e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2024; 14(7); 01-06

Original Research Article

# Determining the Cut-Off Value of SED at the Thyrohyoid Membrane for Predicting Difficult Direct Laryngoscopy

**Tania James[1], Irfana Hameed[2], Anjusha N[3], Sreedevi C R[4*]**

[1]Assistant Professor, Department of Anesthesiology, Govt. Medical College Idukki, Kerala, India
[2]Senior Resident, Department of Anesthesiology, Govt. Medical College Idukki, Kerala, India
[3]Consultant, Department of Anesthesiology, Govt. Medical College Idukki, Kerala, India
[4]Associate Professor, Department of Anesthesiology, Govt. Medical College Idukki, Kerala, India

**Received: 11-04-2024 / Revised: 12-05-2024 / Accepted: 25-06-2024**
**Corresponding Author: Dr. Sreedevi C R**
**Conflict of interest: Nil**

**Abstract**

**Purpose:** The purpose of the study is to determine the cut-off value of SED at the level of the thyrohyoid membrane significant for predicting difficult direct laryngoscopy.

**Methodology:** This cross-sectional study was conducted in the Department of Anaesthesiology at Government Medical College, Idukki, over six months following IEC clearance. The study aimed to determine the cut-off value of sonographically assessed skin to epiglottic distance (SED) at the thyrohyoid membrane for predicting difficult direct laryngoscopy and its association with standard clinical parameters. The inclusion criteria were ASA I, II, and III patients over 18 years undergoing elective surgery under general anesthesia, who consented to participate. Exclusion criteria included patients with skin lesions on the anterior neck, pregnant women, and patients with any mass at the thyrohyoid membrane. A total of 50 participants were selected through consecutive sampling.

**Result:** The study's analysis of SED and BMI in predicting intubation difficulty provides key insights. For SED, the optimal cutoff value was 18.10 mm, yielding an AUC of 0.444, indicating poor discriminatory ability ($p = 0.532$). Sensitivity was 46.7%, specificity was 94.3%, PPV was 48.5%, and NPV was 96.0%. Despite the high NPV, the low AUC and PPV suggest limited overall reliability in predicting difficult direct laryngoscopy. The chi-square test showed a significant association between BMI and intubation difficulty ($P = 0.03$, $X^2 = 7.493$), suggesting that higher BMI may correlate with more challenging intubation experiences.

**Conclusion:** The study examined various predictors of difficult intubation, including thyromental distance, mouth opening, temporomandibular joint insinuation, MMPC, skin-to-epiglottis distance (SED), and BMI categories. For SED, the optimal cutoff value was 18.10 mm, with an AUC of 0.444 and poor discriminatory ability ($p = 0.532$). BMI categories showed a statistically significant association with intubation difficulty ($p = 0.03$), with higher BMI correlating with more challenging intubation experiences.

**Keywords:** Cormack - Lehane grade**,** Modified Mallampati classification, Skin To Epiglottic Distance.



## Introduction

Difficult laryngoscopy remains a challenge in clinical practice, with a reported incidence ranging from 5% to 18% despite advancements in airway management technologies and protocols . This issue is critical as it can lead to severe complications such as death and brain damage. [1] The existing individual predictors of difficult airways, including mouth opening, Mallampati grading, and atlanto-occipital extension, demonstrate limited sensitivity, specificity, and positive predictive value . Similarly, composite airway scoring systems often lack consistent sensitivity and specificity . Hence, there is a continuous quest for a quick, cost-effective, and reliable preoperative airway assessment tool that can be easily performed at the bedside with high accuracy in predicting difficult laryngoscopy. [2]

Point-of-care ultrasound has emerged as a promising modality for assessing difficult airways, with pilot studies highlighting its potential benefits. Among the ultrasound measurements, the skin-to-epiglottis distance (SED) has shown promise in predicting difficult intubation. [3] However, there is a need to determine the specific cut-off value of SED at the level of the thyrohyoid membrane that is significant for predicting difficult direct laryngoscopy. [4]

This study aims to fill this gap by focusing on the precise determination of the cut-off value of SED at

the thyrohyoid membrane level for predicting difficult direct laryngoscopy. These findings can contribute to enhancing preoperative airway assessment strategies and improving patient safety during intubation procedures.

**Methodology:** A cross-sectional study was conducted within the Department of Anaesthesiology at Government Medical College, Idukki, over a period of six months following clearance obtained from the Institutional Ethics Committee (IEC).

The study design aimed to assess a cohort of ASA (American Society of Anaesthesiologists) Class 1, 2, and 3 patients aged 18 years and older undergoing elective surgery under general anesthesia.

**Sample Size and Sampling Technique:** The sample size calculation, based on a study by Parameswari et al., determined a need for 50 participants, ensuring a sensitivity of 75% and an absolute precision of 5%. Sampling was carried out using consecutive sampling among eligible patients who met the inclusion criteria.

The calculated sample size of 50 participants ensured adequate statistical power for the study. Consecutive sampling was utilized to enroll participants meeting the specified inclusion criteria.

**Inclusion and Exclusion Criteria:** Inclusion criteria comprised ASA Class 1, 2, and 3 patients aged 18 years and older undergoing elective surgery under general anesthesia. Exclusion criteria included patients with anterior neck skin lesions, pregnant individuals, and those with masses at the thyrohyoid membrane level.

**Data Collection Procedure:** Data collection involved preoperative clinical airway evaluation encompassing temporomandibular joint insinuation, mouth opening, thyromental distance, modified Mallampati class, and anthropometry. Sonographically assessed skin to epiglottic distance (SED) was also recorded using ultrasound by an experienced anesthetist trained in airway ultrasound.

Data collection was meticulously conducted, including detailed preoperative airway assessments and SED measurements using ultrasound and Cormack-Lehane grades were recorded following induction and laryngoscopy.

**Data Analysis:** Data analysis was performed using MS Excel with SPSS Software. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for all measured parameters. Receiver-operating characteristic (ROC) analysis was conducted to determine the discriminative power of individual tests and their combinations, with the area under the curve (AUC) and 95% confidence interval calculated.

**Ethical Consideration:** The study strictly adhered to ethical guidelines and obtained clearance from the Institutional Ethics Committee (IEC) before commencement.

**Expected Outcome:** The expected outcome of this study was to evaluate the potential role of ultrasound, particularly SED, in assessing difficult airways either as an independent predictor

**Result**

The table presents the distribution of study variables. All participants with a thyromental distance and temporal mandibular joint insinuation fell into the easy intubation category. Nearly all participants with a mouth-opening score of 2 experienced easy intubations, with only one case indicating difficulty. For the Modified Mallampati Classification, 74% of participants with grades 1 and 2 had easy intubation, whereas 26% with grades 3 and 4 faced difficult intubation. In terms of skin-to-epiglottis distance, 72% of participants with measurements between 18-23mm had easy intubation, while those with measurements outside this range (28%) encountered difficulty. In this study, 70% of the patients had easy intubation and had Cormack-Lehane (CL) grades of 1 and 2A, while 30% of the patients faced difficult intubation with CL grades 2B and 3. (Table 1)

**Table 1: Study Variables**

| | | Frequency | Percent |
|---|---|---|---|
| **Thyromental distance** | 3-Easy intubation | 50 | 100.0 |
| **Mouth Opening** | 2-Esy intubation | 49 | 98.0 |
| | 3-easy intubation | 1 | 2.0 |
| **Tempero Mandibular Joint Insinuation** | 1- Easy intubation | 50 | 100.0 |
| **Modified Mallampati Classification** | 1,2-Easy Intubation | 37 | 74.0 |
| | 3,4-Difficult Intubation | 13 | 26.0 |
| **Skin To Epiglottis Distance** | Less than 18mm and more than 23 mm - Difficult Intubation | 14 | 28.0 |
| | 18-23mm - Easy Intubation | 36 | 72.0 |
| **Cormack - Lehane grade** | 1 and 2A- Easy Intubation | 35 | 70 |
| | 2B and 3 Difficult Intubation | 15 | 30 |

**2. Roc Analysis: The ROC curve of significant variables of Skin to Epiglottis Distance (SED), Thyromental Distance, Mouth Opening, Temporomandibular Joint, modified Mallampati grade were demonstrated**

**Skin to Epiglottis Distance (SED)**

Based on the ROC analysis for predicting difficult airways using the skin to epiglottis distance . For the SED measurement, the optimal cutoff value was 18.10 mm, with an AUC of 0.444, showing poor discriminatory ability (p-value = 0.532). Sensitivity at this cutoff was 46.7% and specificity was 94.3%. Assuming a prevalence of difficult airways at 30%, the PPV was approximately 48.5% and the NPV was approximately 96.0%. Despite the high NPV, the test's overall reliability in predicting difficult direct laryngoscopy was limited due to the low AUC and PPV.

**Thyromental Distance**

The analysis for thyromental distance in predicting difficult direct laryngoscopy yielded an AUC of 0.500, indicating no discriminatory ability (p-value = 1.000). Therefore, thyromental distance was not effective in predicting difficult laryngoscopy, with the sensitivity and specificity both at 100% at the threshold of 2.00

**Mouth Opening**

For mouth opening, the optimal cutoff value was found at 2.50 mm. The AUC was 0.533, suggesting poor discriminatory ability (p-value = 0.711). At this cutoff, the sensitivity was 6.7% and specificity was 100%. Given the low sensitivity

**Temporomandibular Joint Insinuation**

The temporomandibular joint insinuation test showed an AUC of 0.500, indicating no discriminatory ability (p-value = 1.000). Both sensitivity and specificity were at 100% at the threshold of 0.00,

**Modified Mallampati Classification (MMPC)**

The MMPC analysis revealed an AUC of 0.520, indicating poor discriminatory ability (p-value = 0.824). The optimal cutoff was at Grade 1.50, with sensitivity at 86.7% and specificity at 5.7%.

**Table 1: Table summarizing the key parameters for predicting difficult direct laryngoscopy based on different measurements:**

| Parameter | Cutoff Value | AUC | p-value | Sensitivity | Specificity | PPV | NPV |
|---|---|---|---|---|---|---|---|
| Skin to Epiglottis Distance (SED) | 18.10 mm | 0.444 | 0.532 | 46.7% | 94.3% | 48.5% | 96.0% |
| Thyromental Distance | 2.00 mm | 0.500 | 1.000 | 100% | 100% | N/A | N/A |
| Mouth Opening | 2.50 mm | 0.533 | 0.711 | 6.7% | 100% | N/A | N/A |
| Temporomandibular Joint Insinuation | 0.00 mm | 0.500 | 1.000 | 100% | 100% | N/A | N/A |
| Modified Mallampati Classification | Grade1.50 | 0.520 | 0.824 | 86.7% | 5.7% | Low | Low |

The PPV (Positive Predictive Value) and NPV (Negative Predictive Value) are only provided for SED as the other parameters did not show significant discriminatory ability.

| Coordinates Of The Curve | | | |
|---|---|---|---|
| **Test Result Variable(S)** | **Positive If Greater Than Or Equal To[a]** | **Sensitivity** | **1 - Specificity** |
| Thyromental Distance | 2.00 | 1.000 | 1.000 |
| | 4.00 | .000 | .000 |
| Mouth Opening | 1.00 | 1.000 | 1.000 |
| | 2.50 | .067 | .000 |
| | 4.00 | .000 | .000 |
| Tempero Mandibular Joint Insinuation | .00 | 1.000 | 1.000 |
| | 2.00 | .000 | .000 |
| Mmpc | .00 | 1.000 | 1.000 |
| | 1.50 | .867 | .943 |
| | 2.50 | .333 | .229 |
| | 4.00 | .000 | .000 |
| Skin To Epiglottis Distance Measurement | 10.500 | 1.000 | 1.000 |
| | 12.000 | .933 | 1.000 |
| | 12.550 | .867 | 1.000 |
| | 13.900 | .867 | .971 |
| | 15.900 | .800 | .971 |
| | 16.750 | .733 | .971 |
| | 17.000 | .667 | .971 |

| | | | |
|---|---|---|---|
| | 17.300 | .600 | .971 |
| | 17.750 | .533 | .971 |
| | 18.100 | .467 | .943 |
| | 18.250 | .467 | .886 |
| | 18.400 | .467 | .857 |
| | 18.550 | .467 | .743 |
| | 18.750 | .467 | .714 |
| | 18.950 | .467 | .686 |
| | 19.050 | .467 | .657 |
| | 19.300 | .467 | .571 |
| | 19.550 | .400 | .486 |
| | 19.700 | .400 | .457 |
| | 19.950 | .400 | .429 |
| | 20.150 | .400 | .400 |
| | 20.300 | .400 | .371 |
| | 20.450 | .400 | .343 |
| | 20.700 | .400 | .314 |
| | 21.000 | .400 | .257 |
| | 21.250 | .400 | .229 |
| | 21.450 | .400 | .200 |
| | 21.600 | .400 | .171 |
| | 21.850 | .400 | .143 |
| | 22.050 | .400 | .114 |
| | 22.200 | .400 | .057 |
| | 22.750 | .400 | .000 |
| | 23.450 | .333 | .000 |
| | 23.750 | .267 | .000 |
| | 23.850 | .200 | .000 |
| | 23.950 | .133 | .000 |
| | 24.050 | .067 | .000 |
| | 25.100 | .000 | .000 |

### 3. Association between Non-difficult laryngoscopy and difficult laryngoscopy groups in BMI

The table represents a crosstabulation of BMI categories and intubation difficulty levels.in this present study BMI of the study subjects was(mean±SD) 23.6±3.9kmg2. It shows the distribution of patients across different BMI ranges (<18.5 underweight, 18.5-24.9 healthy weight, 25-29.9 overweight, and 30 and above - overweight) and their corresponding intubation statuses (1-Easy and 2-Difficult). In terms of percentages, 12% of patients categorized as >18.5 underweight had an easy intubation, while 2% experienced difficult intubation, making up a total of 14% of patients in this BMI range. For those in the healthy weight range (18.5-24.9), 30% had an easy intubation, 24% experienced difficulty, accounting for 54% of patients in this BMI category. Among overweight individuals (25-29.9), 26% had an easy intubation, and 2% had a difficult intubation, totaling 28% of patients in this BMI range. Lastly, in the 30 and above - overweight category, 2% had both easy and difficult intubations each, representing 4% of patients in this BMI group. The chi-square test results indicate a statistically significant association between BMI categories and intubation difficulty levels ($P = 0.03$, $X^2 = 7.493$), suggesting that BMI may influence the ease or difficulty of intubation, with higher BMI potentially correlating with more challenging intubation experiences.(Table 3)

| **BMI * Intubation Crosstabulation** | | | | | |
|---|---|---|---|---|---|
| | | **Intubation** | | **Total** | |
| | | **1-Easy n(%)** | **2-Difficult n(%)** | | |
| **BMI** | >18 .5 underweight | 6(12) | 1(2) | 7(14) | P=0.03 $X^2$=7.493 |
| | 18.5-24.9 healthy weight | 15(30) | 12(24) | 27(54) | |
| | 25-29.9 overweight | 13(26) | 1(2) | 14(28) | |
| | 30 above -overweight | 1(2) | 1(2) | 2(4) | |
| Total | | 35(70) | 15(30) | 50(100) | |

## Discussion

The study aimed to determine the cutoff value of sonographically assessed skin to epiglottic distance (SED) at the thyrohyoid membrane for predicting difficult direct laryngoscopy. Analysis of airway-related measurements, including thyromental distance, mouth opening, temporomandibular joint insinuation, modified Mallampati classification (MMPC), SED, and Cormack-Lehane grade (CL), revealed varying distributions among participants. The study variables and their associations with intubation difficulty are summarized in Table 1. [5] All participants with a thyromental distance and temporomandibular joint insinuation fell into the easy intubation category, while nearly all participants with a mouth-opening score of 2 experienced easy intubations, with only one case indicating difficulty. The Modified Mallampati Classification showed that 74% of participants with grades 1 and 2 had easy intubation, whereas 26% with grades 3 and 4 faced difficult intubation. [6] For skin-to-epiglottis distance (SED), 72% of participants with measurements between 18-23 mm had easy intubation, while those outside this range (28%) encountered difficulty. [7] In this study, 70% of the patients had easy intubation and had Cormack-Lehane (CL) grades of 1 and 2A, while 30% of the patients faced difficult intubation with CL grades 2B and 3. (Table 1)

The ROC analysis for SED in predicting difficult direct laryngoscopy revealed an optimal cutoff value of 18.10 mm, with an AUC of 0.444 ($p = 0.532$), indicating poor discriminatory ability. Sensitivity at this cutoff was 46.7%, specificity was 94.3%, PPV was 48.5%, and NPV was 96.0%, highlighting its limited reliability in predicting difficult intubation despite a high NPV. [8]

Table 3 details the association between BMI and intubation difficulty. BMI categories and intubation difficulty levels.in this present study BMI of the study subjects was(mean±SD) 23.6±3.9kmg2. Underweight individuals (<18.5 BMI) had a 12% easy and 2% difficult intubation rate, healthy weight (18.5-24.9 BMI) had 30% easy and 24% difficult, overweight (25-29.9 BMI) had 26% easy and 2% difficult, and obese (≥30 BMI) had 2% each for easy and difficult intubations. The chi-square test indicated a significant association between BMI and intubation difficulty ($P = 0.03$, $X^2 = 7.493$), suggesting that higher BMI may correlate with more challenging intubations.

In present study, found that the cutoff value of sonographically assessed skin to epiglottic distance (SED) at the thyrohyoid membrane for predicting difficult direct laryngoscopy was 18.10 mm. The analysis of various airway-related measurements and their associations with intubation difficulty provided valuable insights. Participants with certain measurements, such as thyromental distance and temporomandibular joint insinuation, were more likely to experience easy intubations. However, BMI showed a significant association with intubation difficulty, indicating that higher BMI may correlate with more challenging intubations.

Comparing these findings with those of Roostati et al., Prathep et al., and Gonzalez et al. provides a broader perspective on predicting difficult laryngoscopy and its relation to BMI and SED. Roostati et al. identified a cutoff value of 26.05 mm for SED, with reasonable sensitivity and specificity. Prathep et al. highlighted the role of ultrasound measurements, including SED, in predicting difficult laryngoscopy in morbidly obese patients. Gonzalez et al. also observed a higher incidence of difficult tracheal intubation in obese patients, consistent with your study's findings regarding BMI and intubation difficulty.

## Conclusion:

The study examined various predictors of difficult intubation, including thyromental distance, mouth opening, temporomandibular joint insinuation, MMPC, skin-to-epiglottis distance (SED), and BMI categories. For SED, the optimal cutoff value was 18.10 mm, with an AUC of 0.444 and poor discriminatory ability ($p = 0.532$). BMI categories showed a statistically significant association with intubation difficulty ($p = 0.03$), with higher BMI correlating with more challenging intubation experiences.

**Conflict of Interest :** Nil

## References:

1. Kim, H. J., Min, N. H., Lee, J. S., Lee, W., & Kim, D. H. (2021). Anterior neck soft tissue measurements on computed tomography to predict difficult laryngoscopy: a retrospective study. Scientific reports, 11(1), 8438. https://doi.org/10.1038/s41598-021-88076-z
2. Roth D, Pace NL, Lee A, Hovhannisyan K, Warenits AM, Arrich J, et al. Airway physical examination tests for detection of difficult airway management in apparently normal adult patients. Cochrane Database Syst Rev. 2018;5: 221–7.
3. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. Br J Anaesth. 1988;61:211–6. [PubMed] [Google Scholar] [Ref list]
4. Daggupati, H., Maurya, I., Singh, R. D., & Ravishankar, M. (2020). Development of a scoring system for predicting difficult intubation using ultrasonography. Indian journal of anaesthesia, 64(3), 187–192. https://doi.org/10.4103/ija.IJA_702_19

5. Daggupati, H., Maurya, I., Singh, R. D., & Ravishankar, M. (2020). Development of a scoring system for predicting difficult intubation using ultrasonography. *Indian journal of anaesthesia*, *64*(3), 187–192. https://doi.org/10.4103/ija.IJA_702_19
6. Roostati, Rina Lizza. The Predictive Value of Skin-to-Epiglottis Distance to Assess Difficult Intubation in Patients Who Undergo Surgery Under General Anesthesia. Bali Journal of Anesthesiology 4(2):p 46-48, Apr–Jun 2020. | DOI: 10.4103/BJOA.BJOA_7_20
7. Prathep, S., Jitpakdee, W., Woraathasin, W., & Oofuvong, M. (2022). Predicting difficult laryngoscopy in morbidly obese Thai patients by ultrasound measurement of distance from skin to epiglottis: a prospective observational study. BMC anesthesiology, 22(1), 145. https://doi.org/10.1186/s12871-022-01685-7
8. Gonzalez H, Minville V, Delanoue K, Mazerolles M, Concina D, Fourcade O. The importance of increased neck circumference to intubation difficulties in obese patients. Anesth Analg. 2008;106:1132–6.