

Original research article

Correlation of ultrasound guided ratio of pre-epiglottic space and the distance from the epiglottis to the mid-point between the vocal cords (pre-e/e-vc) to the Cormack-Lehane grading: A one year hospital based prospective observational study

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Abstract

Difficult as well as unsuccessful tracheal intubation after performing direct laryngoscopy is one of the most feared complication of general anaesthesia and is associated with serious morbidity and mortality. Ultrasound of the upper airway may prove to be a useful adjunct to traditional clinical assessment tools, as it has been successful in visualizing the proper anatomy and critical structures of the airway. The present observational study was conducted in 60 ASA 1 and 2 patients, aged between 18-60 years posted for elective surgeries under general anaesthesia and endotracheal intubation using direct laryngoscopy. In our study we observed that the ultrasound parameter of Pre-E/E-VC was highly convincing in correlation with the CL grading with sensitivity of 91.67% and diagnostic accuracy of 82%.

Key words: Difficult airway, ultrasound, Pre-E/E-VC

Introduction

Difficult as well as unsuccessful tracheal intubation after performing direct laryngoscopy is one of the most feared complication of general anaesthesia and is associated with serious morbidity and mortality [1].

Any problem during intubation which was not anticipated or evaluated can lead to respiration related adverse outcome such as varying degrees of hypoxia, hypercarbia and rising level of consciousness in a paralysed patient [2].

Several approaches have been initiated to remedy such issues and to identify those patients who'll pose as DI. The important ones are included in the pre-operative anaesthetic evaluation of the airway in those patients undergoing surgery. Earlier the airway examination was performed by single factors like the Mallampati classification, thyromental distances, movement of the head&neck and the inter-incisor gap. Although when it was understood that visualising larynx at the time of intubation may be difficult or dependent on other factors, the concept of multi-factorial analysis or examination came into picture.

Even after using varied methods, there seems to have been occurrences wherein a patient who was predicted to have an easy intubation have faced difficulties while performing the same and vice versa [3].

Over the past few years, Ultrasonography is being recognised and applied in every field of anaesthesiology due to its practicality, ease and portability. There have been multiple studies and researches highlighting the importance of ultrasonography in patient examination and prediction of difficult intubations.

Upper airway ultrasonography is now a valued, noninvasive, easy-to-use, and portable point-of-care ultrasound (POCUS) utilised for evaluating and managing the airway even in situations where the airway anatomy might be distorted by either trauma or pathology [4]. Ultrasound (US) is useful in recognising the airway sonoanatomy by identifying several structures like the epiglottis, the thyroid-cartilage, cricoid

cartilage, cricothyroid membrane, tracheal cartilages, and also the oesophagus.

This applied ultrasonographic evaluation of the airway anatomy helps the anaesthesiologist utilise the same for identifying difficult intubation, endotracheal tube (ETT) and Laryngeal mask airway (LMA) insertion and its depth, ultrasound-guided invasive techniques like PNC as well as tracheostomy, predicting post-extubation stridor and DLT size, and identifying upper airway abnormalities.

Extensive POCUS awareness, improved technological progressions, portability, and availability of ultrasound in most critical places, enabled upper airway ultrasound to become the potential first-line non-invasive airway assessment tool of the future [4].

US is also being used to directly observe the ETT entering into the trachea or the oesophagus by transversely applying the probe at the suprasternal notch level at the time of direct laryngoscopy and intubation without having to confirm with ventilation or circulation [5].

Ultrasonography can be used hand in hand with the traditional methods of assessment of difficult airway as it has been efficacious in imaging the proper anatomy and complex structures of the airway. USG has various benefits for imaging the anatomy airway and it must be used enthusiastically for obtaining maximal benefit in close association with the airway management, i.e., immediately before, during, or after airway interventions [6].

Methodology

Study design: A One Year Hospital Based Prospective Observational study.

Source of Data: Adult patients between age group of 18-60 years, undergoing elective surgery under general anaesthesia with laryngoscopy and endotracheal intubation.

Sample Size: A total of 60 patients.

Inclusion Criteria

- ASA physical status I and II.
- Age above 18 - 60 years of either gender.
- Patients undergoing elective surgeries under general anaesthesia with laryngoscopy and endotracheal intubation.

Exclusion Criteria

- Uncooperative patients.
- Patients having head and neck anatomical pathologies that might give rise to unpredictable effect on the ultrasound airway assessment.
- Patients with inter incisor gap of <3 cm.
- Altered level of consciousness and inability to follow commands.
- Patients requiring rapid sequence intubation.
- Patients having pathology of cervical spine.
- Patients undergoing fibre optic intubation.
- Edentulous patients or those with artificial dentures.

Ethical Clearance

The approval by the institutional Ethical and Research Committee, Jawaharlal Nehru Medical College, Belagavi, was taken before starting the study.

Informed Consent

All the patients who fulfilled the selection criteria were explained about the nature of the study and intervention being done. A written informed consent was obtained from all patients before enrolment in their vernacular language.

Method of Collection of Data

After countenance by the ethics committee and after getting informed consent, prospective and observational study was done on patients of the age group of 18-60 years; both male and female, with the American Society of Anaesthesiologists status I/II and patients who underwent scheduled elective surgery and exacting general anaesthesia with direct laryngoscopy and endotracheal intubation.

The conventional airway assessments including mouth opening, modified Mallampatti scoring, thyromental distance, and neck movements was done during the preanesthetic appraisal. The patients not meeting inclusion criteria were precluded from the study and the inducted patients underwent sonographic assessment of airway by the anaesthesiologist in the preoperative recovery.

On the day of surgery, intravenous route was acquired using appropriate iv cannula and iv fluids were started. In the preoperative holding area, the ultra-sonographic assessment of the patients was done with them lying in supine position together with active maximal head-tilt/chin lift. The high-frequency linear

probe (SonoSite Turbo) was positioned in the submandibular area in the midline. Without changing the location, the linear disposition of the probe was rotated in the transverse planes from cephalad to caudal, until concomitant visualization of the epiglottis and posterior part of vocal folds with arytenoids was observed on the screen.

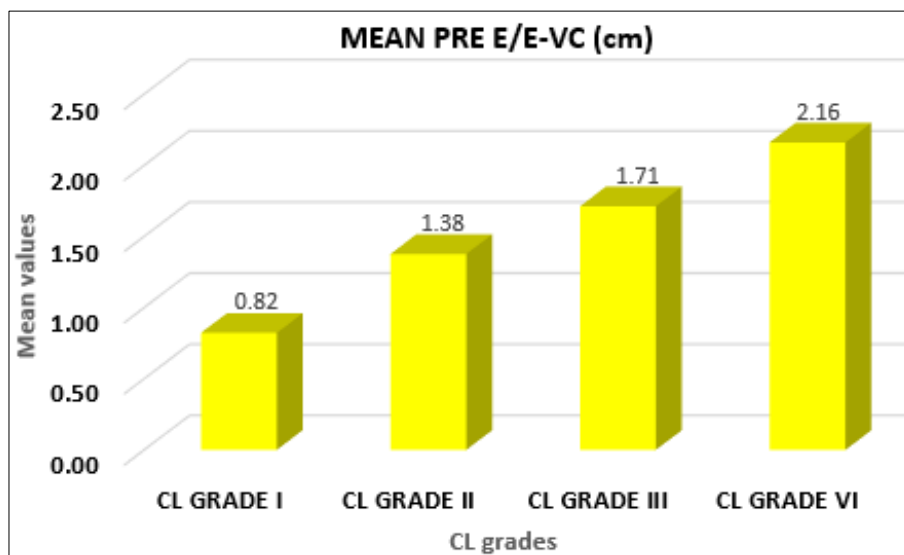
Results

Table 1: Analysis of various parameters with respect to CL grade

	I				II			
	Mean	S.D.	Minimum	Maximum	Mean	S.D.	Minimum	Maximum
BMI (kg/m ²)	24.72	3.89	16.5	32.5	22.56	2.52	19.5	27.5
Pre-E/E-VC	0.82	0.25	0.29	1.23	1.38	0.12	1.23	1.54

	III				IV			
	MEAN	S.D.	Minimum	Maximum	Mean	S.D.	Minimum	Maximum
BMI (kg/m ²)	26.51	2.54	21.5	29.1	22.39	2.22	19.53	25.2
Pre-E/E-VC	1.71	0.12	1.55	1.87	2.16	0.53	1.91	3.1

Using ANOVA, the mean of four CL grades are compared for homogeneity of means in the groups.



Graph 1: Mean Pre-E/E-VC

Table 2: Inference of the analysis

	p Value	Inference
BMI (kg/m ²)	0.0620	NS
PreE/E-VC	0.0000	HS

Pearson's correlation coefficients between CL grades and the other parameters. p values are calculated using student t distribution.

Table 3: Inference of the analysis

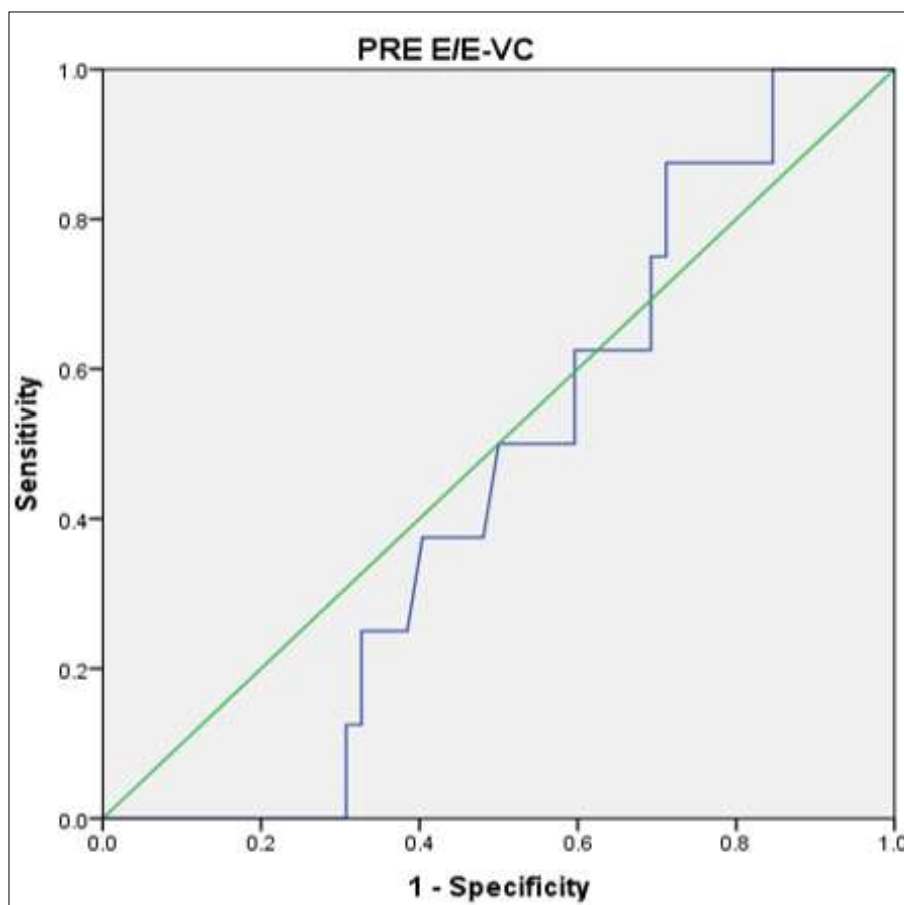
	r Value	p Value	Inference
Pre-E/E-VC	0.8712	<0.0001	HS

With respect to the CL grades, Pre-E/E-VC has highest correlation coefficient with correlation coefficient of 0.8712 and p value of <0.0001.

Hence, among the ultrasound parameters, the Pre-E/E-VC was highly convincing in comparison with Cormack Lehane grading.

Table 4: For PRE-E/E-VC > 1.24

Sensitivity	91.67%
Specificity	41.67%
Positive predictive value	86.27%
Negative predictive value	55.56%
Diagnostic accuracy	81.67%



Graph 2: Relative operating characteristics curve for Pre-E/E-VC

Area under the curve is 0.4542

According to the sensitivity analysis, the ratio of Pre-E/E-VC was found to be highly significant and had a sensitivity of 91.67% and diagnostic accuracy of 81.67%.

Discussion

Airway assessment, care and its management is a vital skill for anaesthesiologists. Maintaining a patent airway requires the ability of the person's lungs to deliver to the nearby tissues with oxygen to prevent hypoxia and related adverse effects. Failure in maintaining the same has been identified as a serious patient safety care.

Since the sequelae of an unexpected difficult airway are conceivably life threatening for the patient, a technique of detailed pre-operative evaluation of the airway has become a crucial pre-requisite.

The evaluation method initially began in 1980s when Vijayalakshmi Patil, proposed that measuring anatomical parameters in the head and neck play a role in the presence of difficult airway. Around the same period Seshagiri Rao Mallampatti² MD., postulated a hypothesis to predict difficult airway build on the structures visible inside oropharynx while the patient's mouth is open wide with tongue protruded out.

Several other clinical indicators of difficult airway have been studied since then like, the inter-incisor gap, sternomental distances, mobility of the neck, etc. This was continued by radiographic indicators such as X-ray neck lateral view to assess the distance from C₁ spine to the occiput, length of the mandible and mandibular space depth. In the last few years, several advanced predictors have been developed such as the Flow Volume Loop, Acoustic Response measurement, flexible bronchoscope and airway assessment using the ultrasound.

In the course of last few years, the science and techniques involved in anaesthesia and its related practices have been gaining eyesight especially with the help of ultrasonography. It is a secure, non-intrusive and a real-time imaging aid, the utility of which is under evaluation in the modern era by anaesthesiologists in various fields.

In this study the usefulness of ultrasonograph in identifying a difficult airway scenario is examined. The main adversity faced was the difficulty in imaging the anatomical airway structures. The reason being that these structures were quite superficially placed and filled with air that in turn produced a high acoustic impedance and resulted in of poor image quality.

Prasad *et al.* studied the feasibility of using ultrasonograph for airway assessment. They have equated the

airway measurements in supra-hyoid and infra hyoid region taken by both the ultrasonography and computed tomography. They came to a conclusion that the US measurements were equivalent with those attained from CT scan. The significance was however, found to be more in the Infra-hyoid region than in the Supra-hyoid region [7].

In this study which is a prospective observational type of study, conducted in Indian population, we have assessed the usefulness of ultrasonograph in predicting difficult airway by measuring the ratio of depth of Pre-epiglottic space to the distance measured from epiglottis to the midpoint of the vocal cords (Pre-E/E-VC), Hyomental distance ratio (HMDR) and Anterior neck soft tissue thickness at the level of vocal cords (ANS-VC) and their association to the CL Grade for predicting difficult laryngoscopy and intubation.

We enrolled a total of 60 ASA 1 and 2 patients aged 18-60 years, posted for elective surgeries under general anaesthesia and endotracheal intubation.

Among the patients enrolled, there were 39 females accounting for 65% of the total population and 21 male patients accounting for 35% of the same.

The mean BMI of the patients was 24.34 ± 3.58 kg/m² while the mean age was 40.12 ± 13.50 yrs.

In our study 73.33% of patients were of ASA grade I and 26.67% were of grade II.

In the study, 11.67% of patients were of MPG I, 80% had MPG II and 8.33% were of MPG III category.

When observed for the ratio of Pre epiglottic space and the distance from the epiglottis to the midpoint between the vocal cords (Pre-E/E-VC), it was found to have a p value of <0.0001 which was highly significant and sensitivity of 91.67% as was observed in a similar study by Koundal *et al.*, where the cut-off for Pre-E/E-VC was ≥ 1.785 with sensitivity of 82.8% and specificity of 83.8% which was comparable.

In a similar study by Gupta *et al.* depicted that assessment of CL grade can be sufficiently done with the help of ratio of Pre-E/E-VC with 67-68% sensitivity and strongest positive correlation with the regression coefficient of 0.495 [3].

In another study by Rana *et al.*, Pre-E/E-VC ratio were observed to be a mean value of 1.33 ± 0.335 and 1.62 ± 0.264 for CL Grade I&II respectively, and 1.87 ± 0.243 , 2.22 ± 0.29 correlated to CL Grade III&IV, however in our study the values 0.82 ± 0.25 , 1.38 ± 0.12 , 1.71 ± 0.12 and 2.16 ± 0.53 corresponded to CL grade I, II, III & IV respectively. In our observation the cut-off values for this ratio was ≥ 3.1 with sensitivity of 91.67% and diagnostic accuracy of 81.67% for predicting difficult airway [8].

Conclusion

- Among the ultrasound parameters, Pre-E/E-VC ratio was highly significant in association to CL grading.
- A cutoff value of 1.55 for the ratio of Pre-E/E-VC entirely outlined the difficult (CL 3&4) and easy intubation (CL 1&2).

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Conflicts of interests There are no conflicts of interest.

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