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Original Research Article

AN OBSERVATIONAL STUDY TO EVALUATE MODIFIED MALLAMPATI SCORE (MMS) AND EXTENDED MALLAMPATI SCORE (EMS) FOR PREDICTION OF DIFFICULT AIRWAY

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Background: Pre-operative prediction of difficult Airway plays a vital role for patients who will be undergoing General Anaesthesia. Unanticipated difficult airway can lead to airway related complications and may even increase mortality and morbidity. Our study aim to evaluate and compare the predictive value of Modified Mallampati Score in head neutral position (MMS) and Modified Mallampati Score in craniocervial extension (EMS) for predicting difficult laryngoscopy.

Materials and Methods: In this Observational hospital-based study, a total of 100 participants were enrolled, aged 18 to 60 years of either sex, belonging to ASA grade I and II, scheduled for elective surgery under general anesthesia requiring laryngoscopy and endotracheal intubation. Modified Mallampati grading was recorded during Pre- anaesthetic checkup, and Cormack-Lehane grading was recorded during laryngoscopy. Pearson Chi-square test was used to determine the relationships between variables. Categorical variables were compared using the chi-square test.

Results: The Sensitivity, Specificity, PPV and NPV of MMS were 62.50%, 55.95%, 21.28%, 88.68% respectively. The overall diagnostic accuracy of Modified Mallampati Score (MMS) was 57.00%. which was relatively low. Whereas for Extended Mallampati Score (EMS), the Sensitivity, Specificity, PPV, NPV were 68.75%, 97.62%, 84.62%, 94.25% respectively. Overall diagnostic accuracy of EMS was 93.00%.

Conclusion: Craniocervical extension (EMS) improve the Sensitivity, Specificity and Positive predictive value of Modified Mallampati test. Overall diagnostic accuracy was significantly improved in EMS as compared to MMS, this shows that EMS is superior to MMS in predicting difficult airway, hence Modified Mallampati evaluation should be performed with head in extended position to maximize the predictive accuracy of difficult airway.

DESIGN OF STUDY- Observational hospital-based study

1. INTRODUCTION

Pre-operative patient assessment is mandatory for patients who will be undergoing any type of major Surgery. Pre-operative prediction of difficult Airway plays a vital role for patients who will be undergoing General Anaesthesia. Unanticipated difficult airway can lead to airway related complications and may even increase mortality and morbidity. Difficult airway management has been a real challenge for anaesthesiologists, as failure to secure airway remains an important cause of hypoxic brain damage and other associated complications. Recognizing patients with probability of difficult airway can help alert the Anaesthesiologist to the need for assistance from a clinician with airway training and having advanced airway management equipment available.

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From 2011 to 2016, the rates of difficult and failed intubation were 1.6 per 1,000 and 0.06 per 1,000 patients, respectively. Mallampati *et al*. suggested a screening test to predict difficult airway which was then later updated by Samsoon and Young which is now reffered to as Modified Mallampati Grading/Score.

There are various tests available to assess the airway, such as **Thyromental Height test**, **the sternomental distance**, and a simple summation of risk factors (Wilson risk sum score), **Upper lip bite test** etc, out of which, **Modified Mallampati score (MMS)** is still one of the most widely used method to predict difficult airway. Usage of Ultrasound to predict difficult airway is becoming more common recently.

These tests individually or in combination could be useful in predicting difficult airway, however it is also important to note that none of them have the prediction capability of or close to 100% sensitivity or specificity. In most previous studies, Difficult Laryngoscopy was determined by a grading system known as Cormack-Lehane Grading. Cormack-Lahane grading is a grading system first published in 1984 and is used to describe laryngeal view during Direct laryngoscopy. Various modification of Mallampati test have been tried, such as Mallampati with craniocervical extension, phonation, supine position. The diagnostic accuracy of these screening tests has also varied from trial to trial . In view of these discrepancy in different recents studies, we aim to evaluate and compare the predictive value of Modified Mallampati Score in head neutral position (MMS) and Modified Mallampati Score in craniocervial extension (EMS) for predicting difficult laryngoscopy.

AIMS AND OBJECTIVES

AIM: Aim of the study is to evaluate Modified Mallampati Score (MMS) and Extended Mallampati Score (EMS) to predict difficult Airway.

OBJECTIVES:

Primary

- To observe and correlate Modified Mallampati Score (MMS) with Cormack and Lehane Grading.
- To observe and correlate Extended Mallampati Score (EMS) with Cormack and Lehane Grading.
- To compare MMS and EMS to predict difficult Airway.

2. MATERIALS AND METHODS

PLACE OF WORK-

Department of Anaesthesiology

Gandhi medical college and associated Hamidia Hospital, Bhopal, Madhya Pradesh.

PATIENT SELECTION

After obtaining approval from institutional ethics committee and informed written consent; 100 patients of ASA grade I, II posted for various elective surgeries and required direct laryngoscopy and endotracheal intubation were selected.

INCLUSION CRITERIA-

- Patients of ASA grade - I , II
- Age group 18-60 years of either sex.

EXCLUSION CRITERIA- Patient’s refusal or not giving consent, Pregnancy, Patient with cervical spine diseases or restricted neck movement and temporomandibular joint abnormality, Patient with maxillofacial trauma/growth.

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METHODOLOGY- This observational study was performed on 100 consecutive ASA I-II adult patients who were scheduled for elective surgery under General Anesthesia requiring endotracheal intubation.

Complete general physical and systemic examination was performed, patient's data which included sex, age, weight was recorded.

Airway examination was performed by an Anaesthesiologist. Modified Mallampati Score and Extended Mallampati Score was asssessed and recorded by the attending Anaesthesiogist. Patients with limited neck extension were excluded from the study.

MMS: Modification of the Mallampati test recorded oral cavity structures visible upon maximal mouth opening. MMS was evaluated with the patient in sitting position and head in neutral position, each patient asked to open their mouth as much as possible and the tongue fully protruded without phonation. The view was classified as:-

MODIFIED MALLAMPATI SCORE

- Class 0. Visualization of hard palate, soft palate, fauces, pillars, uvula and epiglottis
- Class I. Visualization of the hard palate,soft palate, fauces, pillars and uvula
- Class II. Soft palate, fauces and uvula visible
- Class III. Hard palate, soft palate and base of the uvula visible
- Class IV. Only the hard palate visible.

- **EMS** : The EMS was performed with the patient sitting position, craniocervical junction extended, mouth maximally open, tongue fully protruded with no phonation, and the examiner eye-to-eye.
- EMS is classified as:
- I. Entire uvula clearly visible
- II. Upper half of uvula visible
- III. Soft and hard palate clearly visible
- IV. Only hard palate visible.

On patient's arrival to the Operating theater, routine monitoring according to ASA and baseline findings were recorded.

After premedicating the patient, Induction of anaesthesia was performed with IV Propofol 1.5- 2 mg/kg bodyweight.

For facilitation of endotracheal intubation, Succinylcholine IV 1.5-2mg/kg was administered. Laryngoscopy was performed in "sniffing" position with Macintosh blade size 3/4 by Senior Anaesthesiologist who was blinded to the pre-operative airway classification, findings of laryngeal view was noted. Then patients were intubated with appropiate size Endotracheal tube.

The laryngoscopic view was classified by using the **Cormack and Lehane (CL) classification** without external laryngeal manipulation as following:

CORMACK AND LEHANE CLASSIFACTION/GRADING [6] :

- Grade I- Entire glottis is visible.
- Grade II- Only posterior commissure or arytenoids visible.
- Grade III- Only epiglottis visible.
- Grade IV- No glottic structures visible.

During direct laryngoscopy, if the patient had CL III or IV view, it was considered as difficult visualization of the larynx (DVL) and if it was CL I or II, it was considered Easy visualization of the larynx (EVL).

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Table 1: Denotes division of easy and difficult laryngoscopy on the basis Cormack Lehane classification.

Cormack-lehane laryngoscopic view	Laryngoscopy- EASY/DIFFICULT
Grade 1	EASY
Grade 2	EASY
Grade 3	DIFFICULT
Grade 4	DIFFICULT

Patients with Cormack-Lehane grade III and IV were managed according to AIDAA guidelines . The data of MMS, EMS and CL Grade were recorded and statistically analyzed.

STATISTICAL ANALYSIS

The data of MMS, EMS and CL grade were analysed using the trial versions of SPSS, MedCalc, MS Excel, and online software to calculate the p-values and ROC curves. Pearson Chi-square test was used to determine the relationships between variables. Categorical variables were compared using the chi-square test. The model's predictive ability was determined by calculating the estimates for the area under the receiver operating characteristic (ROC) curve. A value of 0.5 under the ROC curve denotes that the variable performs no better than chance while a value of 1.0 indicates perfect discrimination. A larger area under the ROC curve implies more reliability. A p-value of less than 0.05 was considered significant. The final data was presented in tables and graphs.

OBSERVATIONS AND RESULT

Table 2: Distribution of Age and Visualization of Laryngeal View

Age Group (years)	Easy Visualization of the Larynx (EVL) (CL I&II)		Difficult Visualization of the Larynx (DVL) (CL III&IV)		Total	
≤ 20	1	1.2%	0	0.0%	1	1.0%
21-30	25	29.8%	0	0.0%	25	25.0%
31-40	21	25.0%	4	25.0%	25	25.0%
41-50	15	17.9%	7	43.8%	22	22.0%
51-60	15	17.9%	2	12.5%	17	17.0%
61-70	7	8.3%	3	18.8%	10	10.0%
Total	84	100.0%	16	100.0%	100	100.0%
Mean±SD	40.94±13.45		47.75±9.35		42.03±13.09	
t value	-1.933, df = 98					
P value	.056, Not Significant					

Table 2 shows the distribution of age and the corresponding visualization of the larynx, categorized into easy (EVL) and difficult (DVL) visualizations among 100 participants scheduled for elective surgery under general anaesthesia requiring endotracheal intubation. The statistical analysis showed a t-value of -1.933 and a p-value of .056, indicating that the age difference between patients with EVL and DVL was not statistically significant.

Table 3 : Overall cases observed using MMS, EMS and Cormack-lahane grade

Class/grade	no. of patients corresponding to	no. of patients corresponding to	no. of patients corresponding to

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	MMS grade	EMS grade	CL grade
I	20	28	53
II	33	59	31
III	44	12	13
IV	3	1	3

Table 4: Association between Modified Mallampati Score (MMS) Grade and Cormack-Lehane Grade

MMS Grade	Cormack-Lehane Grade								Total	
	I		II		III		IV			
	No.	%	No.	%	No.	%	No.	%	No.	%
I	12	22.6%	5	16.1%	2	15.4%	1	33.3%	20	20.0%
II	16	30.2%	14	45.2%	3	23.1%	0	0.0%	33	33.0%
III	24	45.3%	11	35.5%	7	53.8%	2	66.7%	44	44.0%
IV	1	1.9%	1	3.2%	1	7.7%	0	0.0%	3	3.0%
Total	53	100.0%	31	100.0%	13	100.0%	3	100.0%	100	100.0%

Pearson Chi-Square = 6.152, df = 9, p value = .725, Not Significant

Table 4 shows the association between the Modified Mallampati Score (MMS) and the Cormack-Lehane Grade, inorder to predict the difficulty of laryngeal visualization during intubation.

MMS Grade I was observed in 20 patients. Among these, 12 patients (22.6%) had a Cormack-Lehane Grade I view, and 5 patients (16.1%) had a Grade II view, indicating an easy visualization of the larynx. 2 patients (15.4%) had a Grade III view, and 1 patient (33.3%) had Grade IV view indicative of difficult visualization.
MMS Grade II was observed in 33 patients. Of these, 16 patients (30.2%) had a Grade I view, and 14 patients (45.2%) had a Grade II view, suggesting easy visualization. Conversely, 3 patients (23.1%) had a Grade III view, indicative of difficult visualization.There are no patient with Grade IV view.

Patients with MMS Grade III totaled 44. Within this group, 24 patients (45.3%) had a Grade I view, and 11 (35.5%) had a Grade II view, representing easy visualization. However, 7 patients (53.8%) had a Grade III view, and 2 patients (66.7%) had a Grade IV view, signifying difficult visualization.

For MMS Grade IV, 3 patients were found to have MMS IV. Among them, 1 patient (1.9%) had a Grade I view, and 1 patient (3.2%) with Grade II view, indicating easy visualization. While 1 patient (7.7%) had a Grade III view, indicating difficult visualization. No patients in this group had Grade IV view.
Statistical analysis using the Pearson Chi-Square test yielded a value of 6.152 and a p-value of 0.725. Since the p-value is greater than 0.05, the result is not statistically significant,

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indicating no significant association between the Modified Mallampati Score (MMS) and the Cormack-Lehane Grade. This suggests that the MMS alone may not be a reliable predictor of difficult laryngeal visualization during intubation.

Table 5: Association between Extended Mallampati Score (EMS) Grade and Cormack-Lehane Grade

EMS Grade	Cormack-Lehane Grade								Total	
	I		II		III		IV			
	No.	%	No.	%	No.	%	No.	%	No.	%
I	17	32.1%	9	29.0%	2	15.4%	0	0.0%	28	28.0%
II	34	64.2%	22	71.4%	3	23.1%	0	0.0%	59	59.0%
III	2	3.8%	0	0.0%	7	53.8%	3	100.0%	12	12.0%
IV	0	0.0%	0	0.0%	1	7.7%	0	0.0%	1	1.0%
Total	53	100.0%	31	100.0%	13	100.0%	3	100.0%	100	100.0%

Pearson Chi-Square = 59.241, df = 6, p-value <.001, Significant

Table 5 shows the association between the Extended Mallampati Score (EMS) and the Cormack-Lehane Grade.

For patients with EMS Grade I, there were 28 individuals. Among them, 17 patients (32.1%) had a Cormack-Lehane Grade I view, while 9 patients (29.0%) had a Grade II view, indicative of easy visualization of the larynx. 2 patients (15.4%) had a Grade III view, indicating difficult visualization, and no patient with Grade IV view.

EMS Grade II was observed in 59 patients. Of these, a majority of 34 patients (64.2%) had a Grade I view, and 22 patients (71.0%) had a Grade II view, both suggesting easy visualization. Conversely, 3 patients (23.1%) had a Grade III view, signifying difficult visualization. There were no patients with Grade IV view.

Patients with EMS Grade III totaled 12. Within this group, 2 patients (3.8%) had a Grade I view, representing easy visualization. However, none had a Grade II view, while 7 patients (53.8%) had a Grade III view, and 3 patients (100%) had a Grade IV view, indicative of difficult visualization.

Statistical analysis using the Pearson Chi-Square test yielded a value of 59.241 with 6 degrees of freedom and a p-value of <0.001. Since the p-value is less than 0.05, the result is statistically significant, indicating a significant association between the Extended Mallampati Score (EMS) and the Cormack-Lehane Grade. This suggests that the EMS is a reliable predictor of the difficulty of laryngeal visualization during intubation.

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Table 6: Association between Modified Mallampati Score (MMS) and Extended Mallampati Score (EMS) with Difficult Airway Cases

Variables	Total Cases	Difficult Cases	Proportion of Difficult Cases
MMS			
I	20	3	0.150
II	33	3	0.091
III	44	9	0.205
IV	3	1	0.333
EMS			
I	28	2	0.071
II	59	3	0.051
III	12	10	0.833
IV	1	1	1.000

Table 6 shows the association between the Modified Mallampati Score (MMS) and the Extended Mallampati Score (EMS) with difficult airway cases. The data reveals varying proportions of difficult cases across different grades of MMS and EMS.

Regarding MMS, the findings show that higher grades correspond to a higher proportion of difficult airway cases. MMS Grade III and IV exhibit notable proportions of difficult cases, Conversely, MMS Grade I and II demonstrate lower proportions of difficult cases, reflecting their association with easier airway management during intubation.

EMS grades also illustrate a similar trend where higher scores correlate with a greater proportion of difficult airway cases. EMS Grade III is the highest proportion, indicating that 10 out of 12 cases (83.3%) were identified as difficult. This contrasts with EMS Grades I and II, which show lower proportions of difficult cases, reinforcing the predictive value of EMS in assessing laryngeal visualization challenges.

Table 7: Diagnostic Performance of Mallampatti Class (>2) in Predicting Difficult Airway against Cormack-Lehane Difficulty

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">Cormack-Lehane Difficulty</th><th rowspan="2">Total</th></tr>
<tr><th>Easy</th><th>Difficult</th></tr>
<tr><td rowspan="2">Mallampatti Class (Cut-off >2)</td><td>Easy</td><td>47</td><td>6</td><td>53</td></tr>
<tr><td>Difficult</td><td>37</td><td>10</td><td>47</td></tr>
<tr><td>Total</td><td></td><td>84</td><td>16</td><td>100</td></tr>
</table>

True Positives (TP) = 10
False Positives (FP) = 37
True Negatives (TN) = 47
False Negatives (FN) = 6

Sensitivity : 62.50%
Specificity : 55.95%

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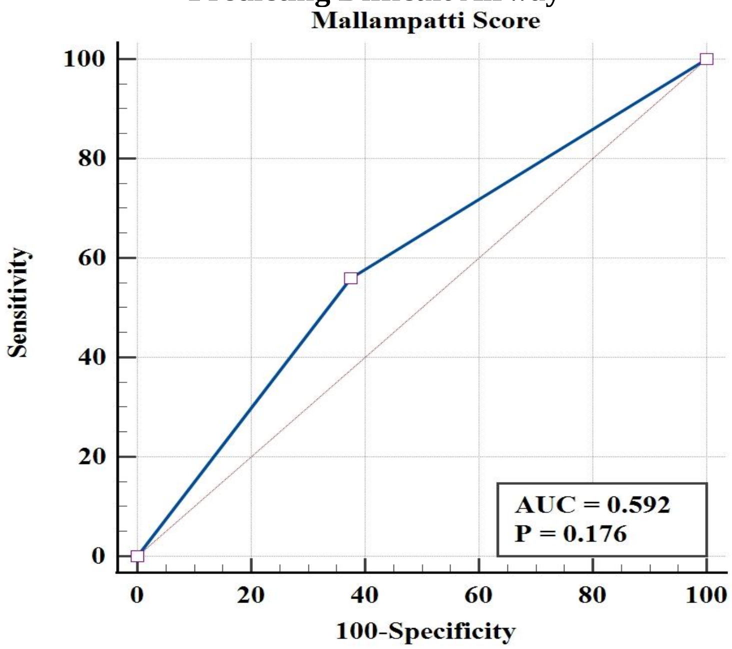
Positive predictive value : 21.28%
Negative predictive value : 88.68%
Diagnostic accuracy : 57.00%

Table 7 shows the diagnostic performance of Mallampatti Class (>2) in predicting difficult airways against Cormack-Lehane difficulty, the cases classified as Easy or Difficult by Mallampatti Class (>2) and Cormack-Lehane grading.
The Mallampatti Class demonstrates moderate sensitivity (62.50%) in predicting difficult airways as defined by the Cormack-Lehane classification. This indicates that the test can correctly identify about two-thirds of patients who will have a difficult airway. However, its specificity is relatively low at 55.95%, suggesting that it incorrectly classifies many easy airways as difficult.
The positive predictive value (PPV) of 21.28% is notably low, indicating that only one in five patients is predicted to have a difficult airway by this test. This low PPV suggests a high rate of false positives, which is confirmed by the large number of false positives (37) compared to true positives (10). In clinical practice, this could lead to unnecessary preparation for difficult intubations in many cases where they are not needed.
On the other hand, the negative predictive value (NPV) is quite high at 88.68%. This means that when the test predicts an easy airway, it is correct nearly 89% of the time. This high NPV can reassure clinicians when the test suggests an easy airway. However, it is important to note that it still misses some difficult airways (6 false negatives out of 16 total difficult airways).
The overall diagnostic accuracy of 57.00% suggests that the test is only slightly better than the chance of correctly classifying airways as easy or difficult. This relatively low accuracy, combined with the low PPV and moderate sensitivity and specificity, indicates that while the Mallampatti Class (cut-off >2) has some predictive value, it should not be relied upon as a sole predictor of difficult airways.

Table 8: Receiver Operating Characteristic (ROC) Analysis of Mallampatti Class for Predicting Difficult Airway



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Variable	Modified Mallampati Score
Classification variable	Difficulty

Sample size	100
Positive group [a]	84 (84.00%)
Negative group [b]	16 (16.00%)

[a] Difficulty = 1
[b] Difficulty = 0

Disease prevalence (%)	unknown

Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.592
Standard Error [a]	0.0682
95% Confidence interval [b]	0.489 to 0.689
z statistic	1.353
Significance level P (Area=0.5)	0.1760

[a] DeLong et al., 1988 (55)
[b] Binomial exact

Youden index

Youden index J	0.1845
Associated criterion	>2
Sensitivity	55.95
Specificity	62.50

The Receiver Operating Characteristic (ROC) analysis of the Mallampatti Class for predicting difficult airways reveals important insights into its diagnostic performance. With an Area Under the Curve (AUC) of 0.592 (95% CI: 0.489 to 0.689), the test demonstrates only marginal improvement over random chance in discriminating between easy and difficult airways.
The Youden Index of 0.1845, corresponding to a cut-off criterion of >2, represents the optimal balance between sensitivity and specificity. At this threshold, the test achieves a sensitivity of 55.95% and a specificity of 62.50%. These moderate values indicate that while the test can identify some difficult airways, it misses a substantial portion and incorrectly classifies a notable number of easy airways as difficult.

Table 9: Diagnostic Performance of Extended Mallampatti Class (>2) in Predicting Difficult Airway against Cormack-Lehane Difficulty

		Cormack-Lehane Difficulty		Total
		Easy	Difficult	
Extended Mallampatti Class (Cut-off >2)	Easy	82	5	87
	Difficult	2	11	13
Total		84	16	100

True Positives (TP) = 11

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False Positives (FP) = 2
True Negatives (TN) = 82
False Negatives (FN) = 5
Sensitivity : 68.75%
Specificity : 97.62%
Positive predictive value : 84.62%
Negative predictive value : 94.25%
Diagnostic accuracy : 93.00%

Table 9 shows the diagnostic performance of Extended Mallampatti Class (>2) in predicting difficult airways against Cormack-Lehane difficulty, the cases classified as Easy or Difficult by Extended Mallampatti Class (>2) and Cormack-Lehane grading.

The Extended Mallampatti Class demonstrates promising performance in predicting difficult airways as defined by the Cormack-Lehane classification. The test shows strong overall accuracy with 82 true negatives and 11 true positives out of 100 cases.

The sensitivity of this test is 68.75% (11 out of 16 difficult airways correctly identified), indicating a good ability to detect truly difficult airways. This is crucial in clinical practice as it helps to prepare for potential complications during intubation. However, it is worth noting that the test still misses about 31% of difficult airways, which is a consideration for patient safety.

The test's specificity is remarkably high at 97.62% (82 out of 84 easy airways correctly identified). This excellent specificity suggests that clinicians can be very confident in that assessment when the EMS predicts an easy airway. The high specificity also translates to a low false-positive rate, which is beneficial in avoiding unnecessary preparations or interventions for difficult airways that are not present.

This test's positive predictive value (PPV) is 84.62% (11 true positives out of 13 predicted difficult cases), indicating that when the test predicts a difficult airway, it is correct about 85% of the time. This high PPV is particularly valuable in clinical decision-making, providing strong confidence in the test's positive results.

The negative predictive value (NPV) is also very high at 94.25% (82 true negatives out of 87 predicted easy cases). This means that when the test predicts an easy airway, it is correct about 94% of the time, providing substantial reassurance to clinicians in these cases.
The overall diagnostic accuracy of the Extended Mallampatti Class (>2) is 93% (93 correct predictions out of 100 total cases), which is excellent. This high accuracy suggests that the EMS is a reliable tool for airway assessment in the preoperative setting.

The Extended Mallampatti Class (>2) performs better than the traditional Mallampatti score in predicting difficult airways. Its high specificity, PPV, NPV, and overall accuracy make it a valuable tool in clinical practice. However, the sensitivity of 68.75% indicates that it should not be used as the sole predictor of difficult airways. Combining the EMS with other clinical assessments and predictors would be prudent to ensure the highest level of patient safety in airway management.

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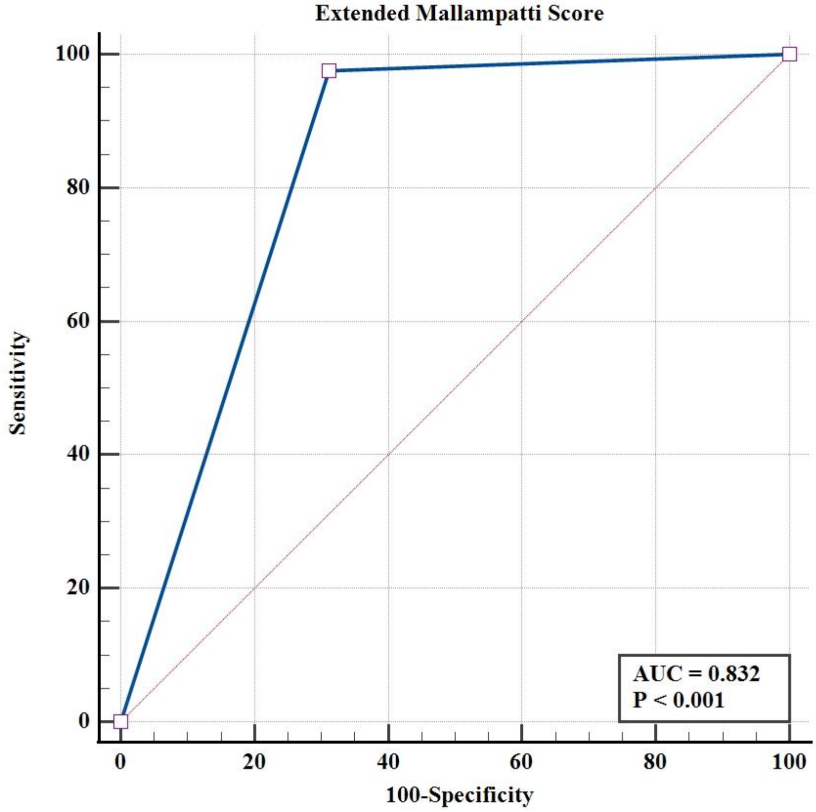
Table 10: Receiver Operating Characteristic (ROC) Analysis of Extended Mallampatti Class for Predicting Difficult Airway



Variable	Extended Mallampati Score
Classification variable	Difficulty

Sample size	100
Positive group [a]	84 (84.00%)
Negative group [b]	16 (16.00%)

[a] Difficulty = 1
[b] Difficulty = 0

Disease prevalence (%)	unknown

Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.832
Standard Error [a]	0.0604
95% Confidence interval [b]	0.744 to 0.899
z statistic	5.492
Significance level P (Area=0.5)	<0.0001

[a] DeLong et al., 1988 (55)
[b] Binomial exact

Youden index

Youden index J	0.6637
Associated criterion	>2

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Sensitivity	97.62
Specificity	68.75

The Receiver Operating Characteristic (ROC) analysis for the Extended Mallampatti Class (EMS) in predicting difficult airways provides valuable insights into its diagnostic performance. The results demonstrate that the EMS is a highly effective tool for airway assessment, significantly outperforming chance and showing strong discriminatory power.

The Area Under the Curve (AUC) of 0.832 (95% CI: 0.744 to 0.899) indicates excellent discrimination between easy and difficult airways. An AUC value between 0.8 and 0.9 is generally considered very good, suggesting that the EMS has strong predictive capability. This is further supported by the highly significant p-value (<0.0001), which firmly rejects the null hypothesis that the AUC equals 0.5 (no discrimination). This statistical significance provides strong confidence in the test's ability to distinguish between easy and difficult airways beyond mere chance.

The Youden Index (J) of 0.6637 is notably high, indicating an optimal balance between sensitivity and specificity. This index, which ranges from 0 to 1, suggests that the EMS achieves a good compromise between identifying difficult airways and correctly classifying easy ones. The associated criterion of >2 aligns with the cut-off used in the previous analysis, confirming its appropriateness.

At this optimal cut-off point, the EMS demonstrates exceptional sensitivity (97.62%) and good specificity (68.75%). The high sensitivity means the test correctly identifies almost all easy airways, minimizing the risk of unexpected difficult intubations. The specificity, while lower, is still good and indicates that about two-thirds of truly difficult airways are correctly identified.

3. DISCUSSION

Difficult airway cases are still encountered by an anesthesiologist in day-to-day practice. Multiple preoperative airway assessment tests have been introduced, Mallampati score is the most frequently performed test due to its simplicity and ability to predict difficult airway. However, it's reliability differs from trial to trial which makes its use as a single assessment method questionable for some researchers. EMS was first introduced in 2006, and is performed in patient sitting position, head extended, mouth fully open with tongue maximally protruded with no phonation. Cormack-Lahane grading was the most frequently used scoring system to record laryngeal view in recent studies, which is also used in our study. CL grade I and II denotes Easy visualization of Larynx, while CL grade III and IV denotes Difficult laryngoscopy.

Demographic parameters

Age: In our study, the combined mean age for all participants was 42.03 yrs (SD= 13.09). The mean age of patients with EVL was 40.94 years (SD= 13.45), whereas the mean age for patients with DVL was 47.75 yrs (SD= 9.35). The statistical analysis showed a t-value of -1.933 and a P value of 0.56, which indicates that the age difference between patients with EVL and DVL was not statistically significant.

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MMS and EMS parameters

MMS mainly reflects the size of the tongue in relation to the oral cavity or the oropharyngeal space. In searching for the best bedside predictor of difficult airway, Modified Mallampati score has been studied with multiple variations (MMS with extended neck, MMS with or without phonation, with sitting or supine or in a combination with other methods).

Lewis *et al* recommended that the MMS be performed with patient in sitting position with craniocervical extension as the predictive value of MMS is dependent on the position of cervical spine. **Mashour et al** also noted that cervical extension decreased the MMS class (p <0.002). The EMS improved specificity and PPV when compared with MMS while still maintaining the value of sensitivity.

In our study, out of 100 participants, 84 patients had Easy visualization of larynx (EVL), while 16 patients had difficult visualization of larynx (DVL).

The number of patients with MMS I, II, III and IV were 20, 33, 44 and 3 respectively, while the number of patients with EMS I, II, III and IV were 28, 59, 12 and 1 respectively and no grade IV.

The number of difficult airway cases with MMS I, II, III, IV was 3, 3, 9 ,1 respectively, while for EMS I, II, III, IV the number of difficult airway case was 2, 3, 10, 1 respectively.

The correlation between MMS and Cormack-Lehane grade was assessed by using Pearson chi-square test, which yielded a value of 6.152 with a p-value of 0.725. This suggests that MMS have no significant correlation with Cormack-lahane grades. Whereas EMS showed a significant correlation with Cormack-lehane grades (p-value <0.001).

Table 7 and 9 shows the diagnostic performance of MMS (>2) and EMS (>2) in predicting difficult airway (CL grade >2).

The sensitivity, specificity, PPV and NPV of MMS were 62.50%, 55.95%, 21.28%, 88.68% respectively. Moderate sensitivity (62.50%) indicates that the test can correctly identify about two third of patients with difficult airway. Specificity is relatively low and PPV is notably low (21.28%), These low PPV suggest high rate of false positive. The overall diagnostic accuracy of MMS was 57.00%. This relatively low accuracy combined with low PPV and moderate sensitivity and specificity indicates that MMS have some predictive value, but should not be relied upon as a sole predictor of difficult airway.

Whereas for EMS, the sensitivity, specificity, PPV, NPV were 68.75%, 97.62%, 84.62%, 94.25% respectively. Overall diagnostic accuracy of EMS was 93.00% which is significantly higher than MMS. Sensitivity was improved from 62.50% (MMS) to 68.75% (EMS), Which indicates a good ability to detect truly difficult Airways. The high diagnostic accuracy suggest that EMS is a reliable tool for preoperative airway assessment.

The area under the ROC curve (AUC) For MMS was 0.592 (95% CI: 0.489 to 0.689), the test demonstrates only marginal improvement over random chance in discriminating between easy and difficult Airways. Whereas EMS shows AUC of 0.832 (95% CI: 0.74420.899) which indicates excellent discrimination between easy and difficult airway. EMS is highly effective tool for airway assessment, significantly outperforming chance and showing strong discriminatory power.

In clinical practice, clinicians should exercise caution when using the Mallampatti Class as a standalone predictor of difficult airways. Its limited discriminatory power suggests integrating it with other assessment tools and clinical judgment rather than being relied upon in isolation. The test's moderate specificity may be more useful in ruling out difficult airways in low-risk patients. However, its lower sensitivity means it could miss many truly difficult cases. Therefore, a comprehensive approach to airway assessment, incorporating multiple predictive factors and clinical experience, remains crucial for ensuring patient safety during airway management procedures. While it can help identify difficult airways, its tendency to overpredict difficulty (high false positive rate) could lead to unnecessary interventions or preparation. However, its high NPV does provide value in identifying likely easy airways, which could help in resource allocation and risk assessment.

The analysis is based on a sample of 100 patients, with 84 classified as having easy airways and 16 as difficult. This imbalanced distribution reflects the typical clinical scenario where difficult airways are less common. However, it also highlights the challenge of achieving high predictive value for the less prevalent outcome.

Extended Mallampatti Class is a highly reliable tool for airway assessment. Its excellent sensitivity makes it particularly valuable for ruling out difficult airways. At the same time, it's good specificity helps identify potential challenges. The high AUC and statistical significance prove its use in preoperative evaluations. However, it is important to note that no single test is perfect, and the unknown prevalence of difficult airways in the general population means that positive and negative predictive values may vary in different clinical settings. Therefore, while the EMS proves to be a superior predictor to the traditional Mallampatti score, it should ideally be used with other clinical assessments and risk factors for comprehensive airway evaluation. The ROC analysis strongly supports using the Extended Mallampatti Class as a highly effective tool in predicting difficult airways, offering significant improvements in sensitivity and overall discriminatory power compared to traditional methods.

Further studies are needed to evaluate prediction of difficult airway with MMS and EMS in patients with comorbidities and its correlation with other airway assessment tools.

4. CONCLUSION

Craniocervical extension (EMS) improve the Sensitivity, Specificity and Positive predictive value of Modified Mallampati test. Overall diagnostic accuracy was significantly inproved in EMS as compared to MMS, this shows that EMS is superior to MMS in predicting difficult airway, hence Modified Mallampati evaluation should be performed with head in extended position to maximize the predictive accuracy of difficult airway.

The relatively low accuracy, combined with low PPV and moderate Sensitivity and Specificity of MMS indicates that the MMS as a sole predictor of difficult airway is of limited value and it is advisable to add other predictive test along with it, while the high diagnostic accuracy of EMS suggest that the EMS is a reliable tool for pre-operative airway assessment.

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