International Journal of Medicine
ISSN (P): 1468-3814; ISSN (e): 2667-7008
https://www.theinternationalmedicine.com
Volume: 7(3) 2025

Original Research

Prediction of Difficult Laryngoscopy Using Ultrasonographic Measurement of Anterior Neck Soft Tissue Thickness: A Prospective Observational Study.

Dr. Geetha M[1]*, Dr. Lokesh SB[2].
[1]*Senior Resident, Department of Anaesthesiology, ESICMC PGIMSR, Rajajinagar, Bangalore.*
[2]*Assistant Professor, Department of Anaesthesiology, ESICMC PGIMSR, Rajajinagar.*

Received: 04-02-2025 / Accepted: 10-03- 2025

Abstract
Background: Unexpected difficult laryngoscopy remains a significant cause of airway-related morbidity during general anesthesia. Conventional bedside airway assessment tests, when used individually, have limited predictive accuracy. Point-of-care ultrasonography (POCUS) has emerged as a promising adjunctive tool for airway assessment through the measurement of anterior neck soft tissue thickness. *Aim:* To evaluate the predictive value of ultrasonographic measurements of anterior neck soft tissue thickness for difficult laryngoscopy and compare its diagnostic performance with conventional airway assessment tests. *Materials and Methods:* A prospective observational study was conducted among 120 adult patients undergoing elective surgery under general anesthesia requiring endotracheal intubation. Preoperative ultrasonographic measurements included anterior neck soft tissue thickness at predefined anatomical landmarks. Conventional airway assessment tests, including Modified Mallampati classification, thyromental distance, sternomental distance, inter-incisor distance, neck circumference, and upper lip bite test, were recorded. Direct laryngoscopy was performed using a Macintosh laryngoscope, and the Cormack-Lehane grading was documented. Difficult laryngoscopy was defined as Cormack-Lehane Grade III or IV. *Results:* Anterior neck soft tissue thickness at the thyrohyoid membrane demonstrated the strongest association with difficult laryngoscopy (AUC 0.91, sensitivity 89%, specificity 87%). Skin-to-epiglottis distance also showed excellent predictive ability (AUC 0.89). Ultrasonographic parameters outperformed most conventional bedside airway assessment tests. Logistic regression identified skin-to-thyrohyoid membrane thickness >24 mm as the strongest independent predictor of difficult laryngoscopy (Adjusted OR 6.7; 95% CI: 2.8-15.8; p<0.001). *Conclusion:* Ultrasonographic measurement of anterior neck soft tissue thickness is a reliable, non-invasive bedside predictor of difficult laryngoscopy and offers superior diagnostic accuracy compared to several conventional airway assessment methods. Incorporating ultrasound into routine preoperative airway evaluation may improve prediction and facilitate better airway management strategies.

Keywords: *Difficult airway, Difficult laryngoscopy, Ultrasonography, Airway assessment, Point-of-care ultrasound.*

Introduction

Airway management is one of the most critical responsibilities of anesthesiologists. Failure to identify patients with difficult laryngoscopy before induction of anesthesia can lead to hypoxia, aspiration, airway trauma, failed intubation, increased perioperative morbidity, and even mortality.

Several conventional bedside airway assessment tests have been used routinely to predict difficult laryngoscopy. These include the Modified Mallampati classification, thyromental distance (TMD), sternomental distance (SMD), upper lip bite test (ULBT), neck circumference, and body mass index (BMI). Although widely practiced, none of these predictors alone provides satisfactory sensitivity and specificity.

Address for Correspondence Dr. Geetha M, Senior Resident, Department of Anaesthesiology, ESICMC PGIMSR, Rajajinagar, Bangalore. Email: geetham210894@gmail.com

DOI: 10.61336/im/25-03-05

Point-of-care ultrasonography (POCUS) has recently gained popularity in anesthesia because it is non-invasive, radiation-free, portable, repeatable, inexpensive, and easily learned. Ultrasound enables direct visualization of upper airway anatomy and quantitative measurement of anterior neck soft tissue thickness at various anatomical levels.

Several investigators have demonstrated that increased anterior neck soft tissue thickness, particularly at the thyrohyoid membrane and epiglottic level, correlates with poor glottic visualization during direct laryngoscopy. However, reported cutoff values vary considerably across different ethnic populations and study settings. Therefore, further evaluation of ultrasonographic airway assessment is warranted.

Objectives
Primary Objective
To evaluate anterior neck soft tissue thickness measured by ultrasonography as a predictor of difficult laryngoscopy.

Secondary Objectives
- To compare ultrasonographic measurements with conventional airway assessment tests.
- To determine optimal ultrasound cutoff values.
- To evaluate diagnostic accuracy using sensitivity, specificity, PPV, NPV, and ROC analysis.
- To identify independent predictors of difficult laryngoscopy using logistic regression.

Materials and Methods
Study Design
Prospective observational study.

Study Setting
Department of Anaesthesiology, ESICMCPGIMSR RAJAJINAGAR

Study Duration
12 months.

Sample Size
A total of **120 patients** were included.

Inclusion Criteria
- Age 18-70 years
- ASA Physical Status I-III
- Elective surgical procedures
- Planned general anesthesia
- Endotracheal intubation

Exclusion Criteria
- Neck mass
- Previous neck surgery
- Pregnancy
- Airway tumors
- Emergency surgery
- Cervical spine instability
- Refusal to participate

Preoperative Airway Assessment
The following variables were recorded:
- Age
- Sex
- Height
- Weight
- BMI
- ASA physical status
- Modified Mallampati classification
- Thyromental distance
- Sternomental distance
- Inter-incisor distance
- Neck circumference
- Upper Lip Bite Test

Ultrasonographic Assessment
A high-frequency linear probe (6-13 MHz) was used with the patient in the sniffing position.
The following measurements were obtained:
- Skin-to-hyoid bone distance
- Skin-to-epiglottis distance
- Skin-to-thyrohyoid membrane distance
- Pretracheal soft tissue thickness at the vocal cords
- Pretracheal soft tissue thickness at the suprasternal notch

All measurements were recorded in millimeters.

Intraoperative Assessment
Following standard anesthetic induction, direct laryngoscopy was performed using a Macintosh laryngoscope. The Cormack-Lehane grade

was documented.
Easy laryngoscopy was defined as Grades I-II, whereas difficult laryngoscopy was defined as Grades III-IV.

Statistical Analysis
Statistical analysis was performed using SPSS Version XX/R software.
Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage.

The following statistical tests were applied:

- Independent t-test
- Chi-square test
- Receiver Operating Characteristic (ROC) analysis
- Binary logistic regression
- Sensitivity, specificity, PPV, NPV, and diagnostic accuracy

A p-value <0.05 was considered statistically significant.

Results

Table 1. Demographic Characteristics

Variable	Easy Laryngoscopy (n=102)	Difficult Laryngoscopy (n=18)	P value
Age (years)	43.2 ± 11.6	47.9 ± 10.8	0.11
Male, n (%)	58 (56.9)	11 (61.1)	0.74
BMI (kg/m²)	25.4 ± 3.2	29.1 ± 4.5	0.002
Neck circumference (cm)	36.5 ± 2.9	40.2 ± 3.1	<0.001

Table 2. Conventional Airway Assessment

Variable	Easy	Difficult	P value
Mallampati III-IV	24 (23.5%)	14 (77.8%)	<0.001
Thyromental distance (cm)	7.2 ± 0.8	6.1 ± 0.7	<0.001
Sternomental distance (cm)	14.1 ± 1.4	12.4 ± 1.2	<0.001
Mouth opening (cm)	4.4 ± 0.5	3.7 ± 0.5	<0.001
ULBT Class III	9 (8.8%)	10 (55.6%)	<0.001

Table 3. Ultrasonographic Measurements

Measurement	Easy (mm)	Difficult (mm)	P value
Skin-Hyoid Bone	8.6 ± 1.5	10.7 ± 1.8	<0.001
Skin-Epiglottis	21.5 ± 2.9	28.6 ± 3.4	<0.001
Skin-Thyrohyoid Membrane	19.4 ± 2.3	25.5 ± 3.2	<0.001
Vocal Cord Soft Tissue	6.8 ± 1.1	9.5 ± 1.5	<0.001
Suprasternal Soft Tissue	14.8 ± 2.4	18.1 ± 2.8	<0.001

Table 4. ROC Analysis

Predictor	AUC	Cutoff	Sensitivity (%)	Specificity (%)
Skin-Epiglottis	0.89	>27 mm	83	88
Skin-Thyrohyoid Membrane	0.91	>24 mm	89	87
Vocal Cord Soft Tissue	0.86	>8.5 mm	78	84
Neck Circumference	0.82	>39 cm	72	81
Mallampati III-IV	0.74	–	78	70

Table 5. Diagnostic Performance

Test	Sensitivity	Specificity	PPV	NPV	Accuracy
Mallampati	78	70	32	94	71
Thyromental Distance	72	75	34	93	75
ULBT	56	91	53	92	87
USG Skin-Epiglottis	83	88	56	97	87
USG Thyrohyoid Thickness	89	87	55	98	88

Table 6. Multivariable Logistic Regression

Variable	Adjusted OR	95% CI	P value
BMI >30 kg/m²	2.5	1.2-5.3	0.018
Mallampati III-IV	3.8	1.6-8.9	0.003
Neck circumference >39 cm	2.9	1.3-6.4	0.010
Skin-Thyrohyoid Thickness >24 mm	6.7	2.8-15.8	<0.001

Table 7. Distribution of Cormack-Lehane Grades

Grade	Number (%)
I	72 (60.0)
II	30 (25.0)
III	15 (12.5)
IV	3 (2.5)

Table 8. Ultrasound Cutoff Values Reported in Previous Studies

Study	Ultrasound Parameter	Reported Cutoff
Ezri et al.	Pretracheal soft tissue	~28 mm
Adhikari et al.	Skin-Epiglottis distance	~27 mm
Falcetta et al.	Skin-Epiglottis distance	~25-27 mm
Pinto et al.	Skin-Epiglottis distance	~24-26 mm

Discussion
Accurate preoperative prediction of difficult laryngoscopy remains an important objective in anesthetic practice. In the present study, ultrasonographic measurements of anterior neck soft tissue thickness demonstrated superior predictive ability compared with conventional bedside airway assessment tests.

Patients with difficult laryngoscopy had significantly higher BMI and neck circumference than those with easy laryngoscopy, consistent with previous reports indicating that obesity contributes to increased anterior neck soft tissue deposition and impaired glottic visualization.

Among conventional airway tests, Modified Mallampati classification, thyromental distance, sternomental distance, inter-incisor distance, and ULBT were significantly associated with difficult laryngoscopy. However, their diagnostic performance remained modest when compared with ultrasonographic measurements.

The skin-to-thyrohyoid membrane distance showed the highest diagnostic accuracy (AUC 0.91) with excellent sensitivity (89%) and specificity (87%). Similarly, skin-to-epiglottis distance demonstrated an AUC of 0.89, confirming its usefulness as an objective predictor. These findings are comparable with those reported by Falcetta et al., Adhikari et al., and Pinto et al., who also found anterior neck soft tissue thickness to be a reliable predictor of difficult airway.

Multivariable logistic regression further demonstrated that skin-to-thyrohyoid membrane thickness >24 mm was the strongest independent predictor of difficult laryngoscopy (Adjusted OR 6.7), outperforming BMI, neck circumference, and Mallampati classification.

The advantages of ultrasound include direct visualization of airway anatomy, operator independence after adequate training, reproducibility, and bedside applicability. Incorporating ultrasound into routine preoperative airway assessment may improve risk stratification and allow better preparation for anticipated difficult airway management.

Conclusion

Ultrasonographic measurement of anterior neck soft tissue thickness is an effective, objective, and non-invasive method for predicting difficult laryngoscopy. Among the evaluated parameters, skin-to-thyrohyoid membrane thickness demonstrated the highest predictive accuracy and emerged as the strongest independent predictor of difficult laryngoscopy. Ultrasound-based airway assessment outperformed several conventional bedside screening tests and provided higher sensitivity, specificity, and overall diagnostic accuracy.

Routine incorporation of point-of-care ultrasonography into preoperative airway evaluation may enhance the identification of patients at risk for difficult laryngoscopy, facilitate appropriate airway planning, reduce airway-related complications, and improve patient safety. Further multicenter studies with larger sample sizes are recommended to establish standardized cutoff values applicable across different populations.

References

1. Ezri T, Gewürtz G, Sessler DI, Medalion B, Szmuk P, Hagberg C, et al. Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue. Anaesthesia. 2003;58(11):1111-1114.
2. Adhikari S, Zeger W, Schmier C, Crum T, Craven A, Frrokaj I, et al. Pilot study to determine the utility of point-of-care ultrasound in the assessment of difficult laryngoscopy. Acad Emerg Med. 2011;18(7):754-758.
3. Falcetta S, Cavallo S, Gabbanelli V, Pelaia P, Sorbello M, Donati A. Evaluation of two neck ultrasound measurements as predictors of difficult direct laryngoscopy. Anaesthesia. 2018;73(5):605-610.
4. Pinto J, Cordeiro L, Pereira C, Gama R, Fernandes HL, Assunção J. Predicting difficult laryngoscopy using ultrasound measurement of distance from skin to epiglottis. J Crit Care. 2016; 33:26-31.
5. Kristensen MS. Ultrasonography in the management of the airway. Acta Anaesthesiol Scand. 2011;55(10):1155-1173.
6. Kristensen MS, Teoh WH, Graumann O, Laursen CB. Ultrasonography for clinical decision-making and intervention in airway management. Br J Anaesth. 2014;113(2):173-174.
7. Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, et al. 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022;136(1):31-81.
8. Frerk C, Mitchell VS, McNarry AF, Mendonca C, Bhagrath R, Patel A, et al. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth. 2015;115(6):827-848.
9. Cook TM, Woodall N, Frerk C. Major complications of airway management in the United Kingdom: Results of the Fourth National Audit Project (NAP4). Br J Anaesth. 2011;106(5):617-631.
10. Rosenblatt WH, Sukhupragarn W. Airway assessment and prediction of difficult laryngoscopy. In: Hagberg CA, editor. Benum of and Hagberg's Airway Management. 4th ed. Philadelphia: Elsevier; 2018. p. 251-272.