International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 6, June 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.6.2024.98

ORIGINAL RESEARCH

Hyomental distance ratio (HMDR) and anterior neck soft tissue thickness at the level of vocal cords (ANS-VC): Ultrasound airway assessment V/s Cormack-Lehane grading to predict difficult laryngoscopy and intubation

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Received: 02Jan, 2024 Accepted: 25Feb, 2024

Abstract
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. We undertook this study to know the efficacy of ultrasound in determining parameters namely hyomental distance ratio (HMDR) and the anterior neck soft tissue thickness at vocal cords level (ANS-VC) and correlating them to the CL grading to predict difficult airway. US is a reliable instrument to anticipate difficult-airway in the pre-operative area by measuring the ratio of pre-epiglottic depth to epiglottis to midpoint of vocal cords, HMDR and ANS thickness at the level of vocal cords

Keywords: Difficult airway, HMDR and ANS thickness

Introduction

Preoperative evaluation of airway using conventional clinical tests is common in anaesthesiology practice but better predictability of the parameters can be done with accuracy using the point of care ultrasonography. Recently, ultrasound has been of paramount importance in assessment of difficult airway.

One of the initial studies undertaken in 2011 by Adhikari, *et al.* demonstrated that sonographic measurements of anterior neck soft tissue thickness at the level of hyoid bone and thyrohyoid membrane can be used to distinguish difficult and easy laryngoscopies. The USG measurements of anterior neck soft tissue were greater in the difficult laryngoscopy group compared to the easy laryngoscopy group at the level of the hyoid bone and TM. Clinical screening tests did not correlate with US measurements, and US was able to detect difficult laryngoscopy, indicating the limitations of the conventional screening tests for predicting difficult laryngoscopy.[1]

In the year 2012, Wojtczak*et al.* studied obese patients who came with difficult and easy intubation by doing an US guided submandibular examination in supine position. The hyomental distances were measured in both neutral and hyper-extended position and the subsequent ratio was attained. The mean hyomental distance did not vary much in neutral position between the two groups, though the hyomental distance in the head-extended position did

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differ considerably. Tongue volumes and the volumes of the floor of the mouth muscle did not differ significantly between the two groups. This study showed that the hyomental distances may indicate difficult intubation.[2]

In the same year, Gupta *et al.* compared and correlated the ultrasonographic view of the airway and the Cormack Lehane grading of the direct laryngoscopy on patients undergoing elective surgery and general anaesthesia. They measured epiglottis to the mid-point of vocal folds distance, pre-epiglottic depth and time taken-up by the clinician to obtain the final ultrasonographic picture. All the measurements were then associated to the Cormack Lehane grading obtained while performing laryngoscopy and intubation. Based on the results it was observed that Pre-E/E-VC ratio had a strong positive correlation with the Cormack Lehane grading, concluding that the non-invasive ultrasonographic pre anaesthetic evaluation can supplement the currently available clinical tests and modalities.[3]

Next in 2014,Hui *et al.*did a prospective study proposing that in addition to the present available airway techniques, not being able to see the hyoid bone on the ultrasound image also provides additional proof for predicting a difficult laryngoscopic grade. Visualization of the hyoid employing US was correlated with a CL grade of 1-2 and had a positive correlation. The other methods had appreciable lower likelihood ratios and sensitivity. The resultant information indicates that sublingual ultrasonography is a viable instrument as an add on to the classical methods of airway assessment.

Methodology

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

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.

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**
HMDR	0.95	0.10	0.77	1.22	0.95	0.10	0.8	1.09
ANC-VC (cm)	0.50	0.12	0.29	0.74	0.52	0.17	0.28	0.98

	III				IV			
	Mean	**S.D.**	**Minimum**	**Maximum**	**Mean**	**S.D.**	**Minimum**	**Maximum**
HMDR	1.00	0.12	0.86	1.16	1.00	0.14	0.83	1.14
ANC-VC(cm)	0.56	0.20	0.4	0.9	0.55	0.19	0.34	0.71

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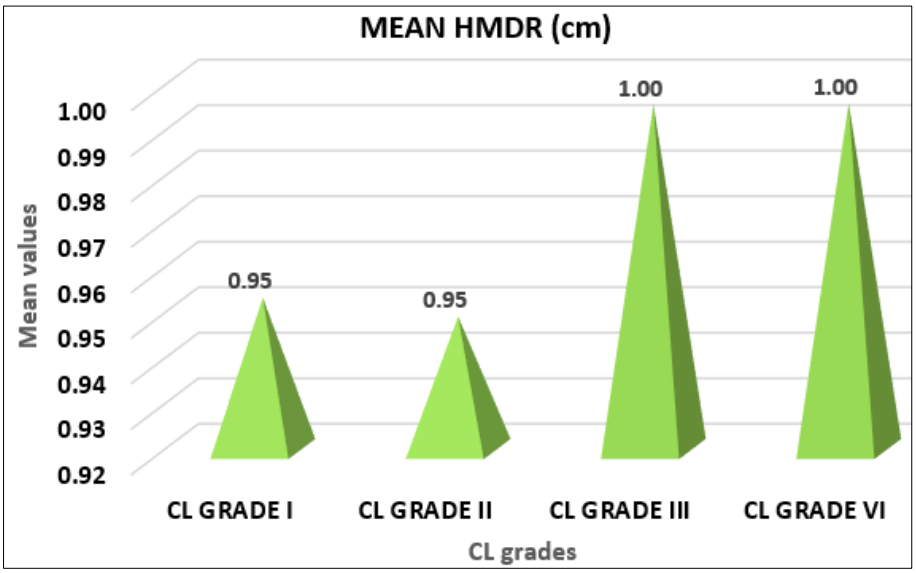
Using ANOVA, the mean of four CL grades are compared for homogeneity of means in the groups.



Graph 1: Mean HMDR (cm)

Table 2: Inference of the analysis

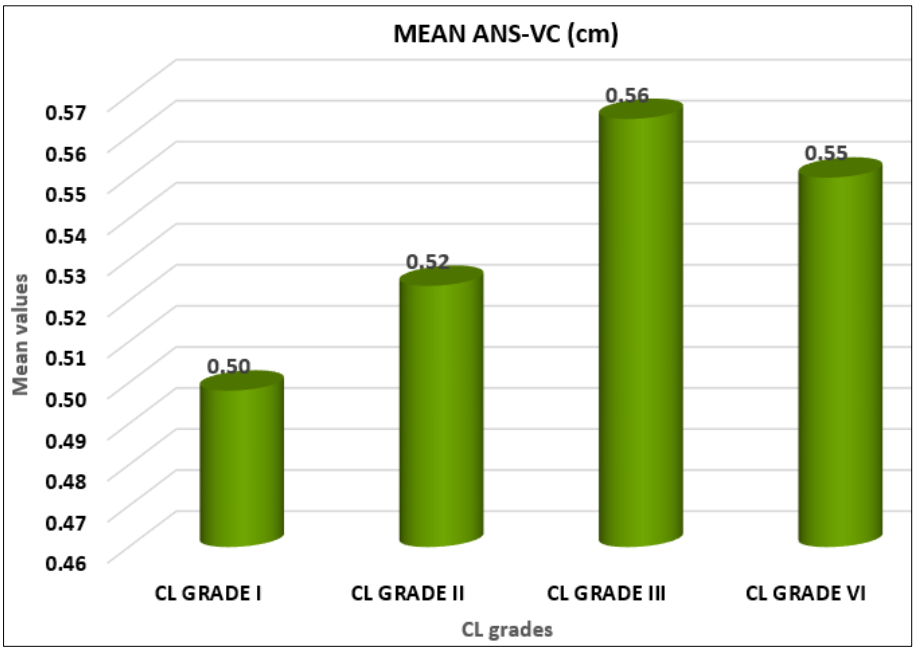
	p Value	Inference
HMDR	0.6684	NS
ANC-VC (cm)	0.6550	NS

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
HMDR	0.1416	0.2805	NS
ANS-VC (cm)	0.1574	0.2298	NS

The HMDR and ANS-VC showed no linear correlation.



Graph 2: Mean ANS-VC

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Discussion

Visualization of the glottis as assessed by CL grading during laryngoscopy depends on several factors, including the extension of the head at the atlanto-occipital and atlanto-axial joints.

Huh *et al.*, stated that the values of HMDR can be a reliable indicator for difficult intubation. In their study HMDR alone had the highest predictive value for difficult laryngoscopy with cut-off point of 1.2 at which this measure had a sensitivity of 88%. However, in our study the value for HMDR did not vary much for the Cormack Lehanegradings with it sensitivity being only 62.51%. The p value obtained made it not so significant for diagnosing difficult airway.[5]

In other study done by Wojtczak*et al*., the mean hyomental distance in the neutral position did not differ significantly between the two groups: 51.3±5.3 mm (difficult intubation) versus 57.5±4.3 mm (easy intubation), although the difference in the mean hyomental distance in the head-extended position, 52.6±5.8 mm (difficult intubation) and 65.5±4.1 mm (easy intubation), did differ significantly (p<.01). But in our study we observed that the mean hyomental distance ratio in CL I and II was 0.95±0.10 whereas it was 1.00±0.12 and 1.00±0.14 in CL III and IV respectively. It did not differ significantly in our study.[2]

In the study conducted by Rana *et al*. in 2018, the range of HMDR is 1.085-1.21 and 1.02-1.15 in the easy and difficult laryngoscopy, respectively (P = 0.00). The difference in the range of values can be due to the different patient profiles and strata. US measurement of HMDR has moderate predictive value in predicting easy and difficult laryngoscopy. However, it was not helpful in predicting CL grade 1 or 2, as the cutoff value was more than 1.085 for both gradings. These observations were similar to what we observed in this study where the range of HMDR in CL grades I and II were beteen 0.77-1.22 and 0.80-1.09 respectively and 0.86-1.16 and 0.83-1.14 in grades III and IV respectively. It had diagnostic accuracy of only 61% demonstrating that ultrasonographic measurement of HMDR is not as significant.[6]

We also studied ANS-VC and found that this parameter had low diagnostic accuracy as compare to the other parameters. The mean values of ANC-VC were 0.50±0.12 and 0.52±0.17 for the CL grades I and II respectively and 0.56±0.20 and 0.55±0.19 for grades III and IV respectively. There was not much difference in the range of this parameter observed in our study population.

In a study by Komatsu *et al*., patients with difficult laryngoscopy had thinner neck soft tissue thickness at the level of vocal cords (20.4±3.0 vs 22.3±3.8mm; P=0.049), although this difference was small (1.9mm) and unlikely to be clinically relevant. Hence there did not appear to be a relationship between anterior soft tissue thickness and the Cormack Lehane grade. Similarly in our study the anterior neck soft tissue thickness at the level of vocal cords did not vary much in all the Cormack Lehane groups and was not a good predictor of difficult laryngoscopy and intubation.[7]

In a somewhat identical study which was undertaken in the Middle Eastern population, the clinicians found that the presence of pre-tracheal soft tissue in both easy and difficult laryngoscopic groups were not correlated. (Ezri*et al*.) They studied that patients with difficult laryngoscopy had a larger neck circumference [50 (3.8) cm] than patients with easy laryngoscopy [43.5 (2.2) cm]; p< 0.001). The difficult laryngoscopy patients also had much more soft tissue in zone 1 [(28 (2.7) mm] (where zone 1 is the distance from the skin to the anterior aspect of the trachea at the level of vocal cords) than did patients with easy laryngoscopy [17.5 (1.8) mm, p< 0.001]. According to their study zone 1 soft tissue appears to be the best predictor of a difficult laryngoscopy.[8]

In a study by Reddy *et al.*, they concluded that the ANS-VC is a strong instrument in the assessment of difficult airway and correlated a depth of more than 0.23cm as a difficult airway predictor.[9]

In another study conducted by Wu *et al.*, in Chinese population they found that the thicknesses of anterior neck soft tissue were greater in the difficult laryngoscopy group i.e. the CL grades III and IV and were significantly correlated. Furthermore, the ranges of anterior neck soft tissue for those with difficult laryngoscopy were mutually exclusive from those patients with an easy laryngoscopy, indicating that they are independent predictors of difficult laryngoscopy.[10]

Conclusion

- US is a reliable instrument to anticipate difficult-airway in the pre-operative area by measuring the ratio of pre-epiglottic depth to epiglottis to midpoint of vocal cords, HMDR and ANS thickness at the level of vocal cords.
- The HMDR and ANS-VC showed no linear correlation

Financial Support: None

Conflicts of interests: There are no conflicts of interest.

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DOI: 10.69605/ijlbpr_13.6.2024.98

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