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Original Article

Comparison of Chest Circumference to Sternomental Distance Ratio and Cormack Lehane Score for Prediction of Difficult Intubation in Obstetric Patients

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Abstract

Introduction: The endotracheal intubation in pregnant patient poses unique challenges. Pregnancy-related changes in maternal anatomy, such as airway edema, breast enlargement, and chest expansion predispose patient for the higher incidence of difficult intubation. Delayed gastric emptying and decreased lower esophageal sphincter tone that further add to risk during airway management as a result of regurgitation and aspiration of gastric content. Physiological changes in obstetric patients, such as decrease in functional residual capacity and increase in oxygen demand result in a very narrow margin of safety for the development of hypoxemia during failure to secure the airway.

Materials and Methods: A prospective observational study was conducted at the Labor Operation Theater and Gynecology Operation Theater at a tertiary care hospital. After getting clearance from the Institutional Ethics Committee, the study commenced from October 2019 till September 2021.

Results: The results of the study are tabulated in various tables which helps in the comparison of Chest Circumference to Sternomental Distance Ratio (CC/SMD) And Cormack Lehane (CL) Score for Prediction of Difficult Intubation in Obstetric Patients.

Conclusion: CC/SMD ratio over 7 has a good corelation with grades of laryngoscopy on CL score and ease of intubation. Hence measurement of CC and ratio of CC/SMD can be included in pre-operative evaluation of obstetric patients undergoing cesarean section with general anesthesia for prediction of ease of intubation. However, to get statistically significant findings, further study with a large sample size may be required to support our conclusion.

Key words: Chest, Circumference, Distance, Patient

INTRODUCTION

The endotracheal intubation in pregnant patient poses unique challenges. Pregnancy-related changes in maternal anatomy, such as airway edema, breast enlargement, and chest expansion predispose patient for the higher incidence of difficult intubation.

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Delayed gastric emptying and decreased lower esophageal sphincter tone that further add to risk during airway management as a result of regurgitation and aspiration of gastric content.[1]

Physiological changes in obstetric patient, such as decrease in functional residual capacity and increase in oxygen demand results in a very narrow margin of safety for the development of hypoxemia during failure to secure the airway.

Unpredictable difficult intubation is very frequent in obstetric anesthesia and needs good planning, ready availability of various airway equipment, and expertise to ensure safe airway management for maternal and fetal safety.

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The pre-operative evaluation is the clinical foundation and framework of perioperative patient management and can potentially reduce operative morbidity and enhance patient's outcome. Mallampati classification (MPC) remains a good predictor of difficult intubation. Although a useful tool, the MPC score by itself is not sufficient enough to assess and predict a difficult airway in obstetric patient.[2,3]

It is obvious that not only the anatomy of the patient but also the laryngoscopy technique has a major influence on glottic visibility. A variety of factors, such as used force, skills, experience, and training contribute to the laryngoscopy technique, and individual differences in these factors may cause some of the inter-observer variations in Cormack Lehane (CL) grading.[4]

The CL described a classification of the laryngeal view during laryngoscopy to identify difficult intubation. It has been widely adopted and is used by most anesthesiologists.

Other parameters for difficult intubation, such as interincisor distance (IID), mandibular protrusion (MP), thyromental distance (TMD), sternomental distance (SMD), and oropharyngeal space are most commonly used pre-operative tests that can assist to predict difficult intubation. For each of these parameters, there are several airway measures available, and their reliability and predictive ability varies widely.[5]

The new predictors of difficult intubation like chest circumference to SMD (CC/SMD) ratio assessment were carried out on pre-operative anesthesia evaluation which might avoid potential consequences of unpredictable difficult intubation.[6]

Hence, this study was carried out in an attempt to assess the predictability of difficult intubation on pre-operative evaluation of the assessment of CC/SMD ratio (SMDR) and comparing this ratio with CL score on direct laryngoscopy at the time of intubation in obstetric patients.

MATERIALS AND METHODS

Study Design

Prospective observational study.

Place of Study

Labor Operation Theater and Genecology Operation Theater at tertiary care hospital.

Duration of Study

After getting clearance from the Institutional Ethics Committee, the study commenced from October 2019 till September 2021.

Table 1.

Age	CC/SMD	CL
Mean	25.03 years	25.11 years
SD	3.71 years	3.9 years
Median	25 years	25 years
Significance	t=−0.119, *P*: 0.906	

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

Table 2.

Weight	CC/SMD	CL
Mean	66.83 kg	61.01 kg
SD	14.23 kg	13.67 kg
Median	65 kg	60 kg
Significance	t=−0.34, *P*: 0.36	

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

Table 3.

BMI	CC/SMD	CL
Mean	27.75	27.01
SD	4.88	4.97
Median	27.54	26.65
Significance	t=−0.995, *P*: 0.323	

BMI: Body mass index, CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

Table 4.

CC/SMD	Value
Mean	7.11
SD	0.61
Median	7.19

CC: Chest circumference, SMD: Sternomental distance

Table 5.

CL score	Interpretation	Number	Percentage
1	Good view of the glottis	12	15
2	Only posterior part of glottis seen	32	40
3	Only epiglottis is visible	34	42.5
4	No glottic structure visible	2	2.5
	Total	80	100

CL: Cormack Lehane

Table 6.

MPC	CC/SMD	CL
Mean	2.11	2
SD	0.52	0.63
Median	2	2
Significance	The t-value is−1.21721. The *P* value is 0.11267. The result is not significant at *P*<0.05	

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane, MPC: Mallampati classification

Sample Size

Approximately: 160.

Table 7.

Comparison between CC/SMDR and CL grading	Interpretation	Mean CC/SMD R	SD
Subgroup E (CL grade 1, 2)	Easy intubation	6.62	0.39
Subgroup D (CL Grade 3, 4)	Difficult intubation	7.51	0.24
Significance		The t-value is−11.64347. The *P* value is<0.00001. The result is significant at *P*<0.05.	

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

Table 8.

Parameters	CC/SMD			CL			*P*-value
	Mean	SD	Median	Mean	SD	Median	
HR	107.5	7.6	100	108.85	8.2	110	0.22
SBP	121.77	16.98	120	122.92	14.95	124	0.32
DBP	82.86	9.8	84	81.26	10.03	81	0.062
SpO_2	99.47	0.67	100	99.55	0.69	100	0.244

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 9.

Parameters	CC/SMD			CL			*P*-value
	Mean	SD	Median	Mean	SD	Median	
HR	104.45	10.71	100	114.23	9.11	114	<0.00001
SBP	118.75	15.99	120	119.97	14.07	120	0.30
DBP	80.65	12.62	80	76.3	11.8	80	0.012
$ETCO_2$	36.15	1.25	36	36.47	1.28	36	0.053
SpO_2	99.57	0.67	100	99.51	0.63	100	0.27

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Sample Method

Convenient sampling method.

Inclusion Criteria

1. Age 18–40 years with single uterine pregnancy
2. ASA grade I, II for cesarean section with indications for general anesthesia (GA).

Exclusion Criteria

1. Patient refusal to participate in the study
2. Patient with upper airway pathology
3. Patient with cervical spine pathology
4. Insufficient time for measuring pre-operative CC and SMD.

After IEC-HR approval, patients of age group 18–40 years of ASA grade I, II undergoing GA for elective/semi-emergency cesarean section and satisfying all inclusion and exclusion criteria were included in the study. All patients undergoing for cesarean section under GA and their immediate relative were explained about the study and written valid informed consent for their willingness to participate in the study was taken.

Preoperative evaluation with general and systemic examination was done. In the pre-operative examination, the height and weight of the patient, mouth opening, MPC class, SMD, and chest circumference (CC) were noted in all patients.

Mouth Opening

Assessed by using the maximal interincisor gap. Mouth opening <3 cm was considered as difficult direct laryngoscopy.

SMD

Was measured with a graduated tape in sniffing morning air position, from sternal notch to mental protuberance with mouth closed. SMD <13.8 cm was considered as Difficult intubation.[6]

The CC

(Widest at the nipple line) was measured in a sitting position with hands behind the head. CC >97 cm was considered as Difficult intubation.[6]

CC/SMDR

>7.1 was considered Difficult Intubation.[6]

Patients were selected in 2 groups as follows:

- Group A: patients in whom pre-operative CC/SMDR was noted
- Group B: patients in whom CL score was noted on direct laryngoscopy.

Standard GA protocol was followed from our institute.

After checking consent and starvation, the patient was taken on the operation table with a wedge under the right buttock. The standard monitors, such as pulse oximetry, ECG, and Non-invasive blood pressure attached. Equipment for difficult airway kept ready and suction checked. Pre-medication with injection of glycopyrrolate 0.004 mg/kg intravenously given. The patient was pre-oxygenated with 100% oxygen under a mask for 3 min using semi closed breathing circuit. Anesthesia induction was done with an injection propofol 2–3 mg/kg intravenously or an injection

Table 10.

Parameters	CC/SMD			CL			*P*-value
	Mean	SD	Median	Mean	SD	Median	
HR	100.87	8.2	99	104.72	9.55	102	**0.003**
SBP	119.12	13.66	118	121.08	12.86	122	0.17
DBP	79.75	11.51	80	77.12	10.16	80	0.064
$ETCO_2$	36.08	1.08	36	36.61	1.03	37	**0.001**
SpO_2	99.65	0.57	100	99.65	0.61	100	0.5

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 11.

MPC	CC/SMD		CL	
	Number	Percentage	Number	Percentage
1	7	8.75	16	20
2	57	71.25	48	60
3	16	20	16	20
Total	80	100	80	100
Significance	The Chi-square statistic is 4.2932. The *P* value is 0.116883.			
	The result is not significant at *P*<0.05			

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

Table 12.

ETT size	CC/SMD		CL	
	Number	Percentage	Number	Percentage
6	2	2.5	1	1.25
6.5	77	96.25	78	97.5
7	1	1.25	1	1.25
Total	80	100	80	100
Significance	The Chi-square statistic is 0.3398. The *P* value is 0.843756.			
	The result is not significant at *P*<0.05			

ETT: Endotracheal tube, CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

thiopentone 5 mg/kg intravenously depending on the hemodynamic of the patient. Cricoid pressure was applied by the assistant when the patient started losing consciousness and injection succinylcholine 1.5 mg/kg intravenously administered. The patient was ventilated with 100% 0xygen till fasciculation disappeared. The direct laryngoscopy was attempted by a senior anesthesiologist using Macintosh laryngoscope blade no. 3 and CL score was noted. Intubation was attempted with a 6/6.5/7 number portex cuffed endotracheal tube (ETT). The cuff inflated with air till there was no palpable audible leak noted. Successful tracheal intubation was confirmed by the presence of six consistent waveforms on capnography. The assistant released cricoid pressure once tracheal intubation confirmed and the cuff inflated. On auscultation, bilateral air entry was checked and confirmed with an $ETCO_2$ monitor.

CL score was noted on direct laryngoscopy during intubation:

- CL 1: Good view of the glottis
- CL 2: Only the posterior part of the glottis seen
- CL 3: Only epiglottis is visible
- CL 4: No glottic structure visible.

CL score group further divided into 2 subgroups:

- Subgroup E: Easy intubation - CL score 1 and 2
- Subgroup D: Difficult intubation - CL scores 3 and 4

Anesthesia was maintained with O_2, N_2O with intermittent Injection of Atracurium and sevoflurane using semi closed circuit with a circle absorber.

The alternative intubation techniques, if required, such as change of patient position, release of cricoid pressure during direct laryngoscopy or endotracheal intubation, use of External laryngeal maneuver (ELM), use of stylet, change of laryngoscope blade or handle was noted. A number of intubation attempts, additional operator required, was also noted.

Statistical Analysis

Association between different categorical variables was assessed using the Chi-square test. Quantitative variables between different groups were compared using Z-test for continuous data. Correlation methods used to find out the correlation between the two methods. CL scoring GROUP was divided into two subgroups: Subgroup E and Subgroup D in and statistical analysis were done by calculating the *P*-value. If calculated *P*-values were found <0.05, the difference was considered as significant.

RESULTS

Age Distribution

We had included 80 patients in each group between 18 and 40 years of age. The mean age of the CC/SMD group was 25 years and it was 25.11 in the CL group. The median of age in both the groups was 25 years and was statistically not significant.

Weight

We had included 80 patients in each group. The mean of

age in the CC/SMD group and CL score was 66.83 kg and 61.01 kg, which was statistically not significant.

Body Mass Index

The mean body mass index (BMI) in the CC/SMDR group was 27.75 and in the CL group, it was 27.01, which were comparable.

CC/SMDR

The mean of CC/SMDR was 7.11 with SD of 0.61.

CL Score (CL Group)

Out of 160 patients, CL scores 1 and 2 were found in 12 patients (15%) and 32 patients (40%), respectively. 34 patients had a CL score of 3, which was 42.5%, and a CL score of 4 was found in 2 patients (2.5%) only.

MPC Comparison for both Groups

The median value of MPC was 2 in both groups and they were comparable.

Comparison between CC/SMDR and CL Score Subgroup E and D

Eighty patients in the CL score group we subdivided again into 2 groups:

Group E (CL 1 and 2) had 44 patients and Group D (CL3 and 4) had 36 patients. The mean of the CC/SMDR in group E was 6.62 and in group D it was 7.51 with a standard deviation of 0.39 and 0.24, respectively. The result was found to be statistically significant ($P < 0.05$).

Vital Parameters

Baseline

Baseline vital parameters were comparable in both groups.

At induction

The mean heart rate (HR) in the CC/SMD group was 104.45 and in the CL group was 114 and also with diastolic blood pressure significant difference was noted at induction.

Post-induction

In post-induction phase, there was seen statistically significant difference as far as HR and $ETCO_2$ were measured.

MPC

We had 80 patients in each group. Out of 80 patients in the CC/SMDR group, 7 patients had MPC class 1 (8.75%), and in the CL score group, it was in 16 patients (20%). MPC 3 was found in 16 patients (20%) in both groups. The difference in two groups was statistically not significant.

ETT Size

Out of 80 patients, 96.25% of patients in the CC/SMDR group and 97.5% of patients in the CL score group intubated with 6.5 no. ETT. 2.5% of patients in the CC/SMDR group and only 1.25% in the CL score group intubated with 6 no. ETT in. 7 no. ETT was used in only 1 patient (1.25%) in both groups. The difference was statistically not significant.

Any Maneuver/Equipment Used

In the CC/SMDR group, out of 80 patients, 10 patients (12.5%) required ELM and a change in position of the patient. McCoy blade and stubby handle were used in 9 (11.25%) and 6 (7.5%) patients, respectively, in the CC/SMDR group. Two patients required the use of Frova.

In the CL score group, out of 80 patients, 9 patients (11.25%) required ELM and McCoy blade. Only 1 patient required a stubby handle in the CL score group. Change in operator and change in position of patient required in 17 (21.25%) and 8 (10%) patients, respectively. About 20 patients (25%) required Frova for intubation, which was a statistically significant difference as compared to CC/SMD group.

No. of Attempts for Successful Intubation

Out of 80 patients in the CC/SMDR group, successful intubation was done with one attempt in 53 patients (66.25%) and 27 patients (33.75%) required 2 attempts for successful intubation.

Out of 80 patients, in the CL score group, 46 patients (57.5%), 32 patients (40%), and 2 patients (2.5%) required 1 attempt, 2 attempts, and 3 attempts for successful intubation. The difference was statistically not significant.

Time Required for Successful Intubation

We had 80 patients in each group, the mean time required for intubation in the CC/SMDR group was 1.78 min and in the CL ratio it was 1.99 min. The difference was statistically not significant [Tables 1-13].

DISCUSSION

Most airway difficulties occur when they are not recognized before induction of anesthesia. Pre-operative prediction of potential difficulty with intubation can help to reduce the incidence of fatal complications by alerting the anesthesiologist to take additional precautions before beginning to administer GA and securing the airway. During pregnancy, anatomical and physiological changes occur in the body, which predisposes patient for higher incidence of difficult laryngoscopy and intubation in obstetric patients.

Parameters for difficult intubation, such as IID, MP, TMD, SMD, oropharyngeal space are the most commonly

used pre-operative tests that can assist to predict difficult intubation. For each of these parameters, there are several airway measures available, and their reliability and predictive ability varies widely.

CL described a classification of the laryngeal view scoring during laryngoscopy to identify difficult intubation which has been widely adopted and used by most anesthetists.[7]

Demographic Data

The two groups were comparable as far as all demographic parameters, such as age, sex, body weight, and BMI were concerned.

MPC Class

In our study, MPC grade 2 was found in 71.25% in the CC/SMDR group and 60% in the CL grade group. The result was statistically not significant.

CC/SMDR and other New Predictors of Difficult Intubation

Jarraya *et al*. in 2019[6] studied new predictors of difficult intubation in 143 obstetric patients undergoing cesarean section delivery under GA.

In pre-operative, SMD, TMD, chest and neck circumferences (NCs) were measured. Laryngoscopy was performed and CL score was recorded by an anesthesiologist who was blinded to pre-operative airway assessment. Patients were divided into two groups according to their Cormack laryngoscopic view: Group E for Cormack I or II, Group D: for Cormack III or IV. Differences between the difficult and easy groups were analyzed using a binary univariate logistic regression model to determine the significant risk factors for difficult intubation. Variables that were significantly associated on univariate analysis were included in a stratified multivariate model to identify significant independent predictors of difficult intubation. The incidence of patients having a CC to SMD over 7 was 18% in group E versus 54% in group D.

They found that new predictors- CC to SMDR were a method for predicting difficult intubation in obstetric patients when it exceeds to 7.1.

In our study, we also studied the CC/SMDR and compared with CL score for the prediction of difficult intubation in two groups of 80 each in obstetric patients. The CL score group was subdivided into subgroup E (CL score 1, 2) and subgroup D (CL score 3, 4) and statistical analysis was done by calculating *P*-value. Subgroup E had 44 patients and subgroup D had 36 patients comparable with no statistical significance in difference. Association between different categorical variables was assessed using the Chi-square test. Correlation methods were used to find out the correlation between the two methods. Statistical analysis was done by calculating the *P*-value.

Himranpour *et al*.[8] did a prospective blinded study for the prediction of difficult laryngoscopy in 716 pregnant women undergoing cesarean section by using the Hyomental Distance in fully extended and neutral positions of the neck, in comparison with four usual bedside tests, such as NC/TMD, Ratio of height to TMD (RHTMD), Modified Mallampati Test (MMT), and Upper Lip Bite Test (ULBT). The laryngoscopic result was graded according to the Cormack-Lehane Classification. Sensitivity, specificity, positive predictive value, and area under the curve (AUC) or receiver operating characteristic (ROC) for each airway predictor in isolation and in comparison, with each other was established. The sensitivity of HMDe and HMDn was 49.2 and 47.7%, respectively. Sensitivity of MMT as an old predictive test was 79.3% in comparison with sensitivity of NC/TMD, RHTMD and ULBT (58.3%, 41.6%, and 50.7%, respectively). The differences of AUC in all tests except ULBT were statistically significant ($P < 0.05$). The conclusion of the study was in addition to MMT, NC/TMD, and HMD in a neutral position and fully extended of the neck were good and reliable predictors of difficult laryngoscopy and intubation in parturient.

In our study, we assessed the CC/SMDR in fully neck extension and found to have a good correlation with easy or difficult laryngoscopy and intubation in obstetric patients.

Hirmanpour *et al*. 2014[9] did a prospective observational study to analyze the predictive value of the ratio of NC to TMD in comparison with four predictive tests for difficult laryngoscopy in 657 obstetric patients scheduled for cesarean delivery.

The five predictive test measurements were performed on all patients: NC to TMD (NC/TMD), NC, MMT, the RHTMD, and the ULBT. A senior anesthesiologist who was not informed of the pre-operative classes carried out a laryngoscopy and evaluated difficulty at intubation.

Patient data and the value of the airway predictors were compared using t-tests for continuous variables and U-tests for MMT or ULBT. Using discrimination analysis, MMT grade >I, ULBT ≥grade 2, RHTMD >28.83, NC >39.5, TMD ≥5, and NC/TMD >5.6 were considered as the cut-off points for predicting difficulty in laryngoscopy. The RHTMD was the least sensitive of the single tests with a sensitivity of 26.4%. ULBT and NC/TMD had the highest sensitivities among single predictors (100% and 71.1%, respectively). They found that difficult intubation was associated with TMD, increasing NC, RHTMD, and the ratio of NC/TMD. This study supported the use of assessing NC/TMD pre-operatively to predict potentially

difficult intubation as an easy and simple test.

However, in our study, we studied the CC/SMDR for the prediction of difficult intubation in 160 obstetrics patients and found that difficult intubation was associated with an increase in CC/SMDR over 7. This ratio predicts potentially difficult intubation with simple and easy pre-operative measurement test.

Al Ramadhani *et al*.[10] did a study to analyze the ability of SMD as a sole predictor of difficult laryngoscopy. SMD and subsequent direct laryngoscopy were recorded in 523 obstetric patients.

Pearson's correlation coefficient or Student's unpaired t-test was used to determine relationships between age, height, weight, BMI, and either SMD or laryngoscopic view. For analysis, laryngoscopic grade was grouped as "difficult" (grades III and IV) or "easy" (grades I and II). Subsequently, discriminant analysis was used to calculate the most accurate SMD cut-off point for discriminating between the difficult and easy laryngoscopic groups. There was a significant difference between SMD in those patients with a grade III or IV laryngoscopic view compared with those with a grade I or II 13.17 (SD 1.54 cm) versus 14.3 (1.49 cm); P=0.0013. A SMD of 13.5 cm or less provided the best cut-off point for predicting subsequent difficult laryngoscopy.

There was no association between SMD and age, weight, height, or BMI, there was a significant association between grade of laryngoscopy (III and IV) and older (P = 0.049) and heavier (P = 0.0495) mothers. The results were suggested that while SMD on its own may not be an adequate sole predictor of subsequent difficult laryngoscopy, the measurement should be incorporated into a series of quick and simple pre-operative tests.

In our study, we also measured SMD but we had taken the ratio of CC to SMD since SMD on its own may not be an adequate predictor of subsequent difficult laryngoscopy as seen from the above study also. It was found that the ratio of CC/SMD correlated well with the CL score.

Eighty patients in the CL score group were subdivided into 2 groups- subgroup E (CL 1, 2) had 44 patients and subgroup D (CL 3, 4) had 36 patients. The mean of the CC/SMDR in subgroup E was 6.62 and in subgroup D it was 7.51 with a standard deviation of 0.39 and 0.24, respectively. The result was found to be statistically significant ($P < 0.05$).

Patel *et al*.,[11] the study was undertaken in 135 adults to assess the validity of different parameters in predicting difficult intubation for GA and the effect of combining the parameters on the validity. MMT was used and the TMD and SMDs for each of the patients were also measured. The CL laryngoscopic grading was assessed following laryngoscopy. The effect of combining different measurements on the validity was also studied. Univariate analysis was performed using the parametric method. The sensitivity and specificity of MMT were 28.6% and 93%, respectively. The TMD (<6.5 cm) had sensitivity and specificity of 100% and 75.8%, respectively. The SMD (<12.5 cm) had a sensitivity and specificity of 91% and 92.7%, respectively. After a combination of MMT grading and TMD and SMD measurements, validity (sensitivity of 100% and specificity of 92.7%) increased. MMT had high specificity. The validity of combination of MMT, SMD, and TMD as compared to MMT alone was very high in predicting difficult intubation in adult patients, hence all parameters should be used in assessing an adult patient for surgery under GA.

However, in our study, we did not study individual parameters but instead compared the CC/SMDR with the CL score for the prediction of difficult intubation in 160 obstetrics patients, selected into 2 groups. The result was found to be statistically significant ($P < 0.05$).

Safavi *et al*.[12] did a prospective observational study in 603 consecutive patients scheduled for elective surgery under GA. They did this study to compare the ability to predict difficult laryngoscopy from pre-operative airway predictive indices, in isolation and combination: MMT, the RHTMD, and the ULBT. Experienced anesthesiologists performed the laryngoscopy and grading as per Cormack and Lehane's classification and not informed about pre-operative airway evaluation findings. Difficult laryngoscopy (Grade 3 or 4) occurred in 41 (6.8%) patients. The AUC of the ROC, was significantly lower for the MMT than the ULBT (P = 0.002), and the RHTMD score (P = 0.001). There was no significant difference between the AUC of the ROC for the ULBT and the RHTMD score.

They used discrimination analysis and found that the optimal cutoff point for the RHTMD for predicting difficult laryngoscopy was 21.06 (sensitivity, 75.6%; specificity, 58.5%). The conclusion of this study was the RHTMD is comparable with ULBT for the prediction of difficult laryngoscopy in the general population.

In our study, the ratio of CC/SMD over 7 was found to be correlated with CL scores 3 and 4 on laryngoscopy with statistically significant difference.

Number of Attempts and/any Alternative Techniques Used for Successful Intubation

Riad *et al*.[13] did a prospective observational study in 94 parturient scheduled for caesarean section under GA to analyze the ability to predict difficult intubation with the help of NC. Pre-operative airway assessment and NC were measured. According to the intubation difficulty scale (IDS), 10 intubations were difficult intubations (IDS ≥5).

A number of intubation attempts, additional operators required, alternative intubation techniques, the position of the vocal cords, and Cormack and Lehane score, external laryngeal pressure and use of lifting force with the laryngoscope to obtain a better view of the vocal cords were also recorded. All these mentioned items were used to determine the IDS.

In our study, we found first that in CC/SMDR group, successful intubation done with one attempt in 53 patients and 27 patients required 2 attempts for successful intubation [Table 14].

In the CL score group, 46 patients required 1 attempt, 32 patients required 2 attempts and 2 patients (2.5%) required 3 attempts for successful intubation. Although, the difference in both groups was statistically not significant.

The mean time required [Table 15] for intubation in the CC/SMDR group was 1.78 min and in the CL ratio it was 1.99 min so it was comparable in both groups.

Second, in our study, 10 patients required ELM and change in position in the CC/SMDR group with the use of McCoy blade in 9 patients and stubby handle in 6 patients. In the CL score group, 9 patients required ELM and the use of a McCoy blade; only 1 patient required the use of stubby handle. Change in operator and change in position of patient required in 17 and 8 patients, respectively. All these results were comparable in both groups.

Kopanaki *et al*.[14] conducted a prospective; the double-blind pilot study included 221 consecutive adult patients scheduled for elective surgery under GA. The aim of this study was to evaluate the effectiveness of the ratio of the SMD in neutral and full neck extension position SMDR as a predictor of difficult laryngoscopy and any need of assisted intubation.

Physical and airway characteristics, SMDR, difficult laryngoscopy (using CL score), and any kind of assisted intubation were assessed. The optimal cutoff point for SMDR was identified using ROC analysis. The association between SMDR and the intubation method was evaluated through multiple logistic regression analysis. A SMDR below 1.55 led in 33% of the cases to assisted intubation and 33–53% of CL III–IV glottic views for McCoy and Macintosh blades, respectively. On the other hand, SMDR above 1.9 led to no CL IV glottic views for both blades and 4% and 11% CL III views glottic views for McCoy and Macintosh, respectively. Assisted intubation rates were significantly higher in patients with an SMDR inferior to 1.7 ($P < 0.001$). The conclusion of the study was SMDR may be helpful in predicting difficult laryngoscopy and assisted intubation in adults.

In our study, the measurement of SMD was done in full neck extension to determine the CC/SMDR for predictability of difficult intubation in obstetric patients.

Djabatey and Barclay[15] performed a retrospective audit of all obstetric patients who undergone GA in a hospital over an 8-year period to determine the incidence of difficult and failed intubation. Data were collected from a number of sources to ensure accuracy. A total of 3430 rapid sequence inductions were done. None of the patients had a failed or esophageal intubation. There were 23 difficult intubations. Difficult intubation was anticipated in nine cases, requiring awake fiber optic intubation in three cases. A bougie was required in 15 patients (65%) and one patient required a change to a McCoy blade.

In our prospective observational study, the McCoy blade and stubby handle were used in 9 patients and 6 patients in the CC/SMDR group. In the CL score group, 9 patients required a McCoy blade and only 1 patient required stubby handle. All these results were statistically not significant.

However, 2 patients required Frova in CC/SMDR group and 20 patients required Frova for intubation in the CL group, which was a statistically significant difference ($P < 0.05$).

Peri Intubation Complication

Mushambi *et al*.,[16] The Obstetric Anaesthetists' Association (OAA) and Difficult Airway Society Guidelines Group was formed in May 2012 with representatives from both organizations. They initially performed a comprehensive review of the literature on failed tracheal intubation following rapid sequence induction of obstetric GA. Further workstreams included a national OAA survey of lead obstetric anesthetists to clarify aspects of the management of difficult and failed intubation.

These guidelines covered the essential elements and steps for the safe management of obstetric GA, with the intention of minimizing the incidence of failed tracheal intubation while ensuring optimal management should it occur.

In our study, there was no incidence of any failed intubation, desaturation episode, esophageal intubation,

Table 13.

Any maneuver /equipment used	CC/SMD		CL		OR	*P*-value
	Number	Percentage	Number	Percentage		
External laryngeal maneuver	10	12.5	9	11.25	0.88	0.8
Change in operator	0	0	17	21.25	NA	NA
Change in position of patient	10	12.5	8	10	0.77	0.61
McCoy blade used	9	11.25	9	11.25	1	**1**
Stubby handle used	6	7.5	1	1.25	0.15	0.53
Frova used	2	2.5	20	25	13	**0.000036**

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

Table 14.

No. of attempts for successful intubation	CC/SMD		CL	
	Number	Percentage	Number	Percentage
1	53	66.25	46	57.5
2	27	33.75	32	40
3	0	0	2	2.5
Total	80	100	80	100
Significance	The Chi-square statistic is 0.0282. The *P* value is 0.866607. Not significant at *P*<0.05			

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

Table 15.

Study groups	Time required for successful intubation	SD
	Mean	
CC/SMD	1.78	1.07
CL	1.99	1.03
Significance	The t-value is 1.23197. The *P* value is 0.109895. The result is not significant at *P*<0.05	

CC: Chest circumference, SMD: Sternomental distance, CL: Cormack Lehane

aspiration, bronchospasm or any other complication occurred during intubation time.

Jarraya *et al.* in 2019[6] studied new predictors of difficult intubation in 143 obstetric patients undergoing caesarean section delivery under GA.

None of the patients had a history of difficult intubation. None of the patients in the study had failed tracheal intubation.

Similarly, in our study, there was no any incidence of failed intubation, desaturation episode, esophageal intubation, aspiration, bronchospasm or any other complication occurred during intubation time.

Djabatey and Barclay[15] performed a retrospective audit of all obstetric patients who undergone GA in a hospital over an 8-year period to determine the incidence of difficult and failed intubation. A total of 3430 rapid sequence inductions were done. None of the patients had a failed or esophageal intubation. There were 23 difficult intubations. There were no recorded cases of difficulty in ventilating through the face mask and no patients required laryngeal mask airway rescue. Only one patient had significant desaturation during attempts at intubation and underwent bronchospasm before extubation, with no evidence of pulmonary aspiration.

In our study, there was no any incidence of failed intubation, desaturation episode, esophageal intubation, aspiration, bronchospasm or any other complication occurred during intubation time.

CONCLUSION

CC/SMDR over 7 has a good corelation with grades of laryngoscopy on CL score and ease of intubation.

Hence measurement of CC and ratio of CC/SMD can be included in pre-operative evaluation of obstetric patients undergoing caesarean section with GA for prediction of ease of intubation. However, to get statistically significant findings, further study with a large sample size may be required to support our conclusion.

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