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# To determine the utility of sonographic measurement of the thickness of anterior neck soft tissue at the level of hyoid bone and thyrohyoid membrane in distinguishing difficult and easy laryngoscopies.

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**Conflicts of Interest:** Nil

## Abstract

**Background:** Airway assessment is an essential aspect of preanaesthetic assessment. Presently, prediction of difficult airway is based on clinical assessment of airway.

**Methods:** Prospective Observational **conducted at** Department of Anesthesiology, Dr. RPGMC Kangra at Tanda, Himachal Pradesh.

**Results:** In the present study, we found that ultrasound (US) measurements of anterior neck soft tissue thickness at hyoid bone (DSHB), thyrohyoid membrane (DSEM), and anterior commissure (DSAC) were significantly associated with the difficult intubation. DSEM had better sensitivity; however, DSHB had better specificity. All the parameters showed a significant relation with the difficult intubation.

**Conclusion:** Thus, we can conclude that ultrasound can be used in combination with other bedside clinical tests, for better prediction of difficult laryngoscopy.

**Keywords:** Ultrasound, endotracheal intubation, direct laryngoscopy

**Introduction:** Airway assessment is an essential aspect of preanaesthetic assessment. Presently, prediction of difficult airway is based on clinical assessment of airway. 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. Even after using multiple clinical screening tests, a significant incidence of unanticipated difficult laryngoscopy (1%–8%) has been observed. Again the clinical assessment tools play a limited role in unconscious and uncooperative individuals. Presently, there is a search for noninvasive and more accurate tools for airway assessment to overcome the above limitations of clinical airway assessment tests.[1-3] Portable, non-invasive and point of care characteristics of ultrasonography can aid in airway assessment and prediction of difficult laryngoscopy. Various ultrasound derived measurements of airway have been used to predict difficult laryngoscopy.[4]

## Material and Methods

**Type of Study:** Prospective Observational

**Place of Study:** Department of Anesthesiology, Dr. RPGMC Kangra at Tanda, Himachal Pradesh

**Study Population:** After approval by institutional ethics committee and obtaining informed consent, prospective and observational study was carried out over the period of one year.

**Inclusion criteria**

1. Males and females between the age group 18-60 years.
2. ASA physical class I-II.
3. BMI 18.5-29.9.

**Exclusion criteria**

1. Patient's refusal to participate in the study
2. Rapid-sequence induction of anesthesia
3. Inability to open the mouth due to existing trauma or medical condition, preexisting neck or facial disease-causing distortion of the airway, edentulous, and/or a history of difficult intubation
4. Altered level of consciousness, confusion, or inability to follow commands
5. Preexisting limitation or pain with cervical spine movement. Patients requiring rapid-sequence induction are already at high risk for aspiration; the airway should be rapidly secured with an endotracheal tube and not subjected to repeated or delayed assessment as might occur in the study.

**Blinding:** The interpreter reliability was double-blinded, that is, the anesthesiologist assessing glottic exposure and the investigator recording the observations were blinded to the preoperative sonographic airway assessment results.

**Methodology:** The enrolled patients underwent sonographic assessment of airway by the anesthesiologist in the pre-operative holding area. The ultrasound view of the airway of all study patients was assessed with a high-frequency linear probe or low frequency curved probe (SonoSite® MicroMaxx® ultrasound system (SonoSite INC, Bothell, WA). The following measurements were obtained with the patient in supine position and head and neck in a neutral position. The thicknesses of anterior neck soft tissue at the hyoid bone and the thyrohyoid membrane were obtained transversely across the anterior surface of the neck with a 13–6 MHz linear array ultrasound probe attached to a SonoSite S-nerve machine (SonoSite Inc., Bothell, WA, USA). At hyoid bone level, the minimal distance from the hyoid bone to the skin surface (DSHB) was measured and at thyrohyoid membrane level, the distance from skin to epiglottis midway (DSEM) between the hyoid bone and thyroid cartilage was measured.

**Statistical analysis:** Data were presented as frequency, percentages or mean ± SD, wherever applicable. Categorical variables between the groups were compared using Chi-square test. Quantitative variables between the groups were compared using student t-test. A P values less than 0.05 considered significant. Statistical analyses were performed using SPSS trial version 21.

**Results**

Table 1: General Characteristics

| | Cormack Lehane Grading (n=200) | | | | P Value |
|---|---|---|---|---|---|
| | Easy (n=142) | | Difficult (n=58) | | |
| | Grade 1 (n=54) | Grade 2 (n=88) | Grade 3 (n=49) | Grade 4 (n=9) | |
| Age (years) | 36.96 ±11.0 | 41.70 ± 13.5 | 45.51 ± 12.3 | 48.89±10.08 | $P^{1234}$=0.002<br>$P^{13}$= 0.004<br>$P^{14}$=0.042 |
| Height | 64.35±2.30 | 63.95 ± 2.05 | 64.51 ± 2.10 | 64.78±2.5 | P=0.392 |

| | | | | | |
|---|---|---|---|---|---|
| Weight (Kg) | 54.63±8.36 | 54.94 ± 8.87 | 59.61 ± 8.233 | 61.44±10.9 | $P^{1234}$=0.003<br>$P^{13}$= 0.021<br>$P^{23}$=0.015 |
| BMI | 21.07±3.07 | 21.52±3.13 | 23.03±2.3 | 23.31±3.36 | $P^{1234}$=0.002<br>$P^{13}$= 0.005<br>$P^{23}$=0.024 |

Table 1 shows a comparison of general characteristics of the patients in different Cormack Lehane grades. The present study found that there was a significant difference (P=0.002) in mean age of the patients in grade 1 (36.96±11.0), grade 2 (41.70±13.5), grade 3 (45.51±12.3), and grade 4 (48.89±10.08).A statistically significant difference in the mean age of the patients was observed between grade 1 and grade 3 (P=0.004), and grade 1 and grade 4 (P=0.042).

Table 2: Comparison of Different variables in different grades

| | | | | | |
|---|---|---|---|---|---|
| DSHB (cm) | .837±.162 | .850±.171 | .976±.23 | 1.15±.18 | $P^{1234}$=0.000<br>$P^{14}$= 0.001<br>$P^{23}$=0.001<br>$P^{24}$=0.000 |
| DSEM (cm) | 1.42±.329 | 1.46±.358 | 1.89±.357 | 1.96±.211 | $P^{1234}$=0.000<br>$P^{14}$= 0.000<br>$P^{23}$=0.000<br>$P^{24}$=0.000<br>$P^{12}$=0.000 |
| DSAC (cm) | .89±.08 | .92±.118 | .960±.144 | 1.08±.122 | $P^{1234}$=0.000<br>$P^{13}$= 0.038<br>$P^{24}$=0.001<br>$P^{14}$=0.000<br>$P^{34}$=0.022 |

**DSHB**

A statistically significant difference (P=0.000) of DSHB in grade 1 (.837±.162), grade 2 (.850±.171), grade 3 (.976±.23), and grade 4 (1.15±.18) was observed (fig 1). There was also a significant difference in DSHB between grade 1 and 4 (P=0.001), grade 2 and 4 (P=0.000), and grade 2 and 3 (P=0.001).

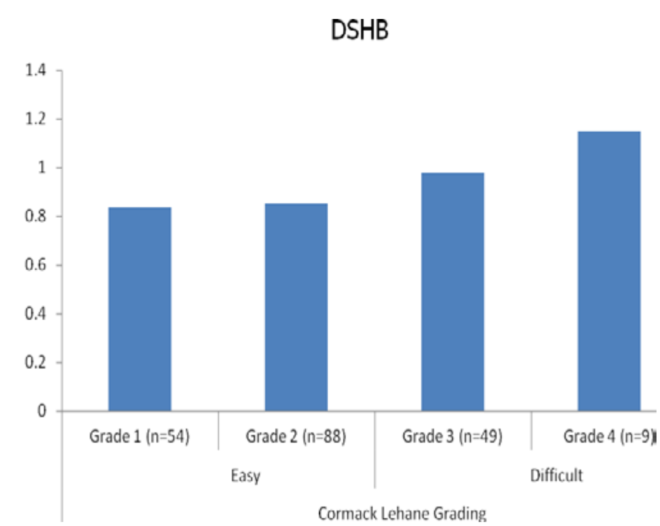


Fig. 1: DSHB

**DSEM**

DSEM was significantly different (P=0.000) in grade 1 (1.42±.329), grade 2 (1.46±.358), grade 3 (1.89±.357), and grade 4 (1.96±.211) (fig 2). There was also a significant difference between grade 1 and 4 (P=0.000), between grade 2 and 3 (P=0.000), between grade 2 and 4 (P=0.000) and between grade 1 and 2(P=0.000).

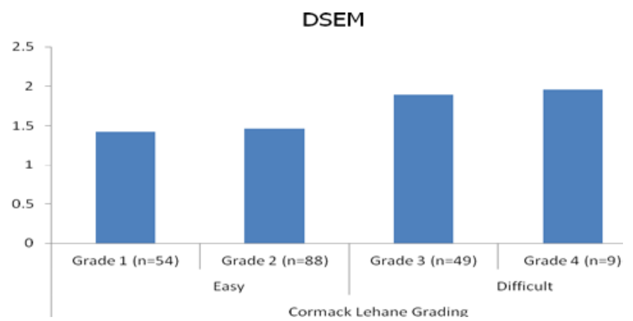


Fig. 2: DSEM

**DSAC**

There was a significant difference (P=0.000) of DSAC in grade 1 (0.89±0.08), grade 2 (0.92±0.118), grade 3 (0.960±0.144), and grade 4 (1.08±0.122) (fig 3). We also found a significant difference in DSAC between grade 1 and 4 (P=0.000), grade 2 and 4 (P=0.001), grade 3and 4 (P=0.022) and grade 1 and 3 (P=0.038).

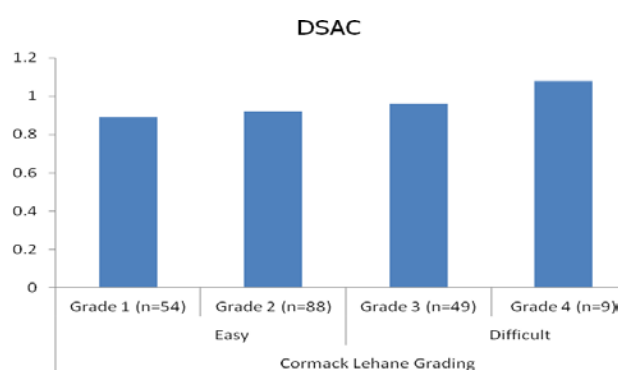


Fig. 3: DSAC

In the present study the thickness of anterior neck soft tissue at the level of the hyoid bone (DSHB) was (mean±SD:: .837±.162 and .850±.171) for CL grade 1 & 2 respectively and DSHB was .976±.23 and 1.15±.18 for CL grade 3 & 4 respectively ( P=0.000). The specificity and negative predictive value of DSHB in predicting easy intubation is 82.39% and 79.59% respectively. The sensitivity and positive predictive value of DSHB in predicting difficult intubation was 48.28% and 52.83% respectively (P=.000).

In the present study the thickness of anterior neck soft tissue at the level of epiglottis to skin midway (DSEM) (mean±SD::1.42±.329 and 1.46±.358) for CL grade 1 & 2 respectively and DSEM was 1.89±.357 and 1.96±.211 for CL grade 3 & 4 respectively ( P=0.000). The specificity and negative predictive value of DSEM in predicting easy intubation is 64.79% and 93.88% respectively. The sensitivity and positive predictive value of DSHB in predicting difficult intubation was 89.66% and 50.98% respectively (P=.000)

In the present study the thickness of soft tissue at anterior commissure level, the minimal distance from skin to anterior commissure (DSAC) was obtained. DSAC was (mean±SD:.89±.08 and .92±.118) for CL grade 1 & 2 respectively and DSAC was .960±.144 and 1.08±.122 for CL grade 3 & 4 respectively ( P=0.00). The specificity and negative predictive value of DSAC in predicting easy intubation is 61.97% and 79.28% respectively. The sensitivity and positive predictive value of DSAC in predicting difficult intubation was 60.34% and 39.33% respectively (P=.005).

**Discussion**

There are several traditional indices of predicting difficult laryngoscopy, but none of them are 100% sensitive and specific. Ultrasound is a new addition to the anesthesiologist's armamentarium, which has revolutionized care in several areas. The role of ultrasound in airway assessment is still primitive, with no established standard parameters to predict a difficult laryngoscopy. The present study was designed to establish a correlation between preoperative sonographically assessed parameters and the grade of difficulty at direct laryngoscopy. The parameters assessed by ultrasound, in our study, were the volume of the tongue, the volume of the floor of the mouth, the skin to hyoid distance, the anteroposterior thickness of the geniohyoid muscle, and the skin to epiglottis distance at the level of the thyrohyoid membrane.

The prevalence of difficult intubation in our study was 9.2%, which is comparable to previous studies. Adhikari *et al*.[5] used ultrasound to determine the utility of sonographic measurements of thickness of the tongue, anterior neck soft tissue at the level of hyoid bone, and the thyrohyoid membrane in distinguishing between easy and difficult laryngoscopy. They 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.

Ease of laryngoscopy also depends on the space available to displace the tongue. The size of the tongue, in relation to the oropharyngeal space, is an important determinant of ease of introduction of the laryngoscope blade. Among the traditional parameters, modified Mallampati classification is used to assess this variable but is of moderate sensitivity. Using ultrasound, we calculated the width and cross-sectional area of the tongue, to calculate the tongue volume, to assess the effect of tongue size on laryngoscopy. The volume of the tongue had a reasonable sensitivity and specificity in predicting difficult laryngoscopy, in our study, but was not as predictive as anterior neck soft tissue thickness. Wojtczak *et al*.,[6] in their study on five obese and seven morbidly obese patients, did not find the tongue volume to differ between easy and difficult laryngoscopy. The difference could be because the tongue volume should be taken in relation to the mandibular volume.

**Conclusion**

Thus, we can conclude that ultrasound can be used in combination with other bedside clinical tests, for better prediction of difficult laryngoscopy.

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