study were compared with other similar studies as shown (Table 2). Number of patients predicted difficult with Ultrasound

were compared with patients found to be difficult clinically during intubation as in (Table 3).

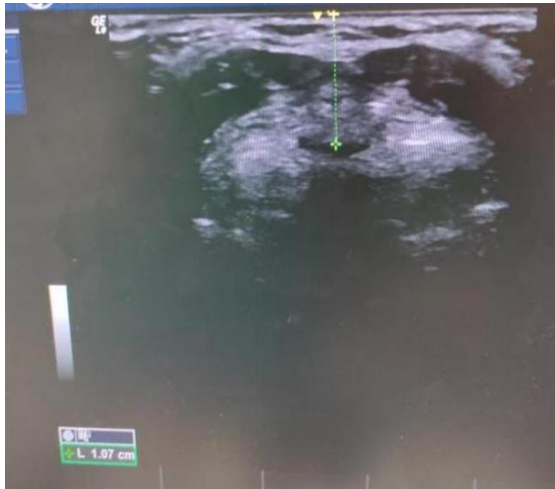


Figure 1: USG guided pre-epiglottic space.

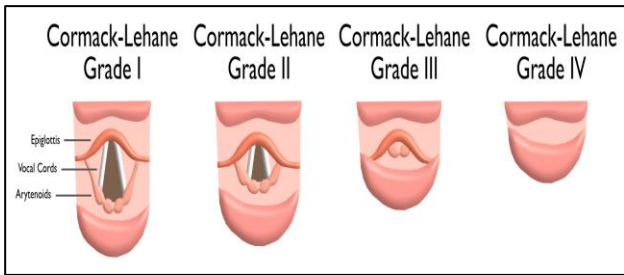


Figure 2: Cormack-Lehane grading.

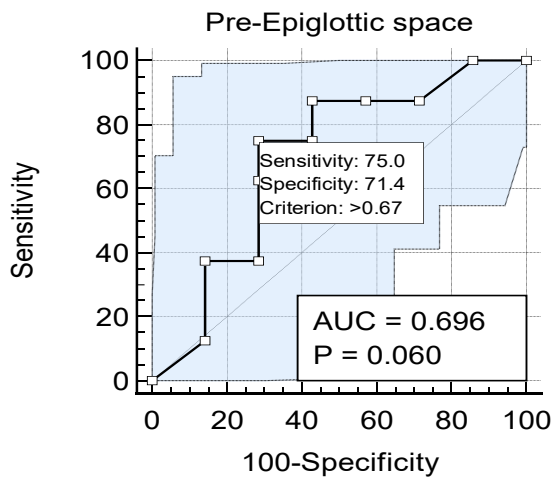


Figure 3: USG guided pre-epiglottic space.

**Tongue thickness**

The sensitivity and specificity of the parameter Tongue thickness was found to be 87.5% and 42.9% respectively with the cut-off value of 4.31 cm as shown in (Table 2).

**Skin to hyoid distance**

The sensitivity of parameter Skin to Hyoid distance was 50% and Specificity was 63.9% with a cut-off value of 0.375 cm shown in (Table 2).

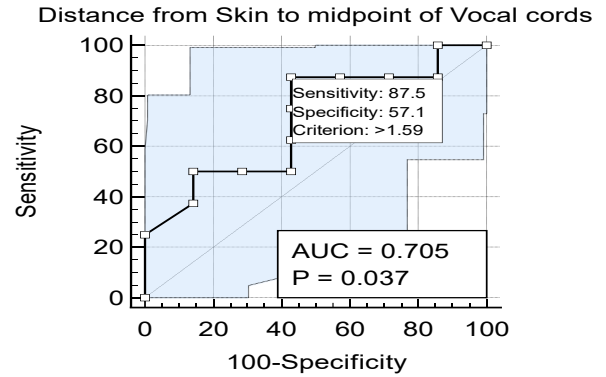


Figure 4: USG guided skin to midpoint of vocal cords.

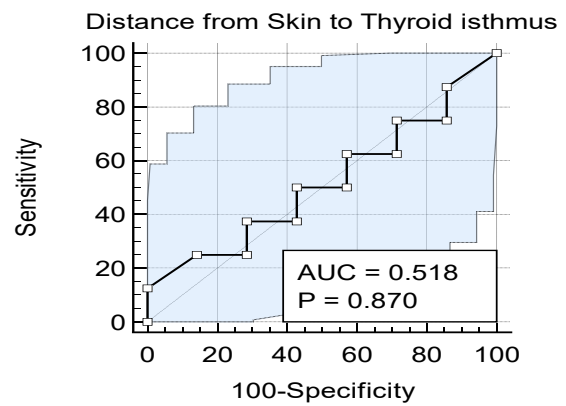


Figure 5: USG guided skin to thyroid isthmus.

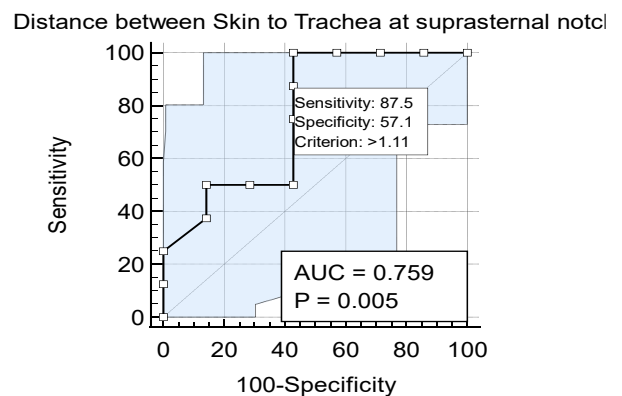


Figure 6: USG guided anterior soft tissue thickness at suprasternal notch.

**Table 2: USG indices cutoff, sensitivity, specificity in comparison with other studies.**

Parameter	Study Cut-off	Other studies Cut-off (cm)	Easy intubation	Difficult intubation	Sensitivity (%)	Specificity (%)
Tongue thickness	4.31cm	6.0	10	20	87.5	42.9
Skin to hyoid	0.37cm	1.40±0.19	12	18	50	63.9
Pre-epiglottic space	0.67cm	0.98± 0.25	14	16	75	71.4
Skin to mid-point of vocal cords	1.59cm	1.35± 0.15	10	20	87.5	57.1
Skin to thyroid isthmus	0.87cm	1.08± 0.33	22	8	12.5	80
Anterior soft tissue thickness at suprasternal notch	1.11cm	1.24± 0.37	10	20	87.5	57.1
Hyomental distance	7.13cm	5.26± 0.58	15	15	62.5	57.1
Thyromental distance	7cm	6.5	18	12	75	57.1

**Table 3: Correlation between USG and clinical parameters.**

Parameters	USG predicted, N (%)	Clinically Predicted N (%)
Easy	9 (30)	14 (46.6)
Difficult	21 (70)	16 (53.3)

**Pre-epiglottic space**

Pre-epiglottic space had a sensitivity of 75% and specificity of 71.4% with a cut-off value of 0.67 cm as in (Figure 3, Table 2). Ultrasound guided measurement of Pre-epiglottic space was depicted in (Figure 1).

**Anterior soft tissue thickness at suprasternal notch**

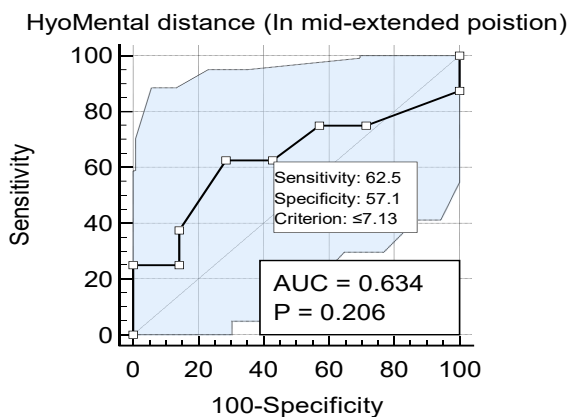
This parameter has a Sensitivity of 87.5% and Specificity of 57.1% with a cut-off value of 1.11cm as in (Figure 6, Table 2).

**Hyomental distance (mid-extended position)**

This parameter has a Sensitivity of 62.5% and Specificity of 57.1% with a cut-off value of 7.13 cm as shown in (Figure 7, Table 2).

**Thyromental distance**

The parameter Thyromental distance showed Sensitivity of 75% with a Specificity of 57.1% and cut-off value of 7.0 cm as in (Table 2).



**Figure 7: USG guided hyomental distance (mid-extended position).**

**Skin to midpoint of vocal cords**

The distance between Skin to midpoint of Vocal cords had a sensitivity of 87.5% with a specificity of 57.1% and cut-off value being 1.59 cm as in figure 4 and (Table 2).

**Skin to thyroid isthmus**

The parameter Skin to Thyroid isthmus was found to have sensitivity of 12.5% and specificity of 80% with a cut-off value of 0.51 cm as shown in figure 5 and (Table 2).

**DISCUSSION**

Now a days, Ultrasound has been a valuable tool for the Anesthesiologist inside the operating room.<sup>6</sup> Being a Gold standard tool in performing regional blocks, Ultrasound has also been gaining popularity both in evaluation and management of airway.<sup>7</sup> Recently, a lot of research is being done in the field of evaluation and management of airway which is an important skill for the Anesthesiologist. Research has been published to date in the areas of airway management like prediction of difficult airway with ultrasound in normal and obese patients.<sup>8</sup> Ultrasound is being used as an aid in confirming the placement of endotracheal tube and also in securing emergency surgical airway. A good number of studies proved the accuracy and validity of Ultrasound guided indices in prediction of difficult laryngoscopy and airway. This observational study has been done using few Ultrasound indices to evaluate the prediction of difficult laryngoscopy and

intubation in obese patients. Anesthesiologist should be well trained in the practice of USG and have sound knowledge of knobology and probology in the usage of ultrasound machine.<sup>9</sup> In this study, Airway examination was performed by a senior Anesthesiologist who is unaware of the clinical data. Statistical analysis was done by another senior Anesthesiologist with the help of faculty of PSM. Of the 30 cases analysed, 16 (53.3%) cases were found to be clinically difficult. Among these 16 cases, 4 (25%) patients were found to have mild difficulty on intubation and 12 (75%) were found to be difficult. On USG evaluation out of 30 cases, 21(70%) cases were found to predict difficulty for Laryngoscopy and intubation depending upon the various Ultrasound guided indices taken in this study. The observed difference in predicting difficult airway when Ultrasound examination was correlated with Clinical examination was found to be 5 (23.8%) false positive cases. The variation observed in Ultrasound examination could be due to differences in the sensitivity and specificity values for different USG indices. The added value of USG airway evaluation in these cases lacked specificity and sensitivity for the indices like Skin to Hyoid and Tongue thickness in this study. Moreover, in obese and short neck patients, difficulty in focusing the vocal cords by Ultrasound was observed. Hence, expertise was needed to focus vocal cords and visualise its mobility with respiration or phonation. Expertise of Anesthesiologist in handling the Ultrasound probe and calculating the parameters will add to the accuracy of a particular ultrasound parameter.

Among the 8 ultrasound indices used to perform airway evaluation pre-operatively, few indices have been shown to be accurate and specific in the prediction of difficult airway when correlated clinically with Cormack-Lehane grading in this study. In this study, senior Anesthesiologist who performed Ultrasound guided airway evaluation was trained by radiologist. Clinically, total 16 (53.3%) patients out of 30 were found to be difficult. By Ultrasound guided indices, 21 (70%) patients out of 30 were predicted to have difficult airway. On considering pre-epiglottic space, 16 (53.3%) out of 30 patients were predicted to have difficult airway with the cut-off of 0.67 cm in this study. This cut-off was comparable to a study done by Preethi Reddy et al on Ultrasonography a viable tool for airway assessment with the cut-off 0.98±0.25 cm.<sup>10</sup> Hence, Pre-epiglottic space was found to be more reliable for difficult airway prediction in this study.

Sharma et al in their study on Ultrasonographic prediction of difficult laryngoscopy in obese patients compared 70 obese patients and found Skin to mid-point of Vocal cords as a better predictor for difficult airway with a cut-off 1.35±0.15 cm.<sup>11</sup> In this study, a comparable cut-off of 1.59 cm was found to be predicting about 20 (66.67%) out of 30 patients to have difficult airway with a good sensitivity of 87.5%.

Alessandri et al in their study on Ultrasound as a new tool in the assessment of airway difficulties: An observational

study with 194 patients found Anterior soft tissue thickness at Suprasternal notch as a reliable predictor with cut-off 1.24±0.37 cm.<sup>12</sup> In this study also, cut-off is 1.11 cm which is correlating with the cut-off of the above study and found to be predicting about 20 (66.67%) out of 30 patients to have difficult airway. In a study on comparison of different ultrasound parameters for airway assessment in patients undergoing surgery under general anaesthesia done by Ohri et al they found a cut-off 5.26±0.58 cm for Hyomental distance for predicting difficult airway.<sup>13</sup> In this study about 15(50%) out of 30 patients were predicted to have difficult airway with a cut-off value of 7.13cm for Hyomental distance.

Adhikari et al in their pilot study to determine the utility of point-of-care ultrasound in the assessment of difficult laryngoscopy with 51 patients, measured thickness of tongue and anterior neck soft tissue at the level of hyoid bone and Thyrohyoid Membrane using Ultrasound and found soft tissue thickness at the level of hyoid bone and Thyrohyoid Membrane to be significant predictor of difficult airway.<sup>14</sup> So the observations of Adhikari et al study with respect to anterior neck soft tissue were correlated with the observations of this study. Ezri et al in their study on Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue at the level of vocal cords and suprasternal notch in obese patients and found that difficult laryngoscopy was associated with more soft tissue at the level of vocal cords.<sup>15</sup>

The observations of Ezri et al study were found to be similar to the observations of the present study. In this study, Thyromental distance was measured using Ultrasound which was comparable with the standard clinical cut-off of 6.5 cm. 12 (40%) out of 30 cases were predicted with difficult airway with USG guided Thyromental distance in this study. In a study done by Gomes et al on useful ultrasonographic parameters to predict difficult laryngoscopy and difficult tracheal intubation, following parameters were significant in predicting a difficult laryngoscopy evaluation of the distance from skin to hyoid bone, skin to epiglottis, skin to vocal cords (VC), skin to anterior aspect of trachea at the level of suprasternal notch, HMD in extended position; tongue cross-sectional area and volume, thickness and ratio of tongue thickness to TMD, Pre-E/aVC, Pre-E/mVC, ratio between HMD ramped position and neutral position (HMDR1); ratio between HMD in the extended position and neutral position (HMDR2), pre-epiglottic area (PEA) and visualization of hyoid bone with sublingual USG approach etc.<sup>16</sup> Out of 26 sonographic parameters studied, they concluded that 7 indices were found to be reliable for prediction of difficult airway. In the present study also out of the 8 indices evaluated, the following USG indices were considered reliable to predict difficult laryngoscopy and intubation in obese patients pre-epiglottic space, Skin to midpoint of vocal cords, Anterior soft tissue thickness at Suprasternal notch, Hyomental distance in mid-extended position, Thyromental distance.

## Limitations

However, there are certain limitations in the present study like: Limited sample size, User dependent and Non-inclusion of certain USG parameters like PES/ E-VC, HMD in all positions, pre-E/mVC. By Ultrasound evaluation, difficult airway prediction was observed to have false positivity of 5 (23.8%) cases with the USG indices taken up for this study, which means that all the 8 USG indices are not reliable and accurate for the prediction of difficult laryngoscopy and intubation in obese patients. This is proved by correlation of USG evaluation with clinical evaluation. There is a lot of scope for future research in this area of Ultrasound evaluation of airway. Further clinical trials with multicentre studies and larger samples are required to validate reliable USG parameters which are specific to predict difficult airway and intubation. With the advancement of better probes, high-resolution imaging, real-time pictures and clinical experience, Ultrasound has the potential to replace other noninvasive airway assessment methods as the primary method in critical care and anaesthesia practice.

## CONCLUSION

This study demonstrates that Ultrasound is a valuable tool for airway evaluation. The following USG indices like pre-epiglottic space, Skin to midpoint of vocal cords, Anterior soft tissue thickness at Suprasternal notch, Hyomental distance in mid-extended position and Thyromental distance were found to be clinically correlated to predict difficult airway and intubation in obese patients.

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