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AN OBSERVATIONAL STUDY TO COMPARE ULTRASOUND-GUIDED AIRWAY ASSESSMENT PARAMETERS WITH CORMACK LEHANE GRADING OF LARYNGOSCOPY IN PATIENTS UNDERGOING GENERAL ANAESTHESIA

Anaesthesiology

Dr Archana Lal DA, DNB, Senior Resident, Department of Anaesthesiology, Jagjivan Ram Railway Hospital

Dr Dinesh Kumar Sahu MD, Head of the Department, Department of Anaesthesiology, Jagjivan Ram Railway Hospital

Dr Haripriya T MD, Consultant Anaesthesiologist, Asian Cancer Institute and Cumballa Hills Hospital, Mumbai

ABSTRACT

Background and Aim: Airway management remains an essential challenge in anaesthesia, and preoperative airway assessment facilitates appropriate preparation when difficulty with intubation or ventilation is anticipated before induction of anaesthesia. This study aimed to evaluate the most widely recommended parameters - Anterior neck soft tissue thickness at the vocal cord level (ANS- VC), Hyomental Distance ratio (HMDr), and Tongue volume (TV) to determine their correlation with modified Cormack- Lehane (CL) grading. **Methodology:** This observational study was conducted to correlate USG findings with CL grading on 120 patients aged 18 to 80 years after receiving permission from the institutional ethical committee. Patients with Mallampati class 3 and 4, thyromental distance less than 6.5 cm, and sternomental distance less than 12.5 cm were predicted to have difficult intubation before the operation. These patients were compared with the Cormack Lehane grading observed during intubation. **Results:** Most patients with an anterior soft tissue vocal cord distance of less than 0.3 cm had no issues with intubation. The diagnostic accuracy of the ANS-VC was 79.17%, suggesting that it could be an independent predictor for difficult intubation. The CL grade depended on the tongue volume cut-off (>65.06 cm3). Tongue volume demonstrated excellent sensitivity (92.31%), but an inferior positive predictive value (19.35%). **Conclusion:** The study found that ANS-VC and TV are more effective in predicting difficult intubation, with ANS-VC being the most reliable predictor. These parameters can be combined to identify the risk of difficult intubation in emergency and elective surgeries.

KEYWORDS

Airway Assessment, Cormack Lehane grading, General Anaesthesia, Ultrasound.

INTRODUCTION

Anaesthesiologists administering general anaesthesia must completely master the patient's airway to ensure adequate ventilation and oxygenation. Any unexpected or unforeseen difficulty in managing the airway can result in severe complications or even the death of patients undergoing elective procedures. Therefore, improving methods for anticipating difficult airways and having the necessary tools to intervene [1] is important. A difficult airway is "the clinical situation in which a conventionally trained Anaesthesiologist experiences difficulty with upper airway ventilation in a mask, difficulty with tracheal intubation or both" [2].Ultrasonography (USG) is widely used for airway assessment among imaging techniques due to its safety, speed, repeatability, portability, and availability. USG provides real-time dynamic images and is a non-invasive technique. [3,4]

Laryngoscopy and tracheal intubation can be difficult in 1.5% to 13% of cases. The ability to predict these difficulties is hindered by variability between observers [5,6] and the low predictability of standard airway assessment screening tests. Several studies have suggested that specific airway sonographic parameters could be used to predict difficult laryngoscopy, although a definitive conclusion has yet to be reached. This study aimed to evaluate the most widely recommended parameters - Anterior neck soft tissue thickness at the vocal cord level (ANS- VC), Hyomental Distance ratio (HMDr), and Tongue volume (TV) to determine their correlation with modified Cormack- Lehane (CL) grading.

MATERIAL AND METHODS

The prospective observational study was conducted for 12 months in a tertiary care institute in an operation theatre complex after approval from the Ethics Committee of JRH, Mumbai (File No. EC/19000153: Govt. of India DGHS/CDSCO Ethics Committee Registration Division).

120 patients between the ages of 18 and 80, with ASA grade I-III, undergoing elective non-obstetric surgeries under general anaesthesia, were enrolled in the study.

Patients with restricted mouth opening, patients requiring rapid sequence induction, pregnant women, patients with soft tissue swelling over the neck, cervical spine injury or abnormality and patients with restricted neck movements were excluded from the study. Patients were informed about the anaesthesia technique and the study's nature, and written informed consent was obtained. An airway examination was conducted using the Modified Mallampati test, thyromental distance, and sternomental distance, and the findings were noted. The study also involved taking three ultrasonography measurements.

1. Anterior Neck Soft Tissue Thickness at Level of Vocal Cords (ANS-VC): The patient was asked to lie down in a supine and sniffing position while a 5-13 MHz linear transducer was used to measure the thickness of the anterior neck soft tissue at the level of the anterior commissure of vocal cords in the transverse section.
2. Hyomental Distance Ratio (HMDr): This ratio was calculated by measuring the distance from the hyoid to the anterior-most of the chin using a curvilinear transducer (3-5 MHz) in the midsagittal plane (HMDn). The patient was then asked to fully extend their head without lifting their shoulders, and the hyomental distance was measured again in this position (HMDe). The hyomental distance ratio (HMDn/HMDe) was calculated from the neutral to extended neck positions.
3. Tongue volume (TV): The tongue volume (TV) was calculated by multiplying the midsagittal cross-sectional area and width in the transverse plane using a curvilinear and linear transducer.

Figure 1: Ultrasound Measurement of ANS-VC: Distance from Skin to Thyroid Cartilage. Ultrasound Probe in Transverse Position

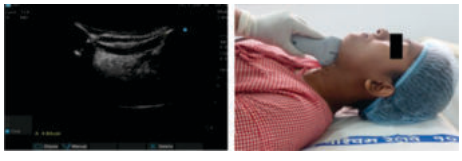

Figure 2: Ultrasound Measurement of HMD: Ultrasound Pprobe in Parasagittal Position

After thoroughly evaluating the patient's airway, they were taken to the operating room and positioned lying on their back with their head elevated 8-10 cm to achieve the optimal sniffing position. Standard

monitors were applied, and a difficult airway cart was kept on standby for all cases. A standard anaesthesia protocol was followed for all patients during the induction of anaesthesia. Direct laryngoscopy was performed by a qualified anaesthesiologist with a minimum of 5 years of experience, and the intubation grade was noted according to the modified Cormack Lehane classification. Intubation was classified as easy (CL grades 1, 2a, and 2b) or difficult (CL grades 3a, 3b, and 4). The number of intubation attempts, alternative difficult intubation approaches, invasive airway access, and procedure cancellations due to the inability to secure the airway were all documented.

Statistical Analysis

Data was collected using a pre-validated case record proforma, and then it was entered into Microsoft Excel and analyzed using the statistical software SPSS 21. For quantitative data, we calculated the mean ± SD, and for qualitative data, we calculated the percentage and proportion. Categorical variables were analyzed using the chi-square test and Fisher exact test. We also calculated sensitivity and specificity and considered a p-value < 0.05 as statistically significant. Finally, we used receiver operating characteristic curve analysis to determine cut-off values for all three parameters (Fig 3).

RESULTS

In our study, we observed that 52 (43.3%) patients were aged 41-60 years, 39 (32.5%) were aged 21-40 years, 22 (18.3%) were over 60 years old, and 7 (5.8%) patients were 20 years old or younger. 58 (48.3%) patients had ASA Grade 1 status, and 48 (40%) patients were in ASA Grade 2. In most cases, 69 (57.5%), had a normal BMI, while 36 (30%) cases were overweight. In our study, most patients had a thyromental distance of more than 6.5 cm and a sternomental distance of more than 12.5 cm. Most patients had Cormack-Lehane grade 2b or lower, whereas 10.9% had a Cormack-Lehane grade higher than 3 (see Table 1).

Table No.1: Distribution of patients according to Cormack-Lehane grade

Cormack- Lehane grade	Number	Percentage
Grade 1	14	11.7
Grade 2a	34	28.3
Grade 2b	59	49.2
Grade 3a	11	9.2
Grade 3b	02	1.7
Total	120	100.0

Patients with a Thyromental distance (TMD) measurement of greater than 6.5 cm had a 94.2% intubation success rate, which involved 98 individuals. In contrast, those with a TMD measurement of less than 6.5 cm had a difficult intubation success rate of 43.8%, involving 7 individuals.

Similarly, patients with a Sternomental distance (SMD) greater than 12.5 cm had a 94% success rate with intubation (94 individuals), while patients with an SMD less than 12.5 cm had a difficulty rate of 35% (7 individuals) with intubation. This suggests that the Cormack-Lehane (CL) grade was reliant on the SMD as shown in Table 2.

Table No. 2 : Distribution of CL grade according to TMD & SMD

TMD	Easy	Difficult	Total
>6.5 cm	98 (94.2%)	6 (5.8%)	104
<6.5 cm	9 (56.3%)	7 (43.8%)	16
Total	107	13	120
SMD	Easy	Difficult	Total
>12.5 cm	94 (94%)	6 (6%)	100
<12.5 cm	13 (65%)	7 (35%)	20
Total	107	13	120

Table no 3: Validity parameters of ANC-VC distance (cm) and TV (mm^3) against ease of intubation as adjudged using Cormack-Lehane grade

Validity parameters	ANS-VC	TV
Sensitivity	76.92%	92.31%
Specificity	79.44%	53.27%
PPV	31.25%	19.35%
NPV	96.59%	98.28%
Diagnostic accuracy	79.17%	57.50%

Table 3 displays the validity parameters of ANS-VC and TV for predicting intubation difficulty. The anterior neck soft tissue vocal cord distance showed good sensitivity (76.92%), but poor positive predictive value (31.25%). This means it can be used as a screening tool to predict difficult intubation, but it cannot be relied upon to confirm difficult intubation.

Anterior neck soft tissue vocal cord distance had good specificity (79.44%), and excellent negative predictive value (96.59%). This indicates that it can be used as a preliminary indicator for predicting and confirming easy intubation. The sensitivity of tongue volume was found to be excellent at 92.31%, but the positive predictive value was low at 19.35%. This means that although tongue volume can be used to screen for potentially difficult intubation, it is unreliable for confirmation.

In Table 4, it is shown that there was a significant correlation between the ANS-VC distance cut-off (>0.3 cm) and the C-L grade (P=0.001), indicating that the C-L grade is affected by the distance cut-off (>0.3 cm). It is noted most patients with ANS-VC < 0.3 cm underwent easy intubation.

Table No.4: Association between Anterior neck soft tissue vocal cord distance (cm), tongue volume and CL Grade.

		C-L Grade		Total
		Difficult	Easy	
Anterior neck soft tissue vocal cord distance (cm) cut-off (>0.3 cm)	>0.3 cm	10 (31.3%)	22 (68.8%)	32 (100%)
	≤0.3 cm	3 (3.4%)	85 (96.6%)	88 (100%)
	Total	13 (10.8%)	107 (89.2%)	120 (100%)
Tongue volume cut-off (>65.06 cm3)	>65.06 cm3	12 (19.4%)	50 (80.6%)	62 (100%)
	<65.06 cm3	1 (1.7%)	57 (98.3%)	58 (100%)
	Total	13 (10.8%)	107 (89.2%)	120 (100%)

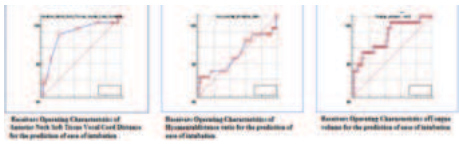

Figure 3: Receiver operating characteristics curve of Anterior neck soft tissue vocal cord distance (cm), tongue volume and CL Grade

DISCUSSION

Airway management is essential in anaesthesia, and preoperative airway assessment helps prepare for potential intubation or ventilation challenges before administering anaesthesia. Our study included 120 patients, with 54 male and 66 female participants. Among patients aged over 60, 27.3% (6) experienced difficult intubation, while only 2.6% (1) of those aged 21-40 encountered difficulty. These findings support previous research by Ezri et al. [7] and H Y Moon et al. [8], suggesting that older age and poor dental health may increase the risk of challenging laryngoscopy and intubation due to bone and joint changes.

The average BMI of the patients in our study was 24.5 ± 3.7. Nine patients had a BMI greater than 30, while 111 had a BMI lower than 30. Previous studies indicate that individuals with a BMI over 30 may experience intubation challenges. However, our study found no significant statistical correlation between high BMI and difficult intubation.

The study found that 25.8% of the participants had a Mallampati score of Grade I, 44.2% had a score of Grade II, and a small percentage of 2.5% had a score of Grade IV. Another study conducted by Safavi et al. [9] showed similar results, where 50.9% of patients had a Mallampati score of Grade I, 36% had a score of Grade II, and only 0.4% had a score of Grade IV.

P. Andruszkiewicz et al. [10] conducted a study on 199 patients, of which 11.1% had difficult intubation and 88.9% had easy intubation. The percentage of easy and difficult intubation was 89.2% (107) and 10.8% (13), respectively. The study found that 10.8% had difficult intubation, consistent with some previous studies. Koh L. K et al. [11] analyzed the distribution of the different grades of modified Cormack Lehane grading in 605 patients to determine the factors that predict difficult laryngoscopy and its association with difficult intubation.

The present study showed that 31.3% of the subjects had difficult intubation with ANS-VC > 0.3 cm, whereas 96.6% had easy intubation

with ANS-VC < 0.3 cm. This indicated that intubation was straightforward in most patients with anterior neck soft tissue vocal cord distance ≤ 0.3 cm. The study also found that anterior neck soft tissue vocal cord distance had reasonable specificity (79.44%) and excellent negative predictive value (96.59%). Hence, anterior neck soft tissue vocal cord distance can be used as a screening tool to predict easy intubation and confirm easy intubation. Overall, the diagnostic accuracy of ANS-VC is excellent (79.17%), suggesting that it can be used as an independent predictor for difficult intubation. These results are consistent with previous studies conducted by Reddy P. B et al [12], Yadav U et al [13], and Singh S et al [14].

In our research, we found that the classification of difficult laryngoscopy (CL grade) depended on a tongue volume cut-off of more than 65.06 cm^3. Tongue volume showed excellent sensitivity (92.31%) but a poor positive predictive value (19.35%). Therefore, tongue volume can be used as a screening tool to predict difficult intubation but cannot be relied upon to confirm difficult intubation.

Parameswari et al. [15] measured the tongue's width and cross-sectional area using ultrasound to calculate the tongue volume and understand how tongue size affects laryngoscopy. Yao et al. [16] used a 2D method and discovered that a thicker tongue was an independent predictor for difficult tracheal intubation and laryngoscopy. Singh S et al. [14] found that ultrasonographic parameters can predict difficult airways by measuring anterior neck soft tissue thickness, hyomental distance ratio (HMDr), and tongue volume.

Our study indicated that a hyomental distance ratio of more than 1.28 corresponded with easy intubation, but the area under the curve was only 0.524 and not statistically significant (P=0.8183). This indicates that the hyomental distance ratio cannot be used to predict ease of intubation. Takenaka et al.[17] studied HMDr in patients with rheumatoid arthritis in the sitting position and concluded that HMDr < 1.2 cm is associated with difficult intubation.

CONCLUSION

This research aimed to evaluate the effectiveness of using ANS-VC, TV, and HMDr measurements under USG guidance to predict difficult airway assessment. The study found that ANS-VC and TV were the best indicators of challenging intubation, with ANS-VC being the most significant factor. Tongue volume can be used as a preliminary screening tool but cannot definitively confirm difficult intubation. On the other hand, HMDr did not show a significant correlation with the ease of intubation. These parameters, when used together, can accurately help eliminate the risk of difficult intubation in both emergency and elective surgeries.

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