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Diagnostic Accuracy of Ultrasonography in Predicting Difficult Direct Laryngoscopy

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Abstract: ***Predicting difficult intubation is a part of pre anaesthetic assessment; many predictors with varying predictive value are available. Ultrasonography is a simple non-invasive tool and has been used to identify difficult intubation. Here the diagnostic accuracy of using pre-epiglottic space thickness in predicting difficult intubation using modified Cormack Lehane grade, is studied in 221 patients undergoing general anaesthesia with tracheal intubation. A strong association between pre-epiglottic space thickness and difficult laryngoscopy was found with a diagnostic accuracy greater than conventional methods***

Keywords: Intubation, Ultrasonography, Pre-epiglottic space

1. Introduction

The maintenance of a patent airway is one of the prime objectives of an anaesthesiologist. Ultrasound has been widely used in the field of airway imaging in recent years as a convenient and non-invasive method for the diagnosis and adjuvant therapy of lower airway conditions. The aim of this study is to determine the diagnostic accuracy of ultrasonography in predicting difficult direct laryngoscopy and to determine the association between pre operative ultrasonographic assessment and Modified Mallampati Class in predicting difficult direct laryngoscopy.

2. Literature survey / Background:

The upper airway is a complicated anatomical structure. The maintenance of a patent airway is one of the prime objectives of an anaesthesiologist. The inability to maintain gas exchange, even if only for a few minutes, can have disastrous consequences[1]

Different non-invasive methods are used to predict Difficult intubation during pre-anaesthetic assessment. Many of these are varying predictive value and has been found to vary according to study population

Recognizing the potential for a difficult airway (DA) allows time for optimal preparation, proper selection of equipment and technique, and participation of personnel experienced in difficult airway management [2,3]

Difficult laryngoscopic tracheal intubation occurs in 1.5%–8% of general anaesthetics[4].

Unanticipated difficult laryngoscopic intubation places patients at increased risk of complications including death[5]

Ultrasonography (USG) is a promising tool for airway assessment, as it is safe, quick, repeatable, portable, widely available, and gives real-time dynamic images. There is limited literature available that compares the ultrasound (US) parameters to the Cormack-Lehane (CL) grade and physical parameters. [6,7]

Wu et al.[8] found that the thickness of the anterior neck soft tissue can be a predictor of difficult laryngoscopy in a study of 203 patients. They discovered that the distance between the skin and the hyoid, as well as the distance between the skin and the epiglottis, were good predictors of difficult laryngoscopy.

3. Problem Definition

The ability to identify patients at risk of difficult laryngoscopy is important especially in patients whose airways appear to be normal. The diagnostic accuracy of the screening tests varies between different studies and remains low[9]. Diagnostic accuracy of Ultrasonography in predicting difficult laryngoscopy is studied.

4. Methodology / Approach

Diagnostic test evaluation was done at Department of Anaesthesiology, Government Medical College, Thiruvananthapuram in patients planned for elective surgery under General Anaesthesia with tracheal intubation

All consecutive patients aged between 18 to 65, ASA-PS I, II, scheduled for elective surgery requiring general anaesthesia with tracheal intubation were enrolled till a sample of 221 was achieved.

Patients requiring rapid sequence intubation, uncooperative, pregnant patients, patients with history of previous difficult intubation, patients with limited cervical spine mobility,

maxillofacial anomalies, ASA grade III, IV were excluded from the study

Pre - epiglottic space thickness at the level of the level of thyrohyoid membrane, Modified Cormack - Lehane grade and Modified Mallampati class were recorded.

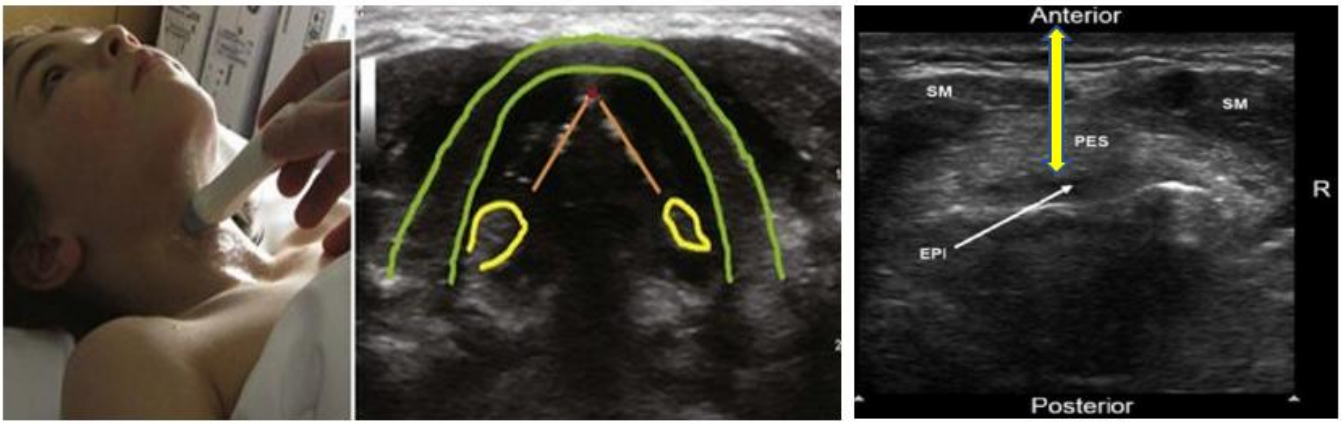

Figure 1: Transverse midline scan over the thyroid cartilage in an 8-year-old boy. (A) Placement of the transducer. (B) The thyroid cartilage is marked in green, the vocal cords in orange, the anterior commissure in red, and the arytenoid cartilages in yellow. (C) Pre-epiglottis space

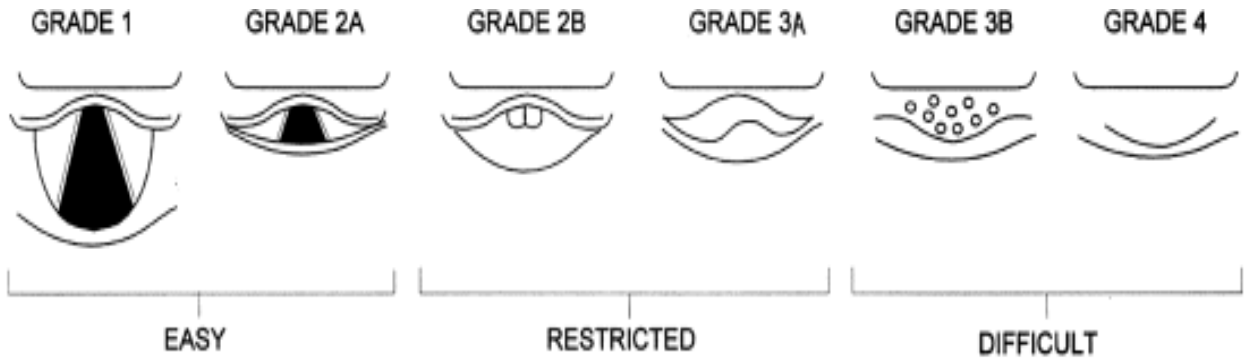

Figure 2: Grading of laryngoscopic view. Top: Cormack-Lehane grading system. Grade 1 is visualization of the entire laryngeal aperture; grade 2A is partial visualization of the vocal cords; grade 2B is visualization of only the posterior commissure of the vocal cords or arytenoid cartilages; grade 3A is visualization of only the epiglottis (epiglottis can be lifted); grade 3B is visualization of only the epiglottis (epiglottis cannot be lifted off the posterior pharynx); and grade 4 is visualization of only the soft palate.

Pre anaesthetic evaluation was done on the previous day of surgery with complete history, clinical examination, airway and systemic examination of cardiovascular and respiratory system. The routine airway assessment including mouth opening, modified Mallampati scoring, thyromental distance, and neck movements, was done.

Sonographic assessment of the airway, with linear high frequency probe was done on day of surgery using the transverse view to obtain pre epiglottic space thickness at the level of thyrohyoid membrane as median distance from skin to epiglottis.

After pre operative assessment, patients are classified as difficult or easy laryngoscopy based on the clinical and sonographic parameters.

After induction of anaesthesia and muscle relaxants, direct laryngoscopy was done using a Mcintosh blade and Cormack-Lehane laryngoscopic view will benoted. For each patient,only the best attempt at direct laryngoscopy will be considered:obtained after optimising position, complete muscle relaxation and if necessary,external laryngeal manipulation.
Modified Cormack Lehane grade 1 or 2a will be classified as easy laryngoscopy and grades between 2b and 4 as difficult laryngoscopy. (Fig:2)

5. Result and Discussion

AGE, gender, ASA
MMC: Out of 221 enrolled patients,56.1 %,39.4% and 4.5% belonged to MMC I, MMC II and MMC III respectively.

Out of 220 enrolled patients,24% of patients were found to have a PEST <18mm and 76% were found to have a PEST >18mm.The maximum number of participants were found to have a PEST >18mm.

52.5% of patients were found to have MCLG I,24.9% were found to have MCLG IIa,17.2% were found to have MCLG IIb,2.7% were found to have MCLG IIIa and the remaining 2.7% were found to have MCLG IIIb.The maximum number of participants were found to have MCLG I.

Figure 3: Distribution of study participants based on MCLG

Correlation between PEST and age, gender, were non-significant.

Majority of patients who were found to have PEST<18mm were of the elder age group, with ASA PS II grade and had an MMC II/III. Similarly, majority of the patients who were found to have MCLG IIb/IIIa/IIIb were of the elder group, with ASA PS II grade and MMC II/III. The association between PEST <18 mm and MCLG IIb/IIIa/IIIb was found to be statistically significant. Hence in majority of patients having PEST <18 mm, laryngoscopy will be difficult.

Receiver Operating Characteristic curve for PEST was plotted at the level of thyrohyoid membrane. Area under the curve was found to be 0.999. The cut off point for PEST was found to be 17.95. Sensitivity, specificity, PPV and NPV of PEST were calculated as 100%, 95.9%, 92.59% and 100% respectively. In this study, majority of patients who were found to have MMC II/III during pre anaesthetic check up had a PEST < 18mm on ultrasonography. The association between MMC and PEST was found to be statistically significant and hence laryngoscopy will be difficult in these patients.

Table 1: Showing association between MMC and PEST.

			Pest		Chi Square	p Value
			<18mm	>18mm		
MMC	I	Frequency	9	115	56.625	<0.001
		(%)	(16.7)	(68.9)		
	II	Frequency	36	51		
		(%)	(66.7)	(30.5)		
	III	Frequency	9	1		
		(%)	(16.7)	(0.6)		

On statistical analysis, there is significant association between ASA PS and PEST.
Association between MCLG and ASA PS

Table 2: Showing association between ASA PS and MCLG-Statistically significant Association between MMC and MCLG

			MCLG					Chi Sqaure	p Value
			I	IIa	IIb	IIIa	IIIb		
ASA	I	Frequency	96	28	12	3	0	49.565	<0.001
		(%)	(82.8)	(50.9)	(31.6)	(50)	(0)		
	II	Frequency	20	27	26	3	6		
		(%)	(17.2)	(49.1)	(68.4)	(50)	(100)		

Table 3: Showing association between MMC and MCLG. On statistical analysis, there is significant association between MMC and MCLG

			MCLG					Chi Sqaure	p Value
			I	IIa	IIb	IIIa	IIIb		
MMC	I	Frequency	104	13	6	1	0	136.205	<0.001
		(%)	(89.7)	(23.6)	(15.8)	(16.7)	(0)		
	II	Frequency	12	41	25	5	4		
		(%)	(10.3)	(74.5)	(65.8)	(83.3)	(66.7)		
	III		0	1	7	0	2		
			(0)	(1.8)	(18.4)	(0)	(33.3)		

Association between MCLG and PEST

Table 4: Association between PEST and MCLG (Significant association)

			Pest		Chi Square	p Value
			<18mm (difficult)	>18mm (easy)		
MCL G	I	Frequency	0	116	200.912	<0.001
		(%)	(0)	(69.5)		
	IIa	Frequency	4	51		
		(%)	(7.4)	(30.5)		
	IIb	Frequency	38	0		
		(%)	(70.4)			
	IIIa	Frequency	6	0		
		(%)	(11.1)			
	IIIb	Frequency	6	0		
		(%)	(11.1)			

Receiver Operating characteristics

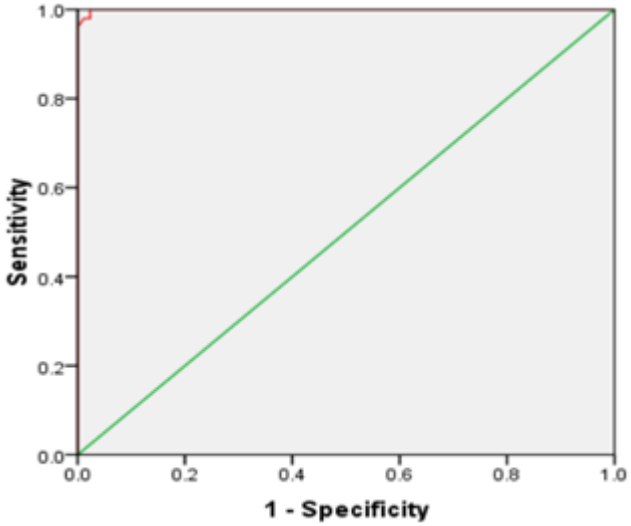

Figure 4: Showing ROC curve of PEST

Area under the curve - 0.999

The cut off point for PEST is 17.95.The cut off was calculated using Youden index (Sensitivity + Specificity – 1).

Validity of PEST

Sensitivity	100%
Specificity	95.9%
Positive predictive value (PPV)	92.59%
Negative predictive value (NPV)	100%

Table 5 shows the validity of test. Sensitivity, specificity, PPV and NPV were calculated taking true positive as those who were found to have PEST 18mm & MCLG I/IIa , false positive as those who were found to have PEST 18mm & MCLG IIb/IIIa/IIIb.

Out of 116 patients who were found to have MCLG I, 89.7%, 10.3% and 0% belonged to MMC I, MMC II and MMC III respectively. Out of 55 patients who were found to have MCLG IIa, 23.6%, 74.5% and 1.8% belonged to MMC I, MMC II and MMC III respectively. Out of 38 patients who were found to have MCLG IIb, 15.8%, 65.8% and 18.4% belonged to MMC I,MMC II and MMC III respectively. Out of 6 patients were found to have MCLG IIIa, 16.7%, 83.3% and 0% belonged to MMC I, MMC II and MMC III respectively. Out of 6 patients who were found to have MCLG IIIb, 0%, 66.7% and 33.3% belonged to MMC I, MMC II and MMC III respectively. On statistical analysis, there is significant association between MMC and MCLG. Hence laryngoscopy will be difficult in patients having MMC II/III.As per conventional studies MMC III is associated with difficult laryngoscopy and in this study, it is statistically shown that MMC II/III is associated with difficult laryngoscopy in both ultrasonographic and laryngoscopic finding.

Out of 54 patients who were found to have PEST 18mm during ultrasonographic assessment, 69.5%, 30.5%, 0%, 0% and 0% had MCLG I, MCLG IIa, MCLG IIb, MCLG IIIa and MCLG IIIb respectively, found during direct laryngoscopy. On statistical analysis, there is significant association between PEST and MCLG. Hence PEST value <18 mm was found to be associated with difficult laryngoscopy.

6. Limitations

1. The ultrasound derived parameters were of the population belonging to Kerala, and thus, the results cannot be generalised to other population groups. 2. Ultrasonographic measurements were obtained by one investigator which could cause some bias. 3. We could not control factors such as experience of anaesthesia providers, equipment used for laryngoscopy and number of intubation attempts. 4. As the ultrasound measurements of anterior soft tissue neck were measured in mm, the amount of pressure applied by the ultrasound probe on the neck can cause a difference in values and may alter the results, so gentle application of the probe is warranted. 5. The study did not include obese patients and pregnant patients where the risk of difficult laryngoscopy is greater and further studies need to be done in this population.

7. Conclusion

In summary, study revealed a strong association between sonographic measurement of PEST and a difficult laryngoscopy. The cut off point for PEST was calculated as 17.95. Sensitivity, specificity, PPV and NPV of PEST were calculated as 100%, 95.9%, 92.59% and 100% respectively. So, the diagnostic accuracy of PEST in predicting in difficult direct laryngoscopy is greater than conventional airway

assessment tests such as MMC and TMD. In majority of our patients who were found to have MMC II/III during pre-anaesthetic check-up had a PEST < 18mm on ultrasonography. The association between MMC and PEST was also found to be statistically significant and hence laryngoscopy will be difficult in these patients. Therefore, inclusion of this new parameter in the clinical practice may significantly enhance our ability to anticipate a DL. Further studies are required to clarify whether ultrasonographic evaluation of PEST could deliver significant clinical progress.

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