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Research Article

Evaluation of Ultrasonography with Conventional Clinical Parameters for Predicting Difficult Laryngoscopy

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ABSTRACT

Background: Unanticipated difficult intubation poses a challenge in routine practice for anaesthesiologists. A preoperative airway evaluation helps in the identification of a difficult airway. Airway assessment with ultrasound is a modality recently being used to predict difficult airway. In this study we evaluate ultrasonography parameters with conventional clinical parameters for predicting difficult airway in adults undergoing elective surgeries.

Methods: This cross sectional randomised clinical trial analyses ASA class 1 and 2 adults requiring endotracheal intubation for surgeries under general anaesthesia were enrolled following which Modified Mallampatti score and thyromental distance as well as ultrasound distance to epiglottis (DSE) and distance to hyoid bone (DSHB) were measured and based on Cormack Lehane grading they were categorised into easy and difficult airway groups.

Results: DSE had the highest sensitivity of 90.48% whereas Modified Mallampatti grading had least sensitivity of 66.67%.

Conclusion: The results of this study showed that ultrasonographic measurements at the thyrohyoid and hyoid level have higher sensitivity and specificity than the clinical parameters for airway assessment.

Introduction

Endotracheal intubation has a major role in airway maintenance and adequate ventilation during general anaesthesia as well as in resuscitation scenario [1]. Inability to secure the airway is one of the significant causes of mortality for patients [2]. Hence unanticipated difficult intubation poses a challenge in routine practice for anaesthesiologists [3]. Difficult airway lacks an accepted standard definition, but it mainly comprises of different components such as difficult mask ventilation, unsuccessful/difficulty of intubation and difficulty in laryngoscopy. Difficult intubation is assessed by the ease of laryngoscopy and graded according to tools such as POGO score and Cormack–Lehane Grade [4].

Assessment of the airway is a prerequisite for anaesthesiologist as it helps to identify a difficult airway, thereby providing time for adequate preparation such as the proper selection of equipment and technique for the same. In many scenarios for sufficient oxygenation as well as ventilation, airway has to be secured. Airway mismanagement often leads to catastrophic outcome for the patients and the medical team involved [5].

Difficult laryngoscopy remains high despite using multiple clinical screening tests such as modified Mallampatti classification, jaw movement, sternomental distance, inter incisor gap, thyromental distance, Wilson score, and LEMON score. Most of them have low predictive values [4-6]. Cormack Lehane grading can be used to classify and identify difficult intubation, but it being a procedure which is invasive, it cannot be included in the pre-anaesthetic evaluation. Therefore, a comprehensive examination of airway that incorporates

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both qualitative and quantitative tests increases the probability of difficult laryngoscopy prediction. Hence it is important to discover a reliable method of airway assessment as a complementary tool to the daily used conventional techniques [5].

Several studies have been done to assess the predictive value of ultrasound in difficult laryngoscopy scenarios, but very few studies have evaluated the use of ultrasonography with the conventional screening methods in determining difficult laryngoscopy in adult patients posted for surgeries where general anaesthesia is administered electively. Hence this study was organised to know if the ultrasonographic estimation is better than the conventional screening tools used in adult patients to predict difficult laryngoscopy under general anaesthesia.

Methods

This cross sectional observational study was conducted in Vijayapura from January 2021 to August 2022.

Acceptance of Ethical Committee from the Institution was obtained [(IEC/2/0-09/2021) dated 22-01-21], the patients who fulfilled the requirements of the study and gave permission to participate in the study, were recruited.

In total 72 adult patients between 18 and 60 years of age belonging to the American Society of Anesthesiologists (ASA) grade 1 and 2 requiring endotracheal intubation for elective surgical procedures were included in the study. Patients with prior airway malformation/ pathologies such as facial/cervical fractures or tumours, or with goitre, patients with prior record of difficulty in laryngoscopy, body mass index > 40kg/m2 were excluded from this study.

The preoperative assessment and airway assessment of all patients were conducted by the same investigator to prevent inter observer variability. In the total 72 patients assessed, Modified Mallampatti grading and thyromental distance were first measured. Modified Mallampatti grade was assessed by the investigator seated facing the patient, where the patient instructed to keep head in the neutral posture and keep their oral cavity exposed maximally with tongue protruded without vocalisation. Modified Mallampatti grades 1 and 2 were contemplated to have ease while doing laryngoscopy whereas grades 3 and 4 were contemplated to be associated with difficulty in laryngoscopy. Patil's test was assessed with the neck of the patient fully extended, where the space between the mentum and the notch of thyroid was studied. A distance below 6.5 cm was predicted to have difficult laryngoscopy and more than 6.5 cm was predicted to be easy laryngoscopy.

All the 72 patients then underwent airway assessment using the ultrasound. They were positioned recumbent with the head kept in a neutral posture and ultrasound measurements taken with the help of the primary investigator who was trained in ultrasonography and was blinded to the laryngoscopic view. Ultrasonic transducer was positioned across the thyrohyoid membrane level. Patients were told to take breaths while performing assessments to reduce mistakes caused due to respiration. The curvilinear hypoechoic structure at the thyrohyoid membrane level with an air mucosal interface seen posteriorly was recognised to be the epiglottis. Distance between skin to the the top of the epiglottis in the median axis (Figure 1) in centimeters extending to the level of the thyrohyoid membrane with differing degrees of angulation cranially and caudally using USG linear probe (Sonosite M-Turbo machine) on B mode. Ultrasonographic measurement of distance between skin and the epiglottis if greater than 1.85 cm was considered to have difficult laryngoscopy and value if less than 1.85 cm was supposed to be easy laryngoscopy.

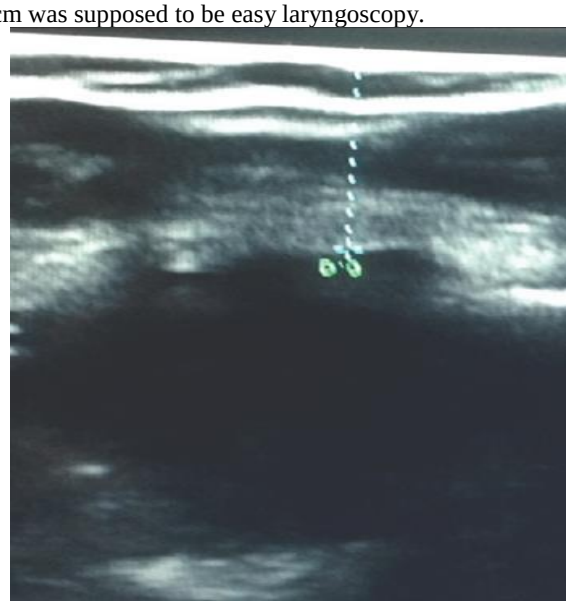

Figure 1- Depth between skin and epiglottis seen

The hyoid bone was identified as an inverted U shaped hyperechoic structure in the submandibular region. The measurement from the skin upto the middle of the hyoid bone was taken (Figure 2). Using ultrasonography if the distance from skin surface to bone of hyoid was greater than 0.78 cm, it was considered difficult laryngoscopy and if measurement was less than 0.78 cm, it was considered to be easy laryngoscopy.

On day of surgery, patients were kept NPO according to ASA guidelines and then shifted to the operation theatre where standard monitoring devices were connected and baseline values were recorded. IV line secured with 20G /18G cannula, and the patient was premedicated and then preoxygenated with 100% oxygen for 3 minutes.

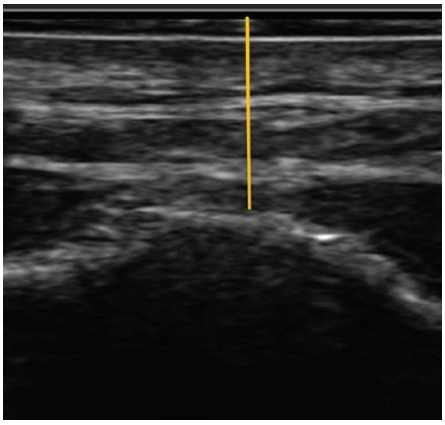

Figure 2- Depth to hyoid bone seen

General anaesthesia was achieved using Injection Propofol (2mg/ kg) and paralysis by Injection Atracurium 0.5mg/kg to secure airway using direct laryngoscopy for endotracheal intubation. The tracheal intubation was done with an appropriately sized ETT (endotracheal tube) by an Anaesthesiologist who was blinded to the study. Macintosh blade used for performing laryngoscopy and then the Cormack Lehane (CL) grade assessed with no superficial maneuvres of the larynx.

Based on Cormack Lehane grading patients were then categorised into easy or difficult laryngoscopy groups. Patients having 3 and 4 grading of Cormack Lehane were assigned to the difficult laryngoscopy category, whereas 1 and 2 grading were assigned to easy laryngoscopy category. Patients were maintained under anaesthesia using oxygen, air and isoflurane and atracurium. After the surgery, on observing the first attempts of breathing, patients given reversal with Injection Neostigmine 0.05mg/kg along with Injection Glycopyrolate 0.01mg/kg. When they were adequately conscious, the endotracheal tube was removed. They were monitored for half an hour postoperatively before being shifted to the ward for further management.

Statistical Analysis

The input collected was filled in an Excel sheet(Microsoft), and analysis of statistics was obtained using SPSS (Version 20). Results were presented as Mean (Median) ±SD, counts and percentages and diagrams. Categorical variables were correlated with Chi square test. All statistical tests were performed two tailed. p value less than 0.05 will be considered statistically significant.

Results

21 patients out of the total sample size of 72 patients were observed to have difficult laryngoscopy (Figure 3).

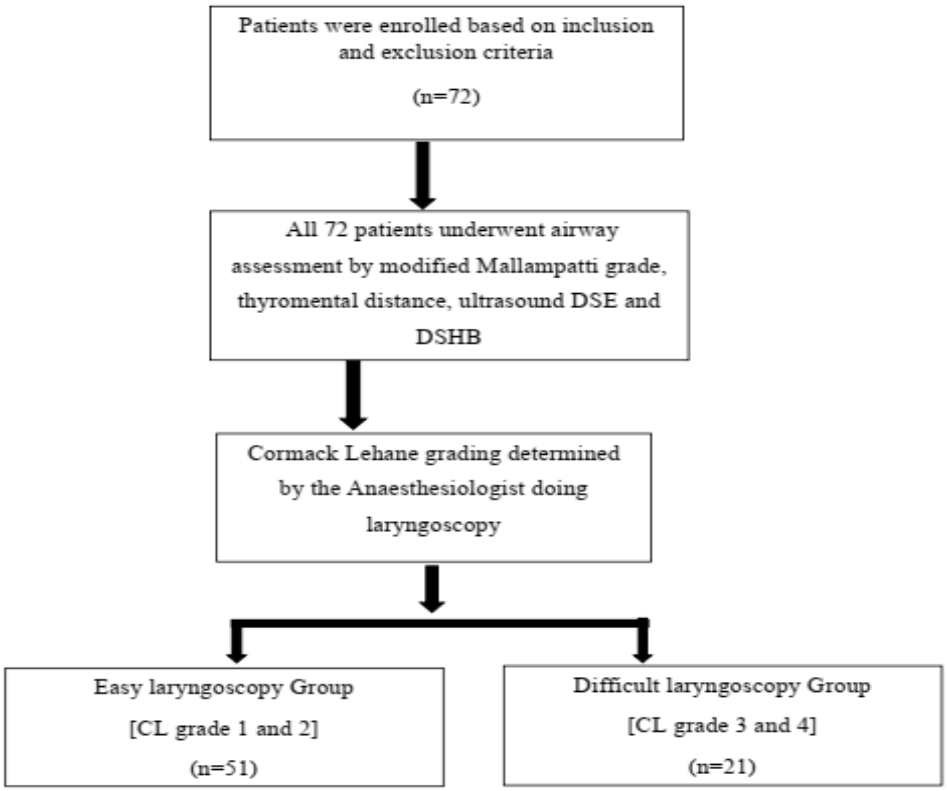

Figure 3- Illustration of study flow chart

Table 1- Distribution of patients according to demographics

Parameters		Laryngoscopy Easy (n=51)		Laryngoscopy Difficult (n=21)		P value
AGE (years)	Mean ± SD	35.3	35.3±12.4	33.2	33.2±12.48	0.63
Male	N %	25	78.13%	7	21.87%	0.17
Female	N %	26	65%	14	35%	
BMI	Mean ± SD	25.7	25.76±4.1	26.48	26.48±4.32	0.78
ASA I	N %	42	79.25%	11	20.75%	0.2
ASA II	N %	9	47.3%	10	52.7%	

n-numeral, QI- Quetelet Index, SD-probable error

Demographic data of patients are shown in (Table 1).

Sample's age wise distribution revealed that there is no statistical significance as the p value is 0.63.

BMI was represented as Mean ±SD. The p value of 0.78 determined it was statistically insignificant. The mean BMI in Difficult laryngoscopy was 26.48±4.32 and in Easy Laryngoscopy was 25.76 ± 4.10.

Percentage of female were 65% and 35 % in Easy and Difficult laryngoscopy group respectively (Figure 4). Percentage of males were 78.13 % and 21.87% in Easy and difficult laryngoscopy group respectively. p value of 0.17 indicated absence of statistical significance here.

Among patients distributed according to MMG, 34 were in difficult laryngoscopy group and 38 were in easy laryngoscopy group (Figure 5).

In (Table 2) we got a p-value of 0.08 which was insignificant from a statistical point of view.

In (Table 3) among patients with thyromental distance less than 6.5cm, 42.2% were in category of difficult laryngoscopy and 57.8% in easy laryngoscopy category.

Here we got a p value of 0.06 which was statistically insignificant.

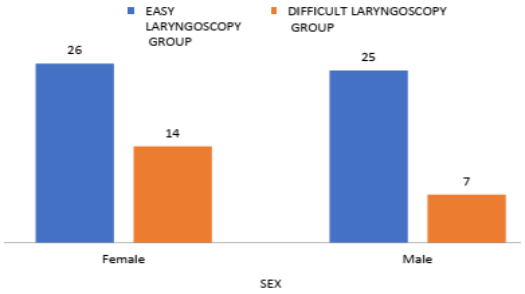

Figure 4- Genderwise distribution shown

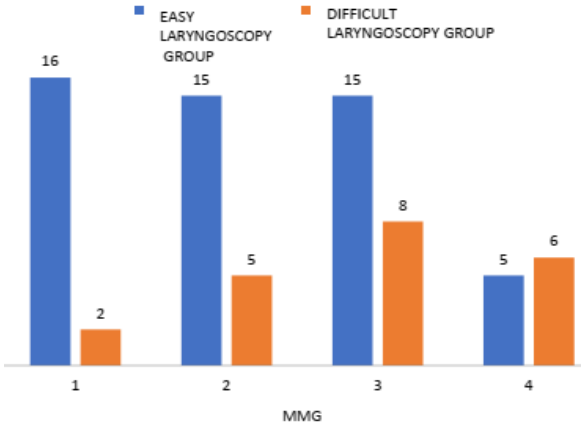

Figure 5- Distribution based on MMG shown

Table 2- Distribution following Modified Mallampatti Grading

Parameter	**MMG**							
	1		**2**		**3**		**4**	
Easy laryngoscopy group	N	%	N	%	N	%	N	%
	16	88	15	75	15	65.3	5	45.45
Difficult laryngoscopy group	2	12	5	25	8	34.7	6	54.55
Total	18	100	20	100	23	100	11	100

MMG – Modified Mallampatti Grade, N - Number

Here the p value of 0.08 was statistically insignificant.

Table 3- Distribution of patients according to thyromental distance

Parameter	**Thyromental distance**				**Total**	
	< 6.5cm		**> 6.5cm**			
	N	**%**	**N**	**%**	**N**	**%**
Difficult Laryngoscopy Group	19	42.2	2	7.4	21	29.2
Easy Laryngoscopy Group	26	57.8	25	92.6	51	70.8

N-Number

Table 4- Distribution of area under ROC curve for MMG, Thyromental distance, DSE, DSHB

Parameters	Area under curve(AUC)	CI(95%) Lower limit	Upper limit	P value
MMG	0.68	0.55	0.82	0.01*
Thyromental distance	0.24	0.12	0.36	0.001*
DSE	0.81	0.68	0.93	0.001*
DSHB	0.79	0.69	0.90	0.001*

*statistical significance, CI- Confidence interval

Area under the ROC curve (Figure 6) for DSE and DSHB were remarkably distinct from AUC reference line. DSE and DSHB had area under curve of 0.81 and 0.79 respectively.

Area under curve for MMG and thyromental distance were 0.68 and 0.24 respectively.

The p value of < 0.05 denoted statistical significance of all the tests as shown in (Table 4).

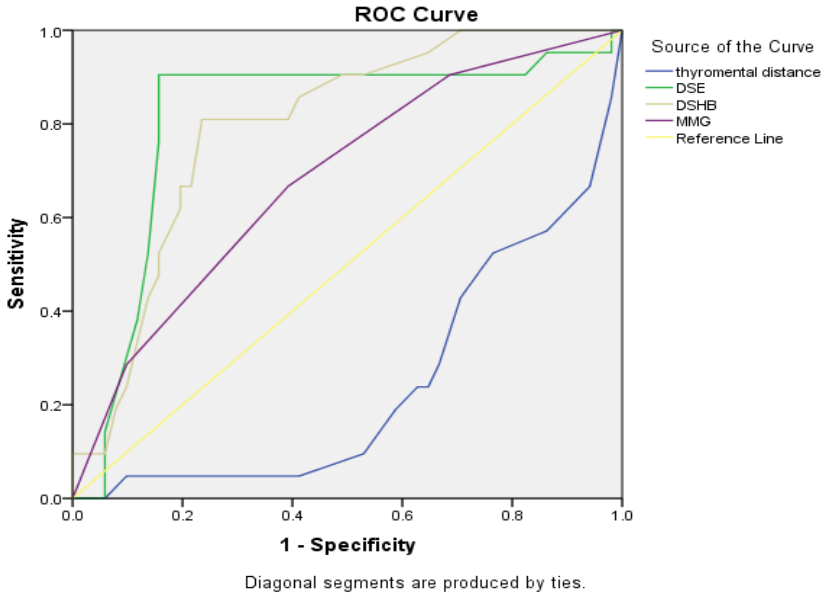

Figure 6- ROC curve for predicting difficulty in laryngoscopy

Table 5- Data of all clinical and ultrasonographic parameters against variables

Variables	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Cut off value (cm)
MMG	66.67%	60.78%	41.18%	81.58%	>2
Thyromental distance	71.43%	66.67%	46.88%	85.00%	<6.5
DSE	90.48%	84.31%	70.37%	95.56%	>1.85
DSHB	80.95%	76.47%	58.62%	90.70%	>0.78

MMG- Modified Mallampatti Grade, DSE – Depth to epiglottis, DSHB- Depth to hyoid, PPV- Positive predictive value, NPV- Negative predictive value

DSE and DSHB showed significantly elevated sensitivity when compared to Modified Mallampatti grading and Thyromental distance as shown in Table 5.

Modified Mallampatti grading and thyromental distance had significantly less positive predictive value when compared to DSE and DSHB.

DSE had the highest sensitivity and specificity of 90.48% and 84.8% respectively whereas modified Mallampatti grading had least sensitivity and specificity of 66.67% and 60.78% respectively.

Discussion

Endotracheal intubation is an essential life saving skill which every Anaesthesiologist should have mastered with confidence to manage any difficult airway scenario [8]. The difficult airway encountered may be due to various factors that may be patient related, based on history of surgeries underwent, airway assessment, the clinical scenario requiring airway to be secured and the patient's current condition [9].

Adequate practice, experience, judgement and evaluation are required for predicting the difficulty of a patient's airway and for planning management of the same. When a patient's airway is assessed to be easy to manage, it is expected that a well-trained and adequately skilled anaesthesiologist will be able to carry out the procedure without complications. Difficult airways needs adequate preparation and planning as well as utilisation of infrequently used methods. Airway evaluation is subjective and skilled anaesthesiologists can also face challenging scenarios due to inaccurate prediction of difficulty in airway management. There are studies which suggest greater than 91% of airway difficulty is unpredicted [10].

This cross sectional analysis was aimed to examine the predictivity of ultrasonographic parameters such as DSE and DSHB and clinical parameters such as thyromental distance and modified Mallampatti score in 72 patients of 18 to 60 years of age, posted for elective surgery undergoing general anaesthesia.

The findings in our study showed similarity to the one conducted by Vishal Koundal et al [4] which observed the significant association of the ultrasound variables in anticipating ease of laryngoscopy. Outcome in our study also showed resemblance to study by Osman Adi et al [11] where it was concluded that ultrasonography of the airway has a prospective use as an accessory in examination of airway. Adhikari et al [7] showed that ultrasonographic measurements of thickness of soft tissue in neck anteriorly may be used to identify difficulty in laryngoscopy.

The study conducted by J.Pinto et al [12] demonstrated that the depth to epiglottis can help in the anticipation of a difficult airway and demonstrated a cut off of 2.75cm for the same which also revealed a similarity to the outcome of our research. The study concluded that when used in combination with the modified Mallampatti grading it increased the predictive power over each test individually.

The study conducted by ECR Moura et al [13] demonstrated that epiglottis distance from skin ($p = 0.019$) were remarkable on comparison of easy and difficult laryngoscopy categories of the Cormack-Lehane grading with depth from the skin -epiglottis cut-off being 2.9 cm. These findings were similar to our study where the depth to epiglottis had a p value of 0.001 with 1.85 cm being the predictive value to differentiate the ease of laryngoscopy.

LH Lundstrom et al [14] observed that Modified Mallampatti score is inadequate to act as an individual test for determining ease of laryngoscopy but has potential to be used as a component of multiple tests used f or predicting the difficulty of laryngoscopy. T Randell et al [15] observed that the predictive value increases when a combination of tests are used as the sensitivity of each test such as Mallampati classification and the thyromental distance. Evidently, the predictiveness is improved, when multiple tests used simultaneously. In our study we found specificity of Modified Mallampatti grading to be 60.78% whereas thyromental distance had a specificity of 66.67 %. T Shiga et al [16] study concluded that tests predicting ease of laryngoscopy were more relevant on combining the Modified Mallampati score with the thyromental distance. Current clinical parameters used for assessing difficult laryngoscopy have predictive value which ranges from poor to moderate when used individually. When the tests were combined it increased the predictive power value rather than when applied alone. The value of conventional airway evaluation alone for determination of difficult laryngoscopy has certain limitations which can be overcome by combining with ultrasonographic parameters.

Hongwei Ni [2] conducted a study in 211 patients and observed that ultrasonographic measurement of the distance from skin to epiglottis to be the most significant independent indicator for predicting difficult laryngoscopy in view of sensitivity of 81.8% and specificity of 85.6%. Similarly, our studies showed that ultrasound measurement of distance from skin to epiglottis had the highest sensitivity and specificity of 90.48% and 84.8%.

In contrast to our study where a DSE value of more than 1.85 cm was used to predict difficult laryngoscopy, Martinez-Garcia et al [17] conducted a study demonstrating that DSE > 3cm had a sensitivity of 56.3% and specificity of 88.2%. Komatsu et al [18] demonstrated that thickness of soft tissues of neck measured by ultrasonography does not accurately help in predicting the difficulty faced during laryngoscopy in patient with obesity implying that the study findings cannot be applied in patients who are obese.

However our study had certain limitations. Primarily the sample involved in the study conducted were regional cases of southern part of India so the anatomical data may vary due to differences in race and ethnicity. Also factors such as experience of the Anaesthesiologist performing laryngoscopy and equipments used for laryngoscopy may influence the glottic exposure and hence the Cormack Lehane grading. Also this study excluded the obese and pregnant patients who have higher risk of difficult laryngoscopy. Hence further research may be required to complete the validation analysis based on the findings of this investigation.

Conclusion

The results of this study showed that ultrasonographic measurements of neck soft tissue have better sensitivity and specificity than conventional clinical tests such as thyromental distance and Modified Mallampatti grading for airway assessment. Commonly used screening tests

for difficult airway prediction have poor to moderate predictive power when used alone. Hence the inclusion of ultrasonographic measurements in routine airway assessment can help in enhancing our potential to anticipate a difficult airway.

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