PREDICTION OF DIFFICULT LARYNGOSCOPY IN PREGNANT WOMEN UNDERGOING CESAREAN SECTION USING THE RATIO OF HYOMENTAL DISTANCE RATIO IN COMPARISON WITH NECK CIRCUMFERENCE TO THYROMENTAL DISTANCE RATIO, HEIGHT TO THYROMENTAL DISTANCE RATIO, MODIFIED MALLAMPATY TEST AND UPPER LIP BITE TEST: A PROSPECTIVE BLINDED STUDY

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Abstract

Background: Unexpected difficult intubation, which may be considered a failed intubation, is a major factor relating to mortality and morbidity, following general anesthesia. We aimed to elucidate the role of five usual tests and their possible correlation in predicting difficult laryngoscopy in parturient patients undergoing cesarean section.
Materials and Methods: 716 consecutive parturient scheduled for elective cesarean section under general anesthesia, requiring endotracheal intubation, were enrolled into this study. Each patient was evaluated regarding HMD ratio, NC/TMD, RHTMD, MMT and ULBT before surgery. Laryngoscopy was assessed by a skilled anesthesiologist, blinded to the preoperative airway assessment. The laryngoscope result was graded according to Cormack-Lehane classification. Sensitivity, specificity, positive predictive value and area under curve (AUC) or receiver operating characteristic (ROC), for each airway predictor in isolation and in comparison with each other, were established.
Results: The sensitivity of HMD ratio was 45.4%, with AUC=0.551(P=0.071). MMT, as an old predictive test (AUC=0.582, 95%CI, 0.545–0.619), NC/TMD (AUC= 0.600, 95%CI, 0.563–0.637), HMDe (AUC=0.672, 95%CI, 0.636 –0.706) and HMDn (AUC=0.651,95%CI, 0.614–0.686) are good predictors for difficult intubation. The differences of the last four ROCs were statistically significant($P<0.05$).
Conclusion: We consider that, in addition to MMT (as an ancient predictor), NC/TMD, HMDn and HMDe in parturient patients with higher incidence of difficult visualization of larynx (DVL) rather than general population, are good and reliable predictors of difficult laryngoscopy and intubation.

Keywords : Cesarean Section; Laryngoscopy; Intubation; Airway management; Anesthesia .

1. Introduction

Failure to achieve endotracheal intubation is a tangible endpoint that causes morbidity and mortality[1]. The incidence of failed intubation has been reported to a range of 0.7–31.3%[2]. However, in obstetrics, this has been considered to approximately ten times greater incidence than in the general population (1 in 250 patients). Most of the airway difficulties occur when they are not predictable before anesthesia. Therefore, a skilled anesthesiologist should have the ability to determine the difficulties with airway management[3,4]. Although performing of general anesthesia in obstetrics has significantly declined in recent years, it is still inevitable in special situations, such as massive maternal hemorrhage, overt coagulopathy, fetal bradycardia, which is life threatening, and finally, patient refusal towards neuraxial techniques. The last reason mentioned above is one of the most frequent indications of general anesthesia in obstetrics, in developing countries.

Recently, studies have shown that neck circumference to thyromental distance (NC/TMD) is a sensitive test to predict difficult airway in general population[5] and obstetric patients[6]. Also, the ratio of height to thyromental distance (RHTMD), that has high sensitivity, is sufficiently sensitive to detect possible difficulties with laryngoscopy and intubation in obstetrics [area under the curve (AUC) = 0.627, 95% confidence interval(95%CI), 0.589–0.664][7].

The modified Mallampati classification has poorprognostic value[2,6,7,8]in many studies. In addition, Savva[8]showed that modified Mallampatitest (MMT) was neither sensitive, nor specific enough, as a single test, in predicting difficult intubation in parturient patients.

In one study, Honarmand et al.[9]showed that HMDR(hyomental distance ratio) is comparable with RHTMD and upper lip bite test (ULBT) in predicting difficult airway. Also,Takenaka et al.[10]showed that HMDR is a clinically reliable predictor of difficult visualization of larynx (DVL) in the general population.

Recently, the description of ULBT, by Khan et al.,[11,12] has come under scrutiny.

No published study has compared HMDR with ULBT,RHTMD, MMT, and NC/TMD by their sensitivity, specificity, and positive and negative predictive values for prediction of difficult laryngoscopy in pregnant patients, yet.

Therefore, the hypothesis underlying this study was to develop predictors for difficult intubation in paturients candidate for cesarean section under general anesthesia, and to test if HMDR has a positive correlation with other mentioned indices, and which of them has a direct correlation with the difficult laryngoscopic view and difficult intubation.

2. Patients and methods:

With approval of the institutional Ethics Committee from our university, informed consent was obtained before each parturient anesthesia.
Patients with a history of trauma to the airway or cranial and cervical spine fracture, cervical and facial regions pathology, or who were edentulous or requiring awake intubation, patients with restricted motility of the neck and mandible (e.g., cervical disc disorders or rheumatoid arthritis), or inability to sit were not included in the study.
During the 18-month period, 716 consecutive American Society of Anesthesiologists (ASA) physical status I and II adult patients, who were undergoing cesarean delivery under general anesthesia, with tracheal intubation, were enrolled into this prospective observational study. Each parturient data collected included age, weight, height and body mass index (BMI). A skilled anesthesiologist, with at least 5-year experience in anesthesia, not imparted to the noted preoperative airway assessment, carried out laryngoscopy and rating of the difficulty of intubation (as per Cormack-Lehane's classification[13,14]).
The Cormack-Lehane grading system for laryngoscopic view is defined as:grade 1 - visualization of the entire laryngeal aperture;grade 2 - visualization of only the posterior portion of the laryngeal aperture;grade 3 - visualization of only the epiglottis;and grade 4 - no visualization of the epiglottis or larynx.
Difficult visualization of larynx (DVL) was defined as grade 3 and 4 of laryngoscopy.

The subsequent five measurements of predictive test were performed in all patients:

- HMDR: The ratio of hyomental distance in full extension of neck to this distance in neutral position(as shown inFigure 1)[10].

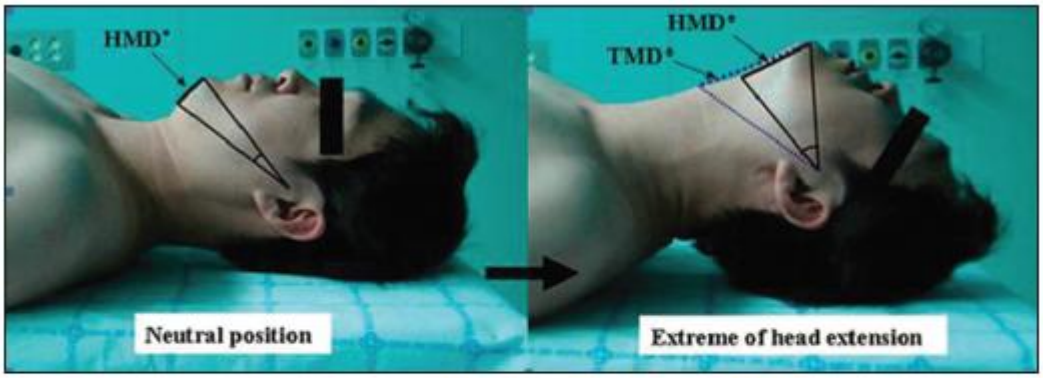

Figure 1: Method for measuring the hyomental distance ratio. The HMDR was defined as the ratio of the hyomental distance at the extreme of head extension (expressed as HMDe) to that in the neutral position (expressed as HMDn). Thyromental distance at the extreme of head extension was expressed as TMD

- NC/TMD: The neck was measured at the level of cricoid cartilage and thyromental distance was measured from the bony point of the mentum, while the head was fully extended, with mouth closed. TheNC/TMD ratio was calculated[5].
- RHTMD: Thyromental distance was measured from the bony point of the mentum, while the head was fully extended with mouth closed.Then, the RHTMD was calculated[7].
- MMT: Modified Mallampati testas described bySamsoon and Young. Classes are differentiated on the basis of thestructures visualized: class I:soft palate, fauces,

uvula, tonsillar pillars;class II: soft palate, fauces, uvula; class III: soft palate, base of theuvula; class IV: soft palate not visible[15].

- ULBT: ULBT was introduced as follows: Class I: the lower incisors can bite the upper lip above the vermilion line; Class II: lower incisors could bite the upper lip below the vermilion line; Class III: lower incisors could not bite the upper lip[11].

After arrival of the patient to the operating theatre and complete monitoring of the vital signs , each parturient who received the aspiration prophylaxis[15], was preoxygenated for 5 minutes and anesthesia was induced intravenously,with sodium thiopental (5mg/kg) and suxamethonium chloride (2mg/kg) for facilitating endotracheal intubation. Sellick maneuver[16] was applied until the patient was intubated and the cuff was inflated and confirmation of successful intubation was made by bilateral auscultation of lungs and capnography. Laryngoscopy was performed with a 5-year experienced anesthesiologist, not imparted of the noted preoperative airway assessment. For the first laryngoscopy in each case, a size 3 Macintosh laryngoscope blade was used.
Difficult visualization of larynx has been defined as grades 3 and 4 in the Cormack-Lehaneclassification, and grades 1 and 2 of this classification are defined as easy visualization of larynx(EVL).
Patient data were presented as mean ± SD. The BMI and value of the airway predictors were compared using *t*-tests for continuous variables and U-test for MMT or ULBT. Sensitivity, specificity, and positive predictive value (PPV) were obtained and compared amongst predictors. Differences between the AUC values for the five predictor tests were analyzed using MedCalc statistical software,version 9.3.6.0 (MedCalc Software bvba, Ostend, Belgium). The data were analyzed using SPSS version 20 (SPSS Inc., Chicago, IL, USA).

3. Results:

A total of 716 patients were enrolled into this study. Three cases had grade IV Cormack-Lehane, which tracheal intubations were performed with the aid of a videolaryngoscope. There are no significant differences in demographic data between EVL and DVL. (Table 1)
The distribution of ASA, MMT, ULBT and the Cormack- Lehane grading are presented in Table 2.
Table 3 shows that the differences on NC/TMD, HMDe and HMDn are statistically significant, in comparison with the other tests.
The predictive value of MMT, ULBT, NC/TMD, RHTMD, HMDe, HMDn, HMDR are presented in Table 4. The main end point in this study, the AUC of the ROC, were lower for ULBT(AUC=0.532; 95%CI, 0.494–0.569) and HMDR (AUC=0.551; 95%CI, 0.514–0.588) and RHTMD (AUC= 0.555; 95%CI, 0.517–0.591) in comparison with MMT(AUC=0.582,95%CI, 0.545–0.619), NC/TMD (AUC= 0.6; 95%CI, 0.563–0.637), HMDe (AUC=0.672, 95%CI, 0.636–0.706) and HMDn (AUC=0.651,95%CI, 0.614–0.686). The differences of the last four ROCs were statistically significant($P<0.05$).
In discrimination analysis, MMT grade >I, ULBT grade ≥II, RHTMD ≥19.2, NC/TMD ≥4.1, HMDe≤6, HMDn≤4 and HMDR ≥1.4 were considered as the cutoff points in predicting DVL. The RHTMD is the least sensitive of the tests, with the sensitivity of 41.6%.The MMT and NC/TMD had the highest sensitivities, among the predictors (73.4% and 58.3%, respectively).

4. Discussion:

Difficult laryngoscopy and intubation can cause irreparable sequels for the patient, if not handled properly. Studies to find predictive tests with high accuracy continue even at this moment. Little works have been published, based on the use HMDR, MMT, ULBT, RHTMD and NC/TMD, in obstetrics airway management. This study was designed to evaluate the efficacy of the five tests above in forecasting difficult laryngoscopy and to reveal a possible correlation between the tests and Cormack-Lehane grade of laryngoscopy. The previous studies have shown the incidence of difficult intubation to range between1.3%–17%[2,20] and it is ten times more in parturient[6]. In this study, the incidence of DVL was 18.4%,which was comparable with the previous studies. In Merah et al.[21] study, the incidence of DVL in Nigerian parturients was 10%. We can support our findingson the presence several differences in head position, degree of muscle relaxation and different anthropometric features.
Several studies have related weight increase and BMI with the risk for DVL[22], although others,[23,24] similar to the present study in parturients, have found that the incidence of DVL was not correlated with BMI. This may be due to not using general anesthesia in these parturient candidates for elective cesarean section.
In this study, ULBT failed to be a reliable bedside test in predicting DVL. The descriptive reason was the limited amount of cases with ULBT grade III(0.8%), of which only 0.1% had DVL. On the other hand, in patients who had ULBT I and II, the probability of DVL was exceedingly low, that is comparable with previous studies[11,12].
The accuracy of NC and NC/TMD for prediction of DVL in non-obstetric patients was documented by Gonzalez[25] and Kim et al.[5] In this study and the previous one[6], we found that NC and NC/TMD were the most useful predictors in parturients with AUC of ROC 0.564(P=0.022) and 0.6(P=0.000), respectively.
The 73.4% sensitivity of the MMT combined with 22.9% PPV, suggests that, for a reliable prediction of difficult laryngoscopy, Mallampati scoring should be combined with other predictors. However, in this study, the AUC of ROC of MMT is 0.582(P=0.003).
The HMD (measured in supine position, with the head fully extended and with the mouth closed, as the straight distance from the lower border of the mandibular mentum to the superior border of the hyoid bone, in centimeters) that was described as HMDe in this study, had a significant difference in DVL(P<0.001). Also, HMDn(measured in supine position, with head in neutral position) is a good predictor of difficult intubation(P<0.001).The study of Khan et al.[12]described the HMD as a valuable predictor of DVL. However, HMDR has the sensitivity of 45.4% and is not a good predictor in the parturients.
In conclusion, there are stepwise increases in the incidence of Cormack-Lehane grades III and IV, as the MMT class shows a rise form II to III and more, the NC/TMD increases from the value of 4.1, the HMDe and HMDn decrease from their predetermined values of 6 and 4 cm, respectively. Therefore, we consider that NC/TMD, HMDe, HMDn are good predictors of difficult laryngoscopy and intubation, in obstetric patients.

5. Tables:

Table 1: Patients characteristics

Variables	Patients(n=716)	EVL(n=584)	DVL(n=132)	Pvalue
Age(years)	28.8±4.9	28.7±4.9	29.1±4.9	0.428

Weight(kg)	76.7±12	76.5±12	77.4±12.1	0.440
Height(cm)	161±6.1	161±6.3	160±5.6	0.082
BMI(kg/m²)	29.6±4.3	29.5±4.3	29.8±4.2	0.398

EVL: Easy visualization of larynx, DVL: Difficult visualization of larynx, BMI: Body mass index, Data are presented as mean ± SD. P<0.05 statistically significant.

Table 2: Distribution of ASA, MMT,ULBT and laryngoscopic view of all patients

Variable	Number(%)
ASA	
I	573(80)
II	143(20)
Mallampati Class	
I	293(40.9)
II	263(36.7)
III	*124(17.3)*
IV	36(5)
ULBT	
I	390(54.5)
II	320(44.7)
III	6(0.8)
Laryngoscopic view	
I	362(50.6)
II	222(31)
III	129(18)
IV	3(4)

ASA: American Society of Anesthesiology, ULBT: Upper Lip Bite Test

Table 3: Distribution of Statistically differences in all tests in DVL and EVL

Variables	DVL(n=132)	EVL(n=584)	P value

TMD	8.9± 1.5	9.2±1.4	0.025
RHTMD	18.5±3.6	17.8±2.9	0.010
NC	36.5±2.5	35.9±2.8	0.018
NC/TMD	4.2±0.8	3.9±0.6	0.000
HMDe	6.6±1	7.2±1	0.000
HMDn	4.9±1.1	5.4±1.1	0.000
HMDR	1.38±0.2	1.37±0.2	0.497

DVL: Difficult view of laryngoscopy, EVL: Easy view of laryngoscopy, TMD: Thyromental distance ratio, RHTMD: Ratio of height to thyromental, NC: Neck circumference, NC/TMD: Neck circumference to thyromental distance, HMDe: hyomental distance in extention of neck, HMDn: Hyomental distance in neutral position of neck, HMDR: ratio of HMDe/HMDn. Data is presented as mean ± SD. P value < 0.05 is significant.

Table 4: Predictive value for MMT,ULBT, RHTMD,NC/TMD, HMDe, HMDn and HMDR to predict the occurrence of DVL according to the modified Cormack- Lehane Classification

Test	Sensitivity	95%CI	Specifisity	95% CI	+LR	-LR	PPV (%)	NPV (%)	AUC of ROC curve	P value
MMT	73.4	65.1-80.8	44.1	40.1-48.3	1.32	0.6	22.9	88.1	0.582	0.003
UBLT	50.7	41.9-59.6	55.6	51.5-59	1.14	0.88	20.6	88.3	0.532	0.262
RHTMD	41.6	33.2-50.6	75	71.3-78.1	1.67	0.78	27.4	85	0.555	0.053
NC/TMD	58.3	49.4-66.8	64.3	60.3-68.3	1.64	0.65	27	87.2	0.600	0.000
HMDe	49.2	40.4-58.1	79.2	75.8-82.5	2.38	0.64	34.9	87.4	0.672	0.000
HMDn	47.7	39-56.5	82.8	79.5-85.8	2.78	0.63	38	87.5	0.651	0.000
HMDR	45.4	36.8-54.3	73.4	69.6-77	1.71	0.74	27.9	85.6	0.551	0.071

MMT: Modified Mallampati Test, ULBT: Upper lip bite test, RHTMD: Ratio of height to thyromental distance, NC/TMD: Ratio of neck circumferences to thyromental distance,HMDe: hyometal distance in head fully extended with closed mouth, HMDn: hyomental distance in neutral position, HMDR: hyomental distance ratio, CI: Confidence Interval, AUC: Area under curve, ROC: Receiver- operating characteristic curve. P< 0.05 statistically significant.

6. Conclusion

Our study demonstrated that, in addition to MMT (as an ancient predictor), NC/TMD,HMDn and HMDe, in parturients with higher incidence of DVL, rather than general population, are good and reliable predictors of difficult laryngoscopy and intubation, using a standard laryngoscope.

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