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Comparison Of Hyomental Distance Ratio And Neck Circumference To Thyromental Distance Ratio For Predicting Difficult Visualisation Of Larynx In Intensive Care Unit, An Observational Study

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ABSTRACT

Background: Anticipating Difficult Visualization of Larynx (DVL) allows the practitioner to be prepared in order to prevent failure of intubation. This study was done to compare the usefulness of Hyomental Distance Ratio (HMDR) versus Neck Circumference to Thyromental Distance Ratio (NC/TMD) in predicting DVL in Diabetic ICU patients.
Methods: 115 ICU patients with diabetes mellitus of age 18-60 years, of both genders, undergoing tracheal intubation were included in study. Using steel ruler, distance from tip of hyoid bone to anterior part of mentum was measured with head in neutral position (HMDn). Distance was then measured with head extended (HMDe). HMDR was calculated. Neck circumference was measured at the level of thyroid cartilage. Thyromental distance was measured from thyroid notch to mentum in full head extension. NC/TMD ratio was calculated. Patients were preoxygenated, induced and paralysed. Glottis was visualised using direct laryngoscopy, by an experienced anaesthesiologist and graded according to Modified Cormack Lehane's grading.
Results: Average age of the subjects included in the study was around 45.07±12.48 years. Incidence of difficult laryngoscopy in our study was found to be 18.26%. As per statistical analysis using Chi-square test, results showed strong significance. Sensitivity of HMDR was 90.48% and specificity was 91.49% with a cut-off of ≥1.2. Sensitivity of NC/TMD ratio was found to be 85.71% and specificity was 87.17% with a cut-off of ≤5. The overall accuracy was also higher with HMDR over NC/TMD ratio. Thus, HMDR was an easy and reliable indicator of DVL compared to NC/TMD.
Conclusion: Hyomental Distance Ratio is a better predictor of Difficult Visualisation of Larynx compared to Neck Circumference to Thyromental Distance Ratio in Diabetic ICU patients. A combination of tests yields better accuracy.
Categories: Anaesthesiology, Critical Care

Key words: Difficult visualisation of larynx, Hyomental Distance Ratio, Neck Circumference to Thryomental Distance Ratio, Diabetes mellitus and Intensive Care Unit.

INTRODUCTION

Endotracheal intubation is a common procedure performed in critically ill patients.[1] It is observed that patients admitted in Intensive Care Units have higher incidence of Difficult intubation of 25-39%[2], compared to those undergoing endotracheal intubation for elective surgeries.[3] It has been reported that 13% of intubations in ICU required three or more attempts and 10% needed 10 or more minutes to intubate.[4]

Since most of the intubations are emergencies, there may be little time for optimisation of the patient, unlike prior to elective surgeries.[3] 22-54% intubations could have complications like hypoxemia, aspiration, hemodynamic instability, hypoxic brain injury and cardiac arrest. [5, 6] Thus, failure or delay in intubation could have life threatening consequences in an already compromised cardiopulmonary state. [2, 3, 5]

Hence, anticipating an event of a possible difficult intubation considerably improves morbidity and mortality of the patients.[7] It allows the practitioner to be prepared in advance for such adverse events, in the form of better planning of first attempt, back up plans, better intubation equipment selection and calling for the help of experienced personnel.[5]

Many attempts have been made to develop a quick, simple and reliable method, requiring minimum equipment and skills, to predict DVL. But many of these bedside tests have moderate predictive power when used alone. Though better in combinations, their clinical accuracy is limited.[8] With this study, we have compared and analysed two such well-established predictive tools for their ability to predict DVL in patients admitted in Intensive Care Unit (ICU).

Hyomental Distance (HMD) has been used to estimate the submandibular space, while increase in the Hyomental Distance Ratio (HMDR) corresponds to the range of extension of Occipio-atlantoaxial (OAA) joint.[9] There are studies to show that HMDR is a clinically reliable predictor of DVL,[10, 11] while not being affected by age and gender.[12]

The incidence of Difficult Intubation (DI) in obese patients is 13%-20%.[13] It has been reported that the amount of pretracheal soft tissue at the level of vocal cords, as quantified by ultrasound, determines a difficult laryngoscopy.[14] It is denoted by neck circumference at the level of vocal cords, that is at the level of thyroid cartilage. Tongue is pushed into the mandibular space during laryngoscopy. TMD is known to estimate the mandibular space.[15] Thus, TMD predicts the difficulty in displacing the tongue during laryngoscopy. A ratio of the two, Neck circumference to Thyromental Distance ratio (NC/TMD) has been concluded as the predictors of difficult intubation.[13]

The objective of this study is to evaluate and compare the diagnostic validity of Hyomental Distance Ratio and Neck Circumference to Thyromental Distance Ratio in predicting the DVL in patients admitted in ICU.

METHODOLOGY

This Cross-Sectional study was done among 115 adult patients undergoing endotracheal intubation in Intensive Care Unit of M S Ramaiah Medical College and Hospitals during the period February 2021 to October 2022, after taking informed consent and Institutional ethical committee approval. This study included hemodynamically stable adult patients with diabetes mellitus (Age 18-60 years) of either gender, admitted in ICU, requiring mechanical ventilation. The Exclusion criteria for the study were patients with Upper airway pathology (maxillofacial fractures, tumours, anatomical deformities), Cervical spine fracture, Midline neck swellings, Recent head and neck surgery and Patients in respiratory distress.

Patient was kept in supine position with head in neutral position and mouth closed, without a pillow. The distance from the tip of the hyoid bone to the anterior most part of the mentum was measured (HMDn) using a steel ruler. The distance was then measured on extending the head maximally, taking care shoulders were not lifted (HMDe). HMDR was calculated as the ratio of HMDe to HMDn. Neck circumference was measured at the level of thyroid cartilage. Thyromental distance was measured as the distance from thyroid notch to the mentum in full head extension. NC/TMD ratio was calculated.

All patients were preoxygenated with 100% oxygen for at least 3 minutes and received Midazolam 0.5 mg and Fentanyl 2 mcg/kg. All the patients were induced with Propofol 2 mg/kg and paralysed with Succinyl choline 2 mg/kg. Head was placed on a head ring and in sniffing position. Using McIntosh Laryngoscopy blade 3 or 4, glottis was visualised by a minimum 1-year experienced anaesthesiologist, who was blinded to the measurements. Visualisation was graded according to Modified Cormack and Lehane grading (CL grade).[16]

Grade 1 – Full view of glottis
Grade 2A – Partial view of glottis
Grade 2B – Only arytenoids seen

Grade 3 – Only epiglottis seen
Grade 4 – Neither epiglottis nor glottis seen
A CL grade of 3 and 4 was taken as DVL. The study ended after CL grade was assessed.

STATISTICAL METHODS:
The Statistical software SPSS 19.0 was used for the analysis of the data.
Student t test (two tailed, independent) was used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. Leven`s test for homogeneity of variance was performed to assess the homogeneity of variance. Chi-square/ Fisher Exact test was used to find the significance of study parameters on categorical scale between two or more groups, non-parametric setting for Qualitative data analysis. Fisher Exact test was used when cell samples were very small.

RESULTS
Subjects with CL grade 3 and 4 were taken as DVL. It was noted that 21 out of 115 (18.26%) study subjects had DVL (Table 1, 2). Out of the total 115 subjects studied, 46 (40%) were female and 69 (60%) were male. Average age of the subjects in our study was 45.07±12.48.
8 of 11 patients with HMD at the head extension (HMDe) ≤ 5.3 cm had difficult visualization of the larynx, while 13 of 104 of patients with HMD at the extreme of head extension > 5.3 cm had difficult visualization of the larynx (Table 3). All the values had strong statistical significance.
16 out of 85 patients with HMD in the neutral position (HMDn) ≤ 5.5 cm had difficult visualization of the larynx, while 5 out of 30 patients with HMD in the neutral position > 5.5 cm had difficult visualization of the larynx (Table 4). The values were not statistically significant.
19 of 27 patients with HMDR ≤ 1.2 had difficult visualization of the larynx, while 2 of 88 of patients with HMDR > 1.2 had difficult visualization of the larynx (Table 5). The sensitivity of HMDR for predicting Difficult Laryngoscopy was 90.48% and specificity was 91.49%. The test has a positive predictive value of 70.37%, Negative predictive value of 97.73%. Thus, overall accuracy of HMDR was 91.30% (Table 6).
2 of 43 patients with NC ≤ 35 cm had difficult visualization of the larynx, while 19 of 72 of patients with NC > 35 cm had difficult visualization of the larynx (Table 7). All the values had moderate statistical significance.
5 of 9 patients with TMD at the head extension ≤ 6.5 cm had difficult visualization of the larynx, while 16 of 106 of patients with TMD at the extreme head extension > 6.5 cm had difficult visualization of the larynx (Table 8). All the values had strong statistical significance.
18 of 31 patients with NC/TMD > 5 had difficult visualization of the larynx, while 81 of 84 of patients with NC/TMD ≤ 5 had Difficult visualization of the larynx (Table 9). The sensitivity of NC/TMD for predicting Difficult Laryngoscopy was 85.71% and specificity was 86.17%. The test has a positive predictive value of 58.06% and Negative predictive value of 96.43%. Thus, the overall accuracy was 86.09% (Table 10).
HMDR had higher sensitivity of 90.48% compared to NC/TMD of 85.71%. HMDR also had higher specificity of 91.49% compared to NC/TMD of 86.17%. Positive predictive value of HMDR was significantly higher (70.37%) compared to that of NC/TMD (58.06%). Negative predictive value of HMDR and NC/TMD was similar (97.73% and 96.43% respectively). Overall accuracy was also better with HMDR (91.30%) compared to NC/TMD (86.09%) (Table 11).

Table no. 1: CL grade – Frequency distribution in study participants

CL GRADE	N	%
1	30	26.1
2a	38	33.0
2b	26	22.6
3	18	15.7
4	3	2.6
Total	115	100.0

Table no. 2: DVL - Frequency distribution in study participants

DVL	N	%
Absent	94	81.74
Present	21	18.26
Total	115	100.0

Table 3: Correlation of findings of HMDe with DVL

HMD(e)	ABSENT		PRESENT		Grand Total		Chi-sq	P value
	N	%	N	%	N	%		
≤ 5.3 cm	3	3.2	8	38.1	11	9.6	20.3	0.0001*
> 5.3 cm	91	96.8	13	61.9	104	90.4		
Grand Total	94	100.0	21	100.0	115	100.0		

Table 4: Correlation of findings of HMDn with DVL

HMD(n)	ABSENT		PRESENT		Grand Total		Chi-sq	P value
	N	%	N	%	N	%		
≤ 5.5 cm	69	73.4	16	76.2	85	73.9	0.07	0.5
> 5.5 cm	25	26.6	5	23.8	30	26.1		
Grand Total	94	100.0	21	100.0	115	100.0		

Table no. 5: HMDR vs DVL

HMDR	CL-DVL			
	PRESENT		ABSENT	
	N	%	N	%
≤ 1.2	19	90.4	8	8.5
> 1.2	2	9.6	86	91.4
TOTAL	21	100	94	100

Table no. 6: Correlation of findings of HMDR to predict DVL

Statistic	Value	95% CI
Sensitivity	90.48%	69.62% to 98.83%
Specificity	91.49%	83.92% to 96.25%
Positive Predictive Value (*)	70.37%	54.68% to 82.38%
Negative Predictive Value (*)	97.73%	91.99% to 99.38%
Accuracy (*)	91.30%	84.59% to 95.75%

Table no. 7: Correlation of findings of NC with DVL

NC	ABSENT		PRESENT		Grand Total		Chi-sq	P value
	N	%	N	%	N	%		
≤ 35 cm	41	43.6	2	9.5	43	37.4	7.1	0.005*
> 35 cm	53	56.4	19	90.5	72	62.6		
Grand Total	94	100.0	21	100.0	115	100.0		

Table no. 8: Correlation of findings of TMD with DVL

TMD	ABSENT		PRESENT		Grand Total		Chi-sq	P value
	N	%	N	%	N	%		
≤ 6.5 cm	4	4.3	5	23.8	9	7.8	6.5	0.01*
> 6.5 cm	90	95.7	16	76.2	106	92.2		
Grand Total	94	100.0	21	100.0	115	100.0		

Table no. 9: NC/TMD vs DVL

NC/TMD	CL-DVL	
	PRESENT	ABSENT

	N	%	N	%
> 5	18	85.7	13	13.8
≤ 5	3	14.3	81	86.2
TOTAL	21	100	94	100

Table no. 10: Correlation of findings of NC/TMD to predict DVL

Statistic	Value	95% CI
Sensitivity	85.71%	63.66% to 96.95%
Specificity	86.17%	77.51% to 92.43%
Positive Predictive Value (*)	58.06%	44.81% to 70.25%
Negative Predictive Value (*)	96.43%	90.42% to 98.72%
Accuracy (*)	86.09%	78.39% to 91.83%

Table no. 11: Comparison of HMDR and NC/TMD to predict DVL

Statistic	HMDR	NC/TMD
Sensitivity	90.48%	85.71%
Specificity	91.49%	86.17%
Positive Predictive Value (*)	70.37%	58.06%
Negative Predictive Value (*)	97.73%	96.43%
Accuracy (*)	91.30%	86.09%

DISCUSSION

Difficult Visualisation of Larynx is the most common cause of failed intubation. Predicting the possibility of such an adverse event gives us vital time to be prepared to prevent a failed intubation and its complications. Numerous tests have been tried and tested with time to come up with an ideal diagnostic bedside test to accurately predict DVL.[17] Consequently, this study was performed to assess and compare diagnostic validity of HMDR versus NC/TMD ratio in difficult visualization of larynx in ICU patients requiring tracheal intubation, admitted in M S Ramaiah Hospitals from February 2021 to October 2022.

During laryngoscopy, straightening of visual axis from mouth to larynx needs to occur, to visualise vocal cords. This is made possible by extension of occipitoatlantoaxial (OAA) complex. [18,19] HMDR represents occipitoatlantoaxial extension capacity.[9] Radiological studies[18] revealed that the HMD increased during extension of the head at the OAA complex and also in the subaxial regions. This means that the hyoid bone moves parallel to the cervical spine during movement of the head and neck. As a result, the HMDR alone was highly correlated with the OAA complex extension capacity.[11] A minimum angle of 15±6° is required to visualise the glottis and at least 10±5° to visualise the arytenoids.[20] The corresponding HMDR was calculated as 1.25.[11] In our study, a cut-off point of 1.2 was taken based on the literature.[10, 11]

There are various studies that has proved the diagnostic utility of HMDR among other parameters in predicting intubation in patients posted for elective surgeries. However, there are only few studies evaluating dependability of HMDR as a predictor of DVL in ICU patients.

Difficult laryngoscopy has been known to occur more in obese patients than non-obese patients.[21] Neck circumference has been proven to be an indicator in predicting DVL in obese patients,[21,22] Since the amount of soft tissue at the level of vocal cords decides the difficulty in laryngoscopy,[14] neck circumference was measured at the level of thyroid cartilage in our study.[22]
Thyromental distance ratio is also another bedside DVL predictor which has been evaluated in numerous studies. TMD is known to estimate the mandibular space, into which tongue is displaced during laryngoscopy.[15] Thus, TMD predicts the difficulty in displacing the tongue during laryngoscopy. NC/TMD ratio is expected to denote the larger amount of soft tissue in the neck, hence predicting the difficult visualisation of larynx.[13]

We conducted our study with patients in supine position, since patients requiring intubation in ICU may not be able to sit, due to altered level of consciousness and poorer general condition. Sitting position causes the caudal shift of hyoid bone due to gravity.[23] Supine position prevents this. Also, supine position would be the final position for endotracheal intubation, hence pre-intubation evaluation will be more accurate.

Demographics: -

A total of 115 patients of 18 to 60 years of age, admitted in ICU requiring tracheal intubation were included in the study. Mean age among the participants was 45.07 years. Out of 115 patients, 69 (60%) were men and 46 (40%) were women. DVL was found more in males compared to females in our study, though the data was not statistically significant.

Incidence:

Visualization of the larynx is expressed using the Cormack and Lehane grading, where grades 3 and 4 usually correlate with Difficult visualisation of larynx. The incidence of DVL was 5.8% in routine surgeries,[1,8] 3.1% for obstetric and 15.8% for obese patients.[8] Based on previous studies, difficult intubation in ICU were attributed to 30% of the cases.[6]

In our study, the larynx was difficult to visualize (Cormack and Lehane grades 3 and 4) in 21 out of 115 (18.26%) patients studied, which is almost similar to other studies. There were no failed tracheal intubations.

Huh et al in their study with 213 patients undergoing general anaesthesia with tracheal intubation, found 12.2% incidence of DVL.[11] Likewise, Liaskou et al. reported an incidence of 10.5% of DVL in their study on 1134 patients undergoing surgeries under general anaesthesia with tracheal intubation.[24] The difference in the incidence of DVL may be due to difference in factors like age, ethnicity, obesity or laryngoscopy blade used.[25]

Sensitivity and specificity of HMDR and NC/TMD:

Cut offs used to calculate the sensitivity and specificity in our study were:

- HMDR ≤1.2
- NC/TMD ≤ 5

In our study, the highest sensitivity of (90.48%) was observed in predicting DVL with HMDR compared to NC/TMD ratio (85.71 %) and the specificity was slightly higher with HMDR (91.49%) than NC/TMD ratio (86.17%). The overall accuracy was also higher with HMDR over NC/TMD ratio.

These results were similar to study by Kalezic et al.[10] where HMDR with cut off of 1.2 had proven to be significant predictor of DI with sensitivity of 95.6% which is better than our study probably due to larger sample size of 262 patients.

Our results contrasted the study conducted by Rao et al.[26] in 198 patients where specificity of HMDR was found to be much higher (98.89 %) compared to our study. Sensitivity (27.78 %) was found to be significantly lower in comparison, may be due to a higher cut off of 1.25. Positive predictive value was similar to our study with 71.43%.

Study conducted by Vikas et al.[27] proposed that better results with higher specificity (98.89%) could be achieved with a higher cut off of HMDR (≤ 1.25). They had similar PPV of 71.43%. In comparison, our results had statistically significant sensitivity with a cut off of ≤ 1.2 for HMDR.

Manayaliul[28] in his study of 328 obese patients, found that NC/TMD ratio had specificity of 89.4% and sensitivity of 76.9%, which was similar to our study results. He had used Intubation difficulty score (IDS) ≥ 5 as difficult intubation standard as opposed to CL grade in our study.

Kim et al.[13] evaluated 123 obese and 125 non-obese patients and found that sensitivity of NC/TMD was 88.2% and specificity was 83%. They found Negative predictive value of 97.8%, similar to our study.

NC/TMD had a higher sensitivity (100%) and specificity (82%) in the study conducted by Naim et al.[29], thus they reported better accuracy with a cut off of ≥ 5.15. But they did their study in only 50 patients with OSA as study subjects.

The HMDR was previously introduced as a new reliable predictor of DVL. HMDR was found to be an easy and quick bedside test, without needing any special devices. It was also proven to be more accurate compared to direct measurement of the OAA complex extension, which needed the use of goniometer.[19] In this study, we confirmed diagnostic validity of HMDR as a predictor of Difficult Visualisation of Larynx to a certain extent. NC/TMD was also found to be a decent predictor, lacking only slightly compared to HMDR. We recommend using a combination of these for better results.

LIMITATIONS

There are some potential limitations in our study. Although our results were statistically significant with the given sample size, studying the validity in a higher sample size could yield better accuracy. More similar studies are needed to use HMDR as a routinely used predictor of difficult intubation in ICU patients.

Although DVL is a major determinant of difficult intubation, it is not the only cause for difficult intubation. In this study, CL grades 3 and 4 were taken as DVL. However, the application of external laryngeal pressure facilitates a better laryngoscopic view and intubation can be performed with ease. There might also be cases where adequate laryngoscopic view may not lead to successful endotracheal intubation.

Our study was conducted in a single centre. A multi-centric study would give more valid results.

CONCLUSION

In our study, the highest sensitivity (90.48%) was observed in predicting DVL with HMDR compared to NC/TMD ratio (85.71 %) and the specificity was slightly higher with HMDR (91.49%) than NC/TMD ratio (86.17%).

Thus, our study concluded that Hyomental Distance Ratio can be used as a reliable predictor of Difficult Visualisation of Larynx in ICU admitted diabetic patients due to its significant diagnostic accuracy, with value 1.2 as cut off, compared to Neck Circumference to Thyromental Distance ratio. Neck Circumference to Thyromental Distance Ratio also was found to be an acceptable predictor with a cut off of 5. Although HMDR alone is a reliable predictor, we recommend using a combination of tests for more accurate results.

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