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**Research Article**

# ULTRASONOGRAPHY OF ANTERIOR NECK SOFT TISSUE THICKNESS AT HYOID BONE LEVEL VS THYROHYOID MEMBRANE LEVEL IN PREDICTING DIFFICULT LARYNGOSCOPY

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**A R T I C L E I N F O**

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Ultrasonography, Difficult intubation, Hyoid bone, Thyrohyoid membrane, Anterior neck, Soft tissue thickness

**A B S T R A C T**

***Objective:*** To compare the effectiveness of ultrasonography of anterior neck soft tissue thickness at hyoid bone level vs thyrohyoid membrane level as a preoperative assessment tool to identify difficult laryngoscopy.

***Materials And Methods:*** 100 patients who were to undergo elective surgery under general anaesthesia with endotracheal intubation were included in the study. Patients with no teeth and head and neck anatomical abnormality were excluded from study. In the pre operative room, clinical airway assessment which included Mallampatti's classification, inter incisor gap Neck circumference and thyromental distance were measured. The ultrasound was done to measure the thickness of soft tissues in the anterior neck at 2 levels namely (a) hyoid bone and (b) thyrohyoid membrane. On the day of surgery anesthesia was provided to the patient according to the standard protocol. The Cormack-Lehane grading was recorded. Statistical analysis was done using the collected data.

***Results:*** There was no statistical significance between the demographic variables like age (P=0.613), sex (P=0.670) and height (P=0.614) of the patients and the occurrence of difficult airway. Among the demographic variables, significant correlation was found between the weight (P=0.000) and difficult airway. The ultrasound measurements made at the 2 levels (a) hyoid bone and (b) thyrohyoid membrane showed significant results. The P values for each of the levels are P=0.000 and P=0.000 respectively. Among the 2 levels, the measurement made at thyrohyoid membrane level (skin to epiglottis thickness) was found to be highly sensitive (100%) and specific(99.3%). A cut-off point of 2.33cms was calculated using the Receiver Operating Characteristic curve (ROC curve). This cut-off point delineates difficult airway and difficult airway.

***Conclusion:*** We concluded that ultrasound of anterior neck soft tissue at the thyrohyoid membrane level can be used as a reliable tool to identify difficult airway as compared with the ultrasound at the level of hyoid bone.



## INTRODUCTION

The management of airway is the primary concern of the anesthesiologist. The purpose of performing an airway assessment is to diagnose the potential for difficult airway so that optimal patient preparation and proper selection of equipment and technique can be done. Initially the airway assessment was carried out by single factors like Mouth opening, Mallampatti grading, Thyromental distance, Neck movements, etc. Then, multivariate factor analysis came into existence. Even then, there have been instances when a patient predicted to have easy intubation had an difficult intubation and vice versa. In the last few years, Ultrasound has been gaining popularity and practical applicability.

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There have been many studies using ultrasound to assess the airway and to predict difficult intubation. These include measuring the anterior neck soft tissue thickness at different levels, namely skin to Hyoid bone, skin to epiglottis at thyrohyoid membrane level and skin to tracheal ring at suprasternal notch level.

## OBJECTIVE

To compare the effectiveness of USG of anterior neck soft tissue at hyoid bone level vs thyrohyoid membrane level as a preoperative assessment tool to identify difficult laryngoscopy using Cormack Lehane (CL) grading.

## MATERIALS AND METHODS

This study was conducted at Saveetha Medical College and Hospital, Chennai on 100 patients who underwent elective surgery requiring general anaesthesia and tracheal intubation.

This study was conducted after obtaining approval from the institutional ethical committee. Patients were explained about the procedure in detail and consent was obtained for the same. It was a prospective observational single blinded study. 100 patients who satisfied the inclusion criteria were included in the study. Inclusion criteria was patients of ASA grade I and II, age 18 to 60 years of both sexes. The patients who were excluded were those with mouth opening less than 3 centimeters, edentulous patients, patients with faciomaxillary trauma and neck pathologies and pregnant women.

In the pre-operative room, clinical airway assessment was done which included Height, Weight, Neck Circumference, Mallampatti's classification, inter incisor gap and Thyromental distance. The ultrasound was done to measure the thickness of soft tissues in the anterior neck at 2 levels namely (a) hyoid bone and (b) thyrohyoid membrane. The patient was made to lie down supine with head in neutral position without a pillow under head as shown in Fig.1 and Fig.3. Patient was instructed to keep the mouth closed and to take slow breaths during measurements to minimize errors in recordings due to movements during respiration. The Ultrasound machine settings is as follows: Linear High frequency transduce, Transverse plane, Frequency - 11 MHz, Depth - 3.0 cm - 4.0 cm. The hyoid bone was identified as an inverted U-shaped hyperechoic structure in the submandibular region as shown in Fig.2. The image was frozen on screen and measurement from skin to mid-point of hyoid bone was taken using the "measure" option in the ultrasound machine.

**Fig.1** Ultrasound measurement taken at the hyoid bone level with the patient in supine position

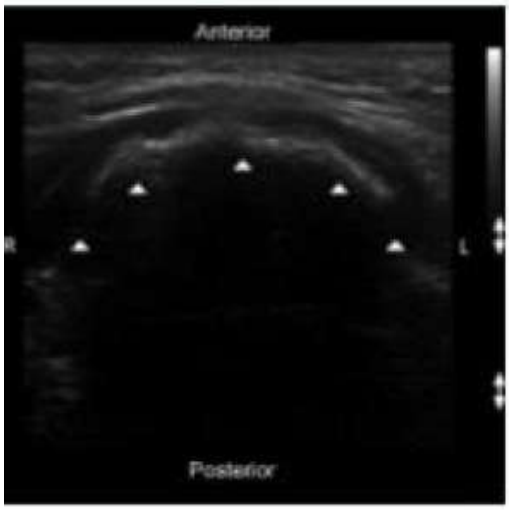



**Fig 2** The hyoidboneappearingasaninvertedU-shapedhyperechoicstructure in the submandibular region on ultrasound

The Epiglottis was identified in the Thyrohyoid membrane level as a linear hypoechoic structure followed by a hyperechoic shadow as shown in Fig.4.Measurement was taken from skin to epiglottis as mentioned previously.

**Fig 3** Ultrasound measurement taken at the thyrohyoid membrane level with the patient in supine position

In the Operating room, anaesthesia was provided to the patient according to the standard protocol. After an overnight fast for 6 hours, patients were shifted to the operating room. After attaching standard monitors, Inj. Glycopyrrolate 0.2 mg IV was given. Preoxygenation was done with 100% oxygen and after ascertaining bag-mask ventilation, induction was done with IV fentanyl 2mcg/kg, propofol 2mg/kg and atracurium 0.5mg/kg. Orotracheal intubation was done and position was confirmed with 5-point auscultation, capnography and SpO2.


**Fig 4** The Epiglottis appearing as a linear hypoechoic structure followed by a hyperechoic shadow on ultrasound

A macintosh blade size 3 or 4 was used for laryngoscopy. The best view obtained at the first attempt by the laryngoscopy without any external maneuver applied was taken as the Cormack Lehane classification (Fig.5).

- GRADE 1 - Visualization of the entire laryngeal aperture
- GRADE 2 - Visualization of only posterior commissure.
- GRADE 3 - Visualization of only the epiglottis
- GRADE 4 - Visualization of only the soft palate.

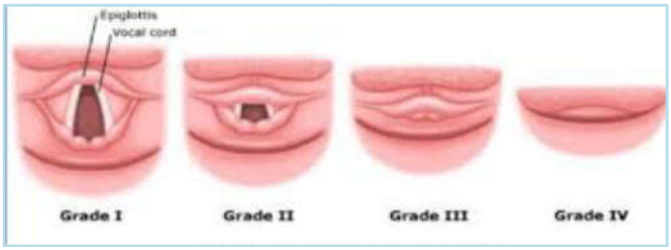
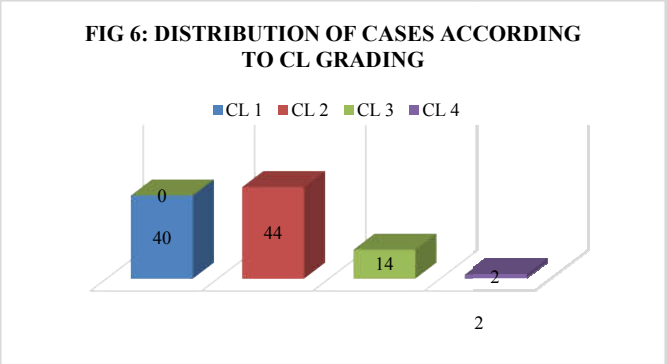
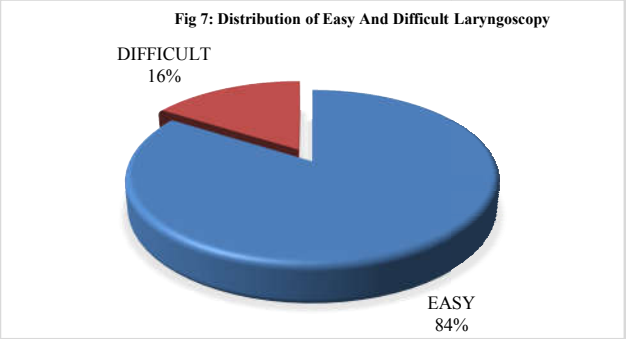



**Fig 5** Cormack and Lehane Grading

## RESULTS

The entire data was statistically analyzed using SPSS version 21.0 for MS Windows. The demographic data were compared with the Chi square test and other parameters were compared using student t-test. ROC curve analysis was used to obtain cut off values for assessing specificity and sensitivity of the parameters. In the entire study, the p-values < 0.05 is considered to be statistically significant. There was no statistical significance between the demographic variables like age, sex and height of the patients and the occurrence of difficult airway. The number of cases with CL grading 1,2,3 and 4 were 40,44,14,2 respectively (Fig.6). Out of 100 cases studied, 84 had easy laryngoscopy and 16 had difficult laryngoscopy (Fig.7).




The distribution of mean of distance (in cm) between skin to hyoid bone in easy laryngoscopy group and difficult laryngoscopy group was 0.74±0.15 and 1.22±0.33 respectively. Similarly, the distribution of mean of distance (in cm) between skin to epiglottis at the level of thyrohyoid membrane in easy laryngoscopy group and difficult laryngoscopy group was 0.72±0.16 and 1.18±0.22 respectively (Table 1).

**Table 1** Distribution of mean of distance (in cm) between skin to hyoid bone and skin to epiglottis in easy laryngoscopy group and difficult laryngoscopy group

| Parameter | Easy | Difficult | P value |
|---|---|---|---|
| Skin to hyoid | 0.74 ±0.15 | 1.22 ±0.33 | 0.001 |
| Skin to epiglottis | 0.72 ±0.16 | 1.18 ±0.22 | 0.001 |

The Receiver operating characteristic (ROC) curve analysis at the hyoid bone level and the thyrohyoid membrane level is shown in figures 8 and 9. The distribution of Area under the ROC Curves (AUC) for the distance between skin to hyoid bone is 0.944 ± 0.028 and the AUC for skin to epiglottis at the level of thyrohyoid membrane is 0.970 ± 0.015.

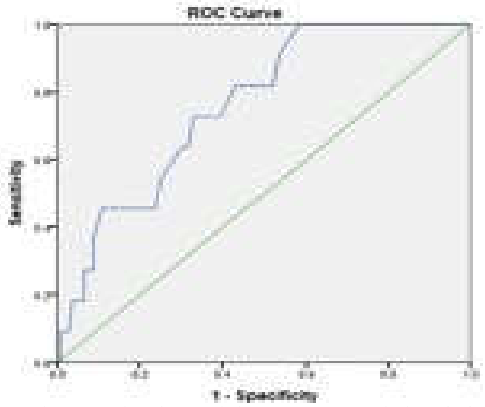



**Fig 8** The Receiver operating characteristic (ROC) curve analysis at the hyoid bone level

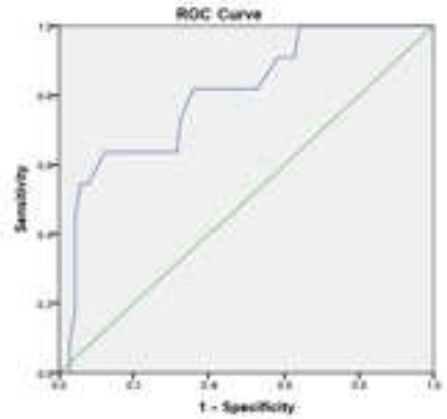



**Fig 9** The Receiver operating characteristic (ROC) curve analysis at the thyrohyoid membrane level

With reference to ROC curve analysis, the optimal cut offs for skin to hyoid bone distance and skin to epiglottis distance for the prediction of difficult laryngoscopy are 0.84cm and 0.93 cm respectively (Table 2)

**Table 2** The distribution of Area under the ROC Curves (AUC) for the distance between skin to hyoid bone and skin to epiglottis at the level of thyrohyoid membrane

| Parameter | AUC ± SE | 95% CI OF AUC | P Value | Cut Off Based on Roc |
|---|---|---|---|---|
| Skin to Hyoid | 0.9444 ± 0.028 | 0.888 – 0.999 | 0.001 | 0.84 |
| Skin to Epiglottis | 0.970 ± 0.015 | 0.940 – 0.999 | 0.001 | 0.93 |

AUC: Area Under Curve, SE: Standard Error, CI: Confidence Interval, ROC: Receiver Operating Characteristic

The sensitivity and specificity of measurements taken at hyoid bone level is 93.7 and 80.9 respectively. Similarly, the sensitivity and specificity of measurements taken at thyrohyoid membrane level is 93.7 and 89.2 respectively. (Table 3)

| Parameter | Sensitivity | Specificity | PPV | NPV | Accuracy |
|---|---|---|---|---|---|
| Skin to Hyoid | 93.7 | 80.9 | 48.4 | 98.5 | 83.0 |
| Skin to epiglottis | 93.7 | 89.2 | 62.5 | 98.7 | 89.9 |

PPV: Positive Predictive Value, NPV: Negative Predictive Value

Table 3 Comparison of the sonographically assessed parameters at 2 different levels in predicting difficult laryngoscopy

## DISCUSSION

Difficult intubation accounts for 17% of the respiratory related injuries and results in hypoxia and hypoxia related adverse effects leading to significant morbidity and mortality. Since the consequences of an unanticipated difficult airway are

potentially life threatening to the patient, a method of appropriate pre-operative airway assessment has become an important necessity. Airway assessment is routinely done with clinical parameters like MMP, TMD, Neck movements and Inter incisor gap. In the past few years, Ultrasonography has found a significant role in the assessment of airway as it is a safe, noninvasive and a real time imaging tool. Ezri, *et al*. in their study proved that patients with a larger distance between skin and hyoid bone (>2.8cm) had difficult laryngoscopy; which was comparable to results from our study. Adhikari *et al*. demonstrated that sonographic measurements of anterior neck soft tissue thickness at the level of hyoid bone and thyrohyoid membrane could be used to distinguish easy from difficult laryngoscopy. Wu *et al*. in their study on 203 patients, have shown that both the skin to hyoid distance as well as skin to epiglottis (thyrohyoid membrane) distance were good predictors of difficult laryngoscopy. In our study, correlating USG measurements of Hyoid Bone and Thyrohyoid Membrane with CL grading, it was found that anterior neck soft tissue thickness at the level of the hyoid bone was able to predict difficult laryngoscopy in 93.7% of patients. Specificity was 80.9%. Similarly, it was found that anterior neck soft tissue thickness at the level of Thyrohyoid membrane was able to predict difficult laryngoscopy in 93.7% of patients. Specificity was 89.2%.The accuracy of a test is measured by the area under the ROC curve.An area of 1 represents a perfect test; an area of 0.5 represents a non-significant test. Area under the curve (AUC) for Hyoid bone distance is 0.94 and AUC for Thyrohyoid membrane distance is 0.97.This shows that ultrasonography at the level of thyrohyoid membrane is a better predictor of difficult laryngoscopy than the measurements made at hyoid bone level.

## CONCLUSION

From this study, concluded that ultrasound of anterior neck soft tissue at the thyrohyoid membrane level can be used as a more reliable tool to identify difficult airway as compared with the ultrasound at the level of hyoid bone.

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**Conflict of Interest:** None
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**Ethical Clearance:** Obtained from institutional ethical committee

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