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Original Research Article

A STUDY OF THE CORRELATION OF PREOPERATIVE ULTRASONOGRAPHIC AIRWAY ASSESSMENT AND CLINICAL ASSESSMENT IN THE PREDICTION OF THE DIFFICULT AIRWAY

Sekar. S[1], Velmurugan. B[2], Nisha V[3], Ramesh M. C[4]

[1]Associate Professor, Department of Anaesthesiology, Government Virudhunagar Medical College Hospital, Tamilnadu, India.
[2]Associate Professor, Department of Anaesthesiology, Government Sivagangai Medical College Hospital, Tamilnadu, India.
[3]Assistant Professor, Institute of Anaesthesia and Critical Care (IACC), Madras Medical College, Tamilnadu, India.
[4]Senior Assistant Professor, Department of Anaesthesiology, Government Sivagangai Medical College Hospital, Tamilnadu, India.

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Corresponding Author:
Dr. Ramesh M. C
Email: mcramesh.tkmc@gmail.com

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Abstract

Background: Ultrasonographic airway assessment could be a useful predictor of a difficult airway and thus correlate with various clinical and laryngoscopic views of the airway. **Aim:** The study aims to determine the correlation between ultrasonographic airway assessment and clinical and laryngoscopic airway assessment for difficult airways. **Materials and Methods:** This prospective randomized study was conducted at the department of anaesthesiology in tertiary care hospital on 150 adult patients undergoing elective surgery requiring general anaesthesia. Adult patients of both sexes between 18- 60 years undergoing elective surgeries requiring general anaesthesia were included. A preoperative evaluation of the patient was done before surgery. The modified Mallampati class was noted by asking the patient to protrude the tongue and not to phonate. **Result:** In the study, patients were aged between 18 and 60 years with 74% male and 35.5% female patients. The hyomental distance found that out of 123 patients with CL grade 1/2, 110 had HMD > 5.5 cm (89.4%). For the patients with CL grade 3/4, HMD was less than 5.5cm for 23 populations (85.2%). Of the population with difficult intubation, 20 (74%) had a neck circumference of more than 40cm. Fifteen patients had a history of OSA and 10 had a tongue width of more than 6.0 cm. The statistical analysis showed that all the ultrasonography parameters ANS-VC, PRE-E, E-VC, and PRE-E / E-VC were significantly correlated with the Cormack Lehane grading. **Conclusion:** Ultrasonographic measurement of the Anterior neck soft tissue -Vocal Cord is thus an excellent predictor of difficult intubation.

INTRODUCTION

The term "airway "refers to the upper airway, defined as the extra pulmonary air passage consisting of nasal and oral cavities. The pharynx includes the nasopharynx, oropharynx, hypopharynx, larynx, trachea, and large bronchi. A "difficult airway" is a problem in establishing or maintaining gas exchange through a mask or any artificial airway or it can be both.[1] A routine preoperative airway examination often involves an evaluation of mouth opening and dentition, Mallampati classification, thyromental distance measurement, and neck mobility evaluation. These approaches can be conducted quickly and simply at the bedside, but their sensitivity and specificity for accurately predicting the trouble with airway control are not the best. The inter-observer variability in these bedside physical airway assessment is significant. They may also be challenging to implement in emergency and critical care settings, where patients are frequently confused, uncooperative, and unable to follow directives.[2]

Difficult airway conditions can swiftly escalate into crises, raising the possibility of life-threatening complications or death. In a 2005 closed claims review, brain damage or death was mentioned in over half of perioperative care claims and all claims for events outside the operating room (OR). A difficult airway thus represents a complicated interplay of patient variables, clinical context, and provider abilities.[3] After direct laryngoscopic

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visualization by placing the intubating± blade in the patient's airway, we can tell the Cormack-Lehane grading. If it becomes 3/4, this is a dreaded feature unless we are prepared for the difficult airway. Hence preoperative prediction of these is a very useful tool for difficult airway assessment.[4]There is no commonly acknowledged conventional definition of a difficult airway; instead, it is a constellation of several features of airway care. Difficult mask or supraglottic airway (SGA) ventilation, problematic SGA installation, difficult or unsuccessful endotracheal intubation, and difficult laryngoscopy are the categories. The modified Mallampati score is more accurate than the original scale in predicting difficult intubation, with an area under the summary receiver operating characteristics curve (sROC) of 0.83 ±0.03 vs 0.58±0.12, respectively.[5]

Numerous medical, surgical, and congenital disorders are connected with a difficult airway in adults and children. Methods used in adults may not be appropriate for babies and children, and children's lack of cooperation makes getting meaningful information substantially more difficult. In the case of an unexpectedly difficult airway, anaesthesiologists must always be prepared with several preformulated and rehearsed procedures for airway management.[1] Recent research has employed anterior soft neck tissue thickness to predict difficult intubation and demonstrated a link between difficult laryngoscopy and several ultrasonic characteristics. The ultrasonic measured distance from skin to epiglottis at thyrohyoid membrane level (US-DSE), which lately produced strong predictive findings, was one of these metrics with notable variance in its value.[6] Because it is safe, rapid, reproducible, portable, and generally available, ultrasonography (US) is a promising method for airway examination. Several studies on this subject have lately been published. However, which sonographic characteristics and associated cut-off values are therapeutically effective predictors of difficult laryngoscopy and intubation remains unclear. The majority of clinical predictors, on the other hand, have poor sensitivity and intermediate specificity. Due to the low occurrence of difficult/failed intubation in the general population, positive predicted values (PPV) are modest. Even though various multivariate scoring methods improve PPV over single tests, prediction scores remain low and many failures remain unforeseen since all airway management procedures might fail.[7]

The concept of difficult intubation is also debatable. However, it is generally derived from laryngoscopy outcomes such as the Cormack-Lehane Grade (CLG) or the Intubation Difficulty Score (IDS). The IDS is based in part on the CLG. The CLG has become a standard for describing difficult laryngoscopy in anaesthetic research. The CLG is the most often utilized physical exam correlation for difficult laryngoscopy and, by extension, intubation.[5]

The current study assesses the correlation between ultrasonographic and clinical laryngoscopic airway assessments for patients with difficult airways. Also, to find out the size of the appropriate endotracheal tube size and the post-extubation complications. This study aims to evaluate the sensitivity of individual parameters in predicting the difficult airway.

MATERIALS AND METHODS

This prospective randomized study was conducted at the department of anaesthesiology, in tertiary care hospital. After obtaining approval from Institute's ethical committee and getting written informed consent, 150 adult patients undergoing elective surgery requiring General Anaesthesia were chosen.

Inclusion Criteria

Adult patients 18- 60years, undergoing elective surgeries, requiring general anaesthesia, both sexes were included.

Exclusion Criteria

Patients with faciomaxillary trauma, fractures in bones of the face, BMI >= 40 kg/m2, and patients with restricted neck movements were excluded.

A preoperative evaluation of the patient was done before surgery. The airway assessment was done in two stages. The modified Mallampati class was noted by asking the patient to protrude the tongue and not to phonate.

The thyromental distance was noted from the mentum to the thyroid notch with full neck extension. The sternomental distance was noted from the suprasternal notch to the mentum with the neck fully extended. The hyomental distance was noted from the hyoid bone to the mentum. Neck circumference was measured using an inch of tape at the midpoint level between the mandible angle and the shoulder, with the head in a neutral position. The ultrasonographic measurements were done using a high-frequency linear probe (6 to 15 MHz) and a low-frequency curvilinear probe (2 -6 MHz).

In the transverse view, the width of the tongue, the cross-sectional area of the floor of the mouth, the anterior neck soft tissue, the skin-to-epiglottis distance, and the related parameter were noted. The mentohyoid distance, the strap muscle, the thyrohyoid membrane, the cricothyroid membrane, thyroid cartilage, and surrounding structures are visualized in the sagittal view.

Clinical parameters such as Modified Mallampati grading, Mouth opening, Hyomental distance, Thyromental distance, and Neck circumference were recorded. Ultrasonographic parameters: Transverse views such as the width of the tongue, the cross-sectional area of the floor of the mouth, Anteroposterior thickness of the geniohyoid muscle, Skin hyoid distance, and Skin epiglottis distance were noted. Mid–sagittal views such as cross-sectional area of the tongue and Mento hyoid

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distance were noted, and Cormack – Lehane grading – I, II, III, IV were also recorded.

All the patients were induced and intubated by an anesthesiologist. According to the patient, direct laryngoscopy was performed using a Macintosh blade size three or size four or Mccoy blade, and Cormack Lehane (CL) grade was noted. The appropriately sized endotracheal tube was used and anaesthesia was maintained.

The MS Excel and SPSS software packages were used for data entry and analysis. The results were averaged (mean ± standard deviation [SD]) for each parameter for continuous data. The Chi-square test was used to determine whether there was a statistical difference between the patients with easy and difficult intubations. The predictive value of the tests was assessed by calculating the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). A Receiver operator characteristics (ROC) curve was plotted to assess the optimal cut-off scores and the area under the curve was calculated to assess the predictive accuracy.

RESULTS

The study includes one hundred and fifty adult patients undergoing elective surgery under general anaesthesia by endotracheal intubation. The study included a population aged between 18 and 60 years, with 74% male and 35.5% female patients. The study population's BMI- Body mass index ranged from 21.63 to 34.89 kg/m2. 40% of patients belonged to Cormack Lehane grade I. 41.3% belonged to Cormack Lehane grade II. 16% of the patients belonged to Cormack Lehane grade III and the remaining 2% of the population belonged to grade IV.

The distribution of Cormack Lehane grade was compared with the ultrasound parameters, i.e., ANS-HYOID (Anterior neck soft tissue – at the level of hyoid), ANS –VC (Anterior neck soft tissue – vocal cord), PRE-E (Pre-epiglottic space), E-VC (Epiglottis to vocal cord distance) PRE-E/E-VC. The four groups in Cormack Lehane grade were analyzed and compared with each parameter.

The Anterior neck soft tissue at the hyoid level was not significant, with a p-value of 0.46; hence, it suggests that it does not correlate with Cormack Lehane grading. The anterior neck soft tissue at the vocal cord level was calculated. The analysis with Cormack Lehane's grading suggests that it is statistically significant with a p-value less than 0.001. Hence it correlates with Cormack Lehane's grade. The distance from skin to epiglottis is Pre epiglottic space distance (p-value < 0.0001) and epiglottis to vocal cord distance (E-VC – p-value <0.0001). Pre-Epiglottis space and epiglottis to Vocal cord distance ratio are also statistically significant. Their ratio is also statistically significant. Hence these values are found to predict difficult intubation.

Table 1: Comparison of ultrasound parameters and Cormack – Lehane CL grade

PARAMETER	CL GRADE	N	MEAN	SD	P-value
ANS-HYOID	1	61	0.36	0.07	0.46
	2	62	0.36	0.07	
	3	24	0.39	0.07	
	4	3	0.38	0.07	
ANS-VC	1	61	0.26	0.08	0.0001
	2	62	0.25	0.08	
	3	24	0.41	0.08	
	4	3	0.39	0.08	
PRE-E	1	61	0.95	0.11	0.0001
	2	62	1.11	0.11	
	3	24	1.03	0.11	
	4	3	1.04	0.12	
E-VC	1	61	0.94	0.08	0.0001
	2	62	0.87	0.08	
	3	24	0.86	0.08	
	4	3	0.86	0.08	
PRE-E/E-VC	1	61	1.02	0.17	0.0001
	2	62	1.27	0.17	
	3	24	1.21	0.17	
	4	3	1.21	0.18	

The distribution of Cormack Lehane grading was compared to Mallampati grading, thyromental distance, and sternomental distance. The analysis was statistically significant, and thus it indicates that there is a correlation between these parameters and CL grading [Table 2].

Table 2: Distribution of Cormack- Lehane according to Mallampati grading, thyromental distance, and sternomental distance

		CLGRADE, NUMBER(%)				TOTAL	P-Value
		1	2	3	4		
MPCLASS	Class1	15(10)	19(12.7)	2(1.3)	0	36(24.1)	0.0001
	Class2	35(23.3)	35(23.3)	6(4)	0	76(50.6)	

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	Class3	11(7.3)	8(5.33)	15(10)	1(0.66)	35(23.3)	
	Class4	0	0	1(0.66)	2(1.3)	3(2)	
TMD in cm	<6cm	1(0.7)	0	0	1(0.7)	2(1.4)	0.0001
	6.0-6.5	4(2.6)	5(3.3)	6(4.0)	1(0.7)	16(10.6)	
	>6.5	56(37.3)	57(38.0)	18(12.0)	1(0.7)	132(88.0)	
PSMD	<12.5	0	0	4(2.6)	2(1.4)	6(4.0)	0.0001
	>12.5	59(39.4)	69(46)	15(10)	1(0.6)	144(96)	

The sensitivity was defined here as true positivity, indicating that the parameter indicates difficult intubation and the CL grade also indicates difficult intubation (CL 2/3). The specificity–true negative is that the parameter indicates easy intubation, and the CL grade also suggests easy intubation (CL 1/2) [Table 3].
The sensitivity and specificity Receiver operator characteristic curve was drawn for ANS VC, Thyromental distance, sternomental distance, and Mallampati grading.

Table 3: Comparison of ultrasonographic measurements in predicting the Cormack – Lehane (CL) grade

Parameter	Sensitivity	Specificity	PPV	NPV
ANS VC >0.23cm	100	25.2	22.7	100
PRE-E/E-VC 2-3	0	100	-	82.0
MP CLASS >3	70.3	84.5	50.0	92.8
TMD <6.5 CM	29.6	91.8	44.4	85.6
SMD ≤12.5CM	18.5	99.1	83.3	84.7

The hyomental distance found that out of 123 patients with CL grade 1/2, 110 had HMD > 5.5 cm (89.4%). For the patients with CL grade 3/4, HMD was less than 5.5cm for 23 populations (85.2%).
Of the population with difficult intubation, 20(74%) had a neck circumference of more than 40cm. The history of choking during sleeping was elicited. Fifteen patients had a history of OSA, and 10 had a tongue width of more than 6.0 cm.
Thus, the statistical analysis showed that all the ultrasonography parameters ANS-VC, PRE-E, E-VC, and PRE-E / E-VC were significantly correlated with the Cormack Lehane grading.

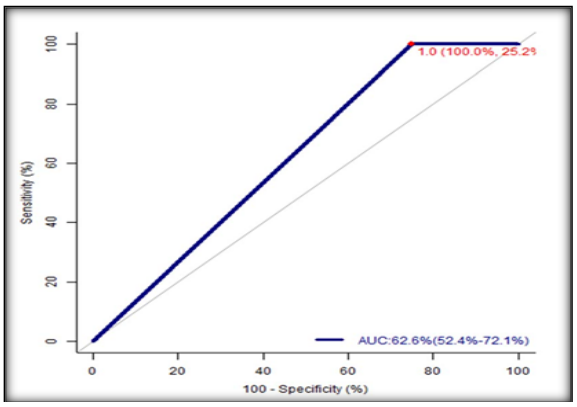

Figure 1: Receiver operator characteristic curve – for anterior neck soft tissue at the level of vocal cord

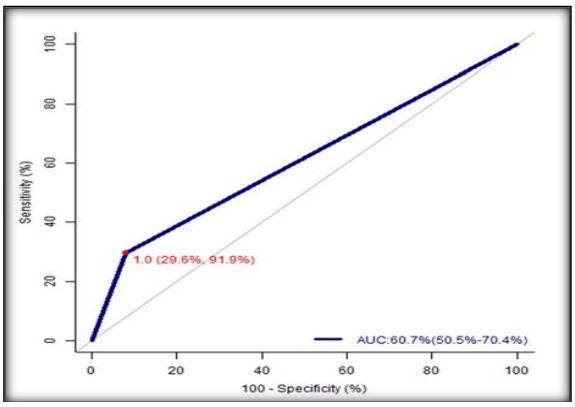

Figure 3: Receiver operator characteristic curve for thyromental distance

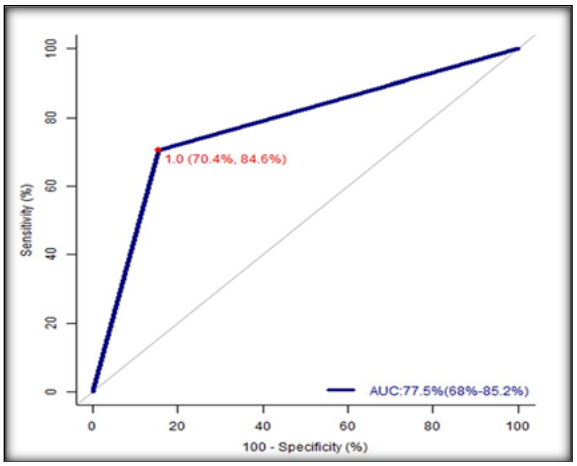

Figure 2: Receiver operator characteristic curve for Mallampati class

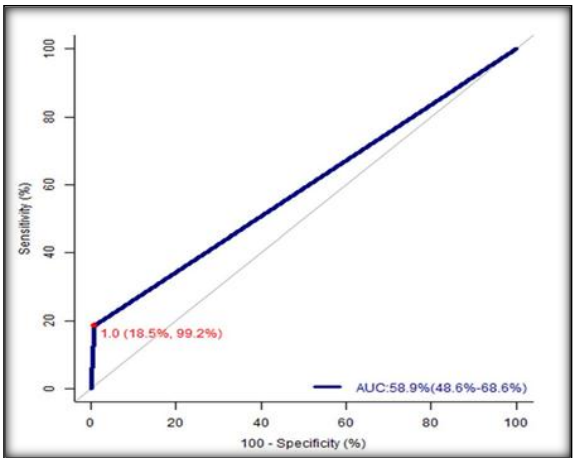

Figure 4: Receiver operator characteristic curve for sternomental distance

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DISCUSSION

Ultrasound has now become part of the anaesthesiologist's work to facilitate various procedures. Imaging the airway has now become the new application after regional nerve blocks. Other applications include predicting the size of the endotracheal tube in the pediatric age group, predicting the size of the double lumen tube, confirming the position of the endotracheal tube, diagnosing other upper airway tumors, and growth, any suggestion of obstruction, locating the cricothyroid membrane and thus acting as guidance for percutaneous dilatational tracheostomy and cricothyroidotomy for performing the nerve blocks for preparation for awake intubation.[8] Various classic predictors of difficult laryngoscopy exist, but none are completely sensitive and specific. Ultrasound is a recent addition to the anesthesiologist's toolbox that has changed care in various ways. Ultrasonography in airway evaluation is still in its early stages, with no standard criteria for predicting a difficult laryngoscopy.[9] The current investigation was carried out to examine the relationship between Ultrasonographic airway evaluation and clinical and laryngoscopic airway assessment in difficult airways. In addition, the optimal endotracheal tube size and post-extubation difficulties must be determined. This study aims to assess the sensitivity of specific indicators in predicting problematic airways.

In one research, the prevalence of difficult intubation was 9.2%, which is comparable to other studies.[9] Another research employed ultrasonography to assess the usefulness of sonographic measures of tongue thickness, anterior neck soft tissue at the level of the hyoid bone and the thyrohyoid membrane in differentiating between simple and difficult laryngoscopy.[10] Sonographic measures of anterior neck soft tissue thickness at the hyoid bone and thyrohyoid membrane level might be utilized to differentiate between simple and difficult laryngoscopy. The anterior neck soft tissue was measured using the skin-to-hyoid and skin-to-epiglottis distances at the level of the thyrohyoid membrane.[9] A different study discovered that the skin-to-hyoid and skin-to-epiglottis distances were reliable indicators of difficult laryngoscopy. In our investigation, the skin-to-hyoid distance exhibited lower sensitivity and specificity for predicting difficult laryngoscopy than the skin-to-epiglottis distance.[11]

In the study, the Anterior Neck Soft tissue – Vocal Cord is a potential guide for assessing the airway and increased thickness had 100% sensitivity in predicting the difficult intubation. The pre-epiglottic soft tissue thickness was also found to be statistically significant. Hence this also predicted difficult intubation. The epiglottis to vocal cord distance was also significant. The ratio of the distances was found to be statistically significant. In contrast, the pre-epiglottic space (Pre-E), the distance from the epiglottis to the midpoint of the distance between the vocal cords (E-VC), the skin to trachea at the level of the thyroid isthmus, the floor of the mouth muscle cross-sectional area, the floor of the mouth muscle volume, the tongue width and tongue thickness-to-oral cavity height ratio, and the Pre-E/pVC ratio were not significant in predicting difficult laryngoscopy.[7]

In the study, the Anterior Neck Soft tissue – HYOID distance was not statistically significant (p-value – 0.46). Previous studies have shown conflicting results in this and the pre-epiglottic distance parameter. This was probably due to differences in the population group. Although hyoid bone imaging was not attainable, sublingual ultrasonography exhibited a sensitivity of 73% and a specificity of 97% for predicting difficult intubation (p 0.0001).[12] The anterior neck surface to hyoid distance (ANS-H) was found to be a statistically significant predictor of difficult laryngoscopy in research with a threshold value greater than 1.67 cm.[13] This is consistent with investigations conducted in 200 patients by Koundal et al. and 90 patients by Imran Nazir et al. (cutoff values were 1.615 cm and 1.77 cm, respectively).[14,15]

Among clinical parameters in our study, the Mallampati class, Thyromental distance, and Sternomental distance had a significant value (p-value < 0.0001) for predicting difficult intubation (CL grade 3/4). A study showed statistical significance between MPC and CL grades (0.001).[13] According to one study, the modified Mallampati score is an insufficient predictor of difficult laryngoscopy as a stand-alone test.[16] Among all parameters, Anterior Neck Soft tissue-Vocal cord distance had the highest sensitivity over the clinical parameters. But its specificity was lower than the clinical parameters. Out of the clinical parameters, Sternomental distance had the highest specificity. The negative predictive value was highest for the Anterior neck soft tissue – Vocal cord, followed by Mallampati class. Pre – Epiglottis/Epiglottis- Vocal Cord was useful in predicting difficult intubation. But it had very low sensitivity. Specificity was high. The clinical parameter Mallampati class had high specificity and negative predictive value. The ultrasound parameter Anterior Neck Soft tissue – Hyoid distance was not a useful indicator. The study discovered that measuring the ANS-VC is a promising tool in airway evaluation and that a thickness greater than 0.23 cm is linked with the prediction of difficult intubation.[17]

CONCLUSION

Ultrasonographic measurement of the Anterior neck soft tissue -Vocal Cord is thus an excellent predictor of difficult intubation. The higher the value is the most sensitive physical parameter compared to other

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clinical parameters such as Mallampati class, Thyromental distance, and Sternomental distance in predicting difficult intubation. Measurement of Anterior neck soft tissue -Hyoid is not a useful indicator in predicting difficult intubation. Thus, the parameters can be used to predict the difficulty, which was until now quantified by the traditional Cormack- Lehane grading.

Limitations

Very few populations had a BMI of more than 30kg/m2. Hence if we had included a larger population of obese individuals, our parameters might have been different and difficult to elicit. We did not include the paediatric age group; the study did not include patients with dentition problems, facial abnormalities, or trauma. The age-increased BMI and the dentition problems do not correlate with the Cormack Lehane grading. Thus, ultrasound is emerging as a tool for airway assessment in preoperative patients and critical care.

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