Original Article

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Predicting Difficult Laryngoscopy by Ultrasound Quantification of Anterior Neck Soft Tissue Thickness- A Prospective Observational Study

Anaesthesia Section

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ABSTRACT

Introduction: Difficult airway can possess a challenge to intubation and deciding role in morbidity and mortality. Hence, at these times Ultrasonography (USG) can play a vital role in the prediction of a difficult airway.

Aim: To determine if USG measurement of anterior neck soft tissue thickness at the hyoid bone, and anterior commissure levels can be used to predict difficult laryngoscopy.

Materials and Methods: This prospective observational study was carried out at the Department of Anaesthesia, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences from January 2021 to January 2022. Total 50 patients, aged 20-60 years were included, and scheduled to undergo general anaesthesia. Correlation analysis between roles of screening tests like Mallampati scoring (MMP), Cormack Lehane (CL) grade Neck Circumference (NC), Thyromental Distance (TMD) and USG measurements was done for predicting difficult laryngoscopy. Portable USG machine with a linear frequency probe, measuring tape and laryngoscope blade was required. The data was analysed using Statistical Package for Social Sciences (SPSS) version 22.0.

Results: The incidence of difficult laryngoscopy was 18% and the mean age of the study participants in the easy group was 44.26 years and in the difficult group it was 45.13 years. The USG measurements were significant (p-value=0.01) in determining difficult intubation, which shows greater validity to predict difficult laryngoscopy. USG measurement along with bedside screening test aids in better identification and assessment of difficult airway.

Conclusion: Anterior neck soft tissue thickness measured by USG at the hyoid bone, and anterior commissure levels combined with the screening tests and risk factors might increase the ability to predict difficult airways.

Keywords: Difficult airway, Difficult intubation, Obese patients, Ultrasound measurements

INTRODUCTION

When doing elective surgery or in an emergency, endotracheal intubation is a crucial life-saving treatment that helps to secure the airway and give oxygenation and ventilation on several occasions. However, direct laryngoscopy intubation can be a laborious procedure because of problems with the airways brought on by aberrant anatomy, limited cervical motion, obesity, and trauma [1]. Numerous techniques have been developed over the years to evaluate such challenging airways and aid in the anesthesiologist's preparation. Due to its portability and non invasive nature, USG has become a common tool. It is paramount for the detection of pneumothorax, central venous access, and USG-guided nerve blocks in the operating room [2]. USG plays a significant role in focusing on airway architecture and improved visibility.

To secure airways during general anaesthesia and when performing resuscitation, endotracheal intubation is a crucial skill for an anesthesiologist. Failure to do so can result in serious morbidity and fatality. As a result, unexpectedly difficult intubation continues to be a major concern for anesthesiologists [3]. This problem can be addressed by a thorough preoperative airway evaluation to minimise or eliminate unexpectedly difficult intubation. But, the rate of difficult laryngoscopy still stands at around 1.5-13 percent due to the limited accuracy of conventional techniques, algorithms, and configurations of screening tools in anticipating a possibly difficult airway [4]. As a result of increased knowledge of the anatomy and physiology of the airway and its characteristics may now be seen more clearly [5,6]. It has been determined that sonography is a viable imaging method for identifying significant anatomical features of the airway [7].

Thus, the study aimed to compare USG-guided measurements of anterior neck soft tissue thickness with CL grading, to predict difficult laryngoscopy.

MATERIALS AND METHODS

This prospective observational study was conducted at the Department of Anaesthesia, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra, India. Duration of the study was from January 2021 to January 2022. The research was conducted after taking approval from the Institutional Ethics Committee, AVBRH, DMIMS (DU), Sawangi Wardha, Maharastra, India. Ref no. (DMIMS(DU)/IEC/2020-21/109 along with the written consent.

Inclusion criteria: All patients aged between 20-60 years who were planned for elective surgeries, requiring GA and endotracheal intubation with American Society of Anesthesiologists (ASA) Class I, and II patients and were willing to give informed written consent were included.

Exclusion criteria: Patients with bleeding disorders, facial fractures, cervical spine instability, requiring rapid sequence induction, patients with poor submandibular space compliance, pregnant patients, patients with airway pathology and uncooperative patients were excluded from the study.

Sample size calculation: Sample size calculation was done by using the formula;

$$n \geq \frac{Z^2_{1-\alpha/2} \times p(1-p)}{d^2}$$

Alpha (a)=0.05

Estimated proportion (p)=0.113

Estimation error (d)=0.09

Sample size=48

Finally, 50 patients were included in the study.

Methodology

A detailed history and a thorough general examination was done for all the patients. Preoperatively, patients were examined for MMP score, thyromental distance and sternomental distance was noted. In the preoperative assessment, parameters like inter incisor gap which is the distance between upper and lower incisors, modified MMP classification [5]. In the intraoperative period, the CL [6], grade of larynx observed without application of any external laryngeal manipulation was recorded, A CL grade I or II was considered as easy and grade III or IV as difficult laryngoscopy.

Other airway parameters that were assessed like NC at the level of the thyroid cartilage and TMD with patient's neck fully extended. The patients were made to lie down supine with active maximal head tilt-chin lift. The USG transducer was oriented transversely across the anterior surface of the neck (transverse view), using a high-frequency linear probe of the USG machine. The anterior neck soft tissue thickness was measured as Distance from Skin to anterior aspect of Hyoid bone (DSH) (in cm) and Distance from Skin to the Anterior Commissure of vocal cords (DSAC) (in cm). After following standard general anaesthesia protocol, laryngoscopy under muscle relaxant was done by trained anaesthesiologist and Cormack Lehane score (CL) was noted. The number of attempts at intubation, need for alternate intubation technique and cancelation of procedure due to inability to secure airway were noted. The USG measurements were then correlated with CL grading and other screening tests.

Parameters Assessed

1. **Airway parameters**

Was seen using CL Grading, NC, TMD, Modified MMP Score, Sternomental Distance.

2. **USG-based measurements.**
   A) DSH
   B) DSAC

STATISTICAL ANALYSIS

Data was analysed using SPSS version 22.0. Comparisons between difficult and easy airway groups, a two way Student's t-test were employed as appropriate. Spearman, a rank correlation coefficient was used to examine association between screening test and USG measurements. A p-value of <0.05 was considered statistically significant.

RESULTS

Nine participants (18%) out of 50 were classified to have difficult laryngoscopy, of which females were 5 (55.56%). When compared to participants with easy laryngoscopy, those with difficult laryngoscopy had considerably higher weight and Body Mass Index (BMI) [Table/Fig-1].

Variables	Easy (CL grade I/II) N=41	Difficult (CL grade III/IV) N=9	p-value
Gender, n (%)			
Male	16 (39.02%)	4 (44.44%)	0.68
Female	25 (60.98%)	5 (55.56%)	
Age (in year), Mean±SD	44.26±13.60	45.13±12.45	0.82
Weight (kg), Mean±SD	65.24±9.49	68.72±8.71	**0.037**
Height (cm), Mean±SD	163.84±9.12	164.56±7.651	0.71
BMI (kg/m^2), Mean±SD	23.32±3.04	26.39±2.44	**0.008**

[Table/Fig-1]: Baseline characteristics.
p-value <0.05 considered significant

The thicknesses of anterior neck soft tissue measured by USG were greater in the difficult laryngoscopy group compared to the easy laryngoscopy group at sternomental distance, NC, level of the hyoid bone, epiglottis and anterior commissure (p<0.05). However, no statistically significant difference was found between easy and difficult laryngoscopy groups for TMD and Inter Incisors Distance (IIG) [Table/Fig-2].

Variables	Easy (Mean±SD)	Difficult (Mean±SD)	p-value
TMD	6.74±0.68	6.63±0.91	0.47
IIG	3.88±0.48	3.73±0.40	0.18
Sternomental distance	17.72±1.41	17.34±1.38	0.13
Neck circumference	34.39±3.55	37.86±4.22	0.004

[Table/Fig-2a]: Descriptive data of clinical assessments parameters for predicting difficult laryngoscopy.
TMD: Thyromental distance; IIG: Inter incisors distance; p-value <0.05 considered significant

Variables	Easy (Mean±SD)	Difficult (Mean±SD)	p-value
DSHB	0.96±0.24	1.54±0.29	<0.01
DSEM	1.46±0.37	2.35±0.32	<0.01
DSAC	0.91±0.21	1.33±0.28	<0.01
Tongue thickness	5.24±1.01	6.19±1.07	<0.01

[Table/Fig-2b]: Descriptive data of Ultrasound (USG) parameters for predicting difficult laryngoscopy.
DSHB: Distance from skin to hyoid bone; DSEM: Distance from skin to thyrohyoid membrane; DSAC: Distance from skin to anterior commissure; p-value <0.05 considered significant

The USG measurements were better than the bedside clinical assessment tests, thus showing greater validity to predict difficult laryngoscopy. Sensitivity and specificity for all bedside clinical tests were found to be lesser than that of USG-based parameters [Table/Fig-3].

Variables	Sensitivity	Specificity
TMD	0.43	0.48
IIG	0.61	0.54
Sternomental distance	0.49	0.52
Neck circumference	0.63	0.68
DSHB	0.67	0.70
DSEM	0.65	0.71
DSAC	0.62	0.66
Tongue thickness	0.74	0.73

[Table/Fig-3]: Sensitivity and specificity of all clinical tests and USG parameters to predict difficult laryngoscopy.

DISCUSSION

Several factors leading to a difficult airway have been witnessed by an anaesthesiologist, of which obesity leads to a majority, studies have shown that there is a direct relation between BMI and difficulty of intubation [8]. Similarly, to forecast difficult laryngoscopy, the thickness of the tongue, the distance between the skin and thyrohyoid membrane of the anterior neck in the sniffing and neutral positions, and the distance across the skin and hyoid bone using USG were measured. Nine participants (18%) out of 50 were classified into the category of patients with difficult laryngoscopy, of which females were 5 (55.56%). Regarding age and height, there was no difference between the participants with simple and difficult laryngoscopy. Subjects with difficult laryngoscopy had significantly higher weights and BMIs than those with easy laryngoscopy.

The thicknesses of anterior neck soft tissue measured by USG were greater in the difficult laryngoscopy group compared to the easy laryngoscopy group at sternomental distance, NC, level of the hyoid bone, epiglottis and anterior commissure (p<0.05). However, no statistically significant difference was found between easy and difficult laryngoscopy groups for TMD and IIG in the present study. The USG measurements had greater AUC than the bedside clinical assessment tests, thus, showing greater validity to predict difficult laryngoscopy. Sensitivity and specificity for all bedside clinical tests were found to be lesser than that of USG -based parameters in this study.

Similarly, Yadav NK et al., reported that the sensitivity and specificity of the USG measurements were higher than those of bedside clinical test to detect difficult laryngoscopy. Previous studies on airway USG have evaluated parameters such as tongue thickness, volume of tongue, skin to hyoid bone distance in supine and in neck extended position and ratio of these two distances, skin to thyrohyoid membrane distance, distance from the epiglottis to the midpoint of vocal cord (E-VC), depth of the pre-epiglottic space and ratio of these distances for predicting difficult laryngoscopy [8].

A pilot study by Adhikari S et al., found that thickness of anterior neck soft tissue at hyoid bone and thyrohyoid membrane was greater in patients with difficult laryngoscopy [9]. Similarly, Voyagis GS et al., conducted a study where Mallampati scoring was used to predict difficult laryngoscopy in obese patients [10] and Wu J et al., studied 203 patients and found that USG measurement at the level of hyoid bone, thyrohyoid membrane and anterior commissure can independently predict difficult laryngoscopy [11].

The thickness of tongue, Skin to hyoid Bone (STH) and Skin to Thyrohyoid Membrane (STHM) distance were measured as they can be easily recorded at the bedside, do not involve complex calculations and have been found to predict difficult laryngoscopy in a previous pilot study. The tissue at hyoid level needs to be lifted by the tip of the laryngoscope blade and higher CL grade is expected with increasing tissue thickness. The simplicity of the test and better results when compared to clinical screening tests allow it to be used in day-to-day setup.

Limitation(s)

The blinding of investigators were not done which might lead to some bias in the study. During the study, certain variables like equipment, external laryngeal maneuvers, number of intubation attempts could not be controlled. Hence, standardisation of all these factors should be done for future studies.

CONCLUSION(S)

Ultrasonography (USG) measurements of soft tissue thickness of anterior neck at hyoid and thyrohyoid level and tongue thickness have greater sensitivity and specificity than conventional airway tests and can be used in combination with other bedside clinical tests, for better prediction of difficult laryngoscopy.

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