# ORIGINAL ARTICLE

## Correlative Value of Airway Assessment by the Modified Mallampati Classification and Cormack and Lehane grading in Patients with Goitre Scheduled for Thyroidectomy Under General Anaesthesia

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**ABSTRACT** **Background:** Patients with goitres may present with difficult airway. The Modified Mallampati test (MMP) assists the anaesthetist in planning airway management. Aim of the study was to determine the correlative value of the MMP and Cormack and Lehane (CL) in goiter patients scheduled for thyroidectomy.

**Methodology:** Patients recruited were 250. MMP was assessed preoperatively and CL grading at laryngoscopy. MMP and CL 1 and 2 were rated easy intubations while MMP and CL 3 and 4 were rated difficult intubations. Data collected: number of patients in MMP and CL, true positive (TP), false positive (FP), true negative (TN) and false negative (FN). Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and correlation were derived.

**Results:** Highest percentage of patients in MMP were in class II, 45.6% and the lowest were in class IV, 4.8%. Highest percentage of patients in CL were in grade 1, 42.8% while the lowest were in grade 4, 13.2%. There were 37, 36, 131 and 46 patients that had TP, FP, TN and FN respectively. Sensitivity, specificity, PPV, NPV and diagnostic accuracy were 50.68%, 74.01%, 49.22%, 75.12% and 66.27% respectively. Pearson's correlation coefficient was 0.192, p = 0.002. Three patients had failed intubation.

**Conclusion:** MMP had low sensitivity of 50.68% and low positive predictive value of 49.22% in goitre patients scheduled for thyroidectomy under general anaesthesia. Though there was positive correlation between MP and CL, it was negligible Addition of other tests may improve predictive accuracy when there is a high index of suspicion.

**Keywords:** Goitre, Difficult laryngoscopy, Predictive tests, Mallampati test, Cormack and Lehane grading.

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## INTRODUCTION

The fundamental responsibility of the anesthetist to the surgical patient is to maintain adequate gas exchange by ensuring a continuously patent airway. Failure to maintain a patent airway may expose the surgical patient to significant risks of hypoxic brain damage and death. This may result from difficult mask ventilation, multiple attempts at intubation or failed intubation which can lead to 'can't intubate, can't ventilate' scenario. Difficult airway may result from congenital, anatomical, acquired and pathological causes. Pathological causes include neck masses such as goiters.

The incidence rates of difficult intubation have been documented to be between 2.2 – 8.0%.[1,2] The incidence of difficult intubation in goiter patients scheduled for thyroidectomy in our environment was found to be 13.6% while failed intubation was found to be 1.6%.[3]

Preoperative airway assessment assists the anaesthetist in planning airway management of patients scheduled for surgery under anaesthesia. Among the bedside tests

commonly used for airway assessment and predicting difficult airway are the Modified Mallampati classification[4] with four grades, which was initially described by Mallampati et al[5] with three grades and the thyromental distance (TMD).[6] The TMD is a straight line measured from the thyroid cartilage to the lower border of the mandibular mentum with the neck fully extended. While it is easy to perform the MMP in the patient with goiter, it may be difficult or impossible to perform the TMD in such patients because of the presence of an anterior neck mass which may be huge. An infrequently used test is the Wilson risk score which scores five factors (weight, head, and neck movements, jaw movements, receding mandible and buck teeth) from 0 to 2 giving a total range from 0 to 10.[7] However, none of these tests have been shown to be full proof.[8]

These predictive tests are correlated with the findings at laryngoscopy during endotracheal intubation using the Cormack and Lehane[9] grading. While some researchers have used single tests to predict difficult airway, others have used a combination of tests for prediction. Sen et al[10] showed that though TMD and MMP were potent in predicting difficult airway respectively, the combination of the two were a much better predictor of difficult airway. Though Narang et al[11] reported that MMP and TMD each had significant correlation with laryngoscopic grade; the false positive rates were high. They concluded that when both tests were combined as predictors of difficult intubation, specificity was greatly improved while false positive rates decreased significantly. However, Nasir et al[12] showed in their study that MMP and CL were good predictors for tracheal intubation in patients in all surgical specialties undergoing elective surgeries under endotracheal general anaesthesia.

Previous studies[10,11,12] assessing predictive tests for difficult intubation involved patients who did not have obvious head and neck pathology for which the researcher anticipated difficult airway. Airway management during anaesthesia is always the primary concern when dealing with patients with goiters because of the challenges of difficult airway and/or intubation. Thyroid surgeries are the most common endocrine surgeries performed all over the world.[13] The MMP is an easy bedside predictive test to perform. Because of manpower challenges in the specialty of anaesthesia in our environment, most patients are reviewed in the evening before surgery by anaesthetists that are busy throughout the day with the elective lists and the MMP is therefore commonly used to predict airway difficulty. Review of literature showed paucity of studies in predictive tests for difficult airway in goiter patients scheduled for thyroidectomy. This study was carried out to assess the correlative value of the MMP and CL in predicting difficult intubation in goiter patients scheduled for thyroidectomy.

## PATIENTS AND METHODS

Following institutional ethics approval, 250 consenting patients scheduled for elective thyroidectomy under general anaesthesia, were enrolled into this prospective cross-sectional observational study. The study was carried out in our hospital which is a 600-bed tertiary health institution located in the North Central zone of Nigeria. Patients of either sex, aged between 18 and 70 years were enrolled. The following patients were excluded: previous difficult intubation, head and neck pathology other than goitre, unstable cervical spine, emergency surgery, restricted neck movements, recurrent goitre, pregnant women and patient refusal.

**Sample size:** Minimum sample size was determined with the Fisher's formula[14,15] for observational studies. Using the prevalence P, 15% of goitre in our environment as reported by Isichei et al,[16] the minimum sample size with 10% attrition required for the study was 215. A total of 250 patients were recruited in this study.
During the pre-anaesthetic review, the Modified Mallampati test (MMP)[4] was done for all patients as part of airway assessment. An observer, one of the research consultant anaesthetists who was level with the patient, asked the patient to sit upright, head in a neutral position, to open the mouth and maximally protrude the tongue without phonation. The observer gave a score between I and IV based on the pharyngeal structures seen. Class I- soft palate, uvula, fauces and pillars visible. Class II- Soft palate, fauces and uvula visible. Class III- Only soft palate visible. Class IV- Pharyngeal structures not visible (Figure 1). Other parameters recorded were sex, weight, height and vital signs of the patient.

In the operating room, the patient was connected to DASH 4000 multi-parameter monitor (GE Medical System Information Technology, Inc 820W, Tower Ave, Milwaukee, Wisconsin, USA) for non-invasive blood pressure (NIBP), arterial oxygen saturation ($SpO_2$), pulse rate, temperature and electrocardiogram. Venous access was secured with either size 16 or 18G intravenous cannula on the forearm or dorsum of the hand.

The anaesthesia workstation was checked to be functional while various sizes of cuffed endotracheal tubes and functional laryngoscopes (direct rigid laryngoscopes) with various sizes of Macintosh blades were made available. As at the time of the study, these were the types of laryngoscope and blades available in our institution. Intubation aids such as gum elastic bougies, laryngeal mask airways and stylets were provided.

A pre-induction dose of atropine 0.04 mg/kg was administered intravenously as required. Induction technique of anaesthesia depended on whether or not difficult intubation was anticipated. Where difficulty was anticipated, based on our institutional protocol, induction was by inhalational method using sevoflurane in 0.5% increments up to 3% until hypnosis was achieved. The patient was thereafter test-ventilated manually and gentle laryngoscopy carried out. If the larynx was visualized

and intubation was adjudged possible, patient was given intravenous suxamethonium 1.0 - 1.5 mg/kg to facilitate endotracheal intubation.

Where difficulty was not anticipated, iv fentanyl 1-3 µg/kg was administered, and induction of anaesthesia was achieved with iv propofol 2.5-3.5 mg/kg and iv suxamethonium 1.0-1.5 mg/kg was given to facilitate endotracheal intubation.

At laryngoscopy, before endotracheal intubation, the initial laryngoscopic view as described by Cormack and Lehane[9] was noted as follows: grade 1: complete visualization of the vocal cords. grade 2: Visualization of the inferior portion of the glottis. grade 3: visualization of only the epiglottis. grade 4: non-visualization of the glottis or epiglottis (Figure 2). Laryngoscopy was performed by one of the research consultants who was not involved in assessing the MMP preoperatively.

In this study, patients who had Modified Mallampati classes 1 and 2 and Cormack and Lehane grades 1 and 2 were rated as easy intubations while Modified Mallampati classes 3 and 4 and Cormack and Lehane grades 3 and 4 were rated as difficult intubations. The Modified Mallampati (MMP) classes III or IV were used to predict that laryngoscopy would be difficult (Cormack and Lehane grades 3 or 4) while MMP I or II were used to predict that laryngoscopy would be easy (Cormack and Lehane grades 1 or 2). Patients who had failed intubation were also noted.

Maintenance of anaesthesia was ensured with oxygen/air mixture with sevoflurane. Muscle paralysis was with intravenous pancuronium 0.1 mg/kg while analgesia was ensured with fentanyl. At the end of surgery, residual neuromuscular paralysis was reversed with a combination of neostigmine 40 µg/kg and atropine 20 µg/kg IV, the patient extubated with return of spontaneous respiration and adequate tidal exchange. There was no incident of adverse event at extubation in any of the patients. The patient was admitted into the post-anaesthesia care unit for immediate postoperative management and discharged subsequently to the ward after fulfilling the hospital discharge criteria.

Data collected were as follows: Number (%) of patients in classes and grades of MMP and CL, number (%) of patients that were true positive, false positive, true negative and false negative respectively. The following predictive values were derived: sensitivity (ability to detect difficult laryngoscopy), specificity (ability to detect easy laryngoscopy), positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy.

**Data analysis:** Data were presented as frequencies (percentages), means and standard deviations and analyzed using SPSS version 20. Pearson's correlation coefficient between MMP and CL was determined. A p value less than 0.5 was considered significant in this study.

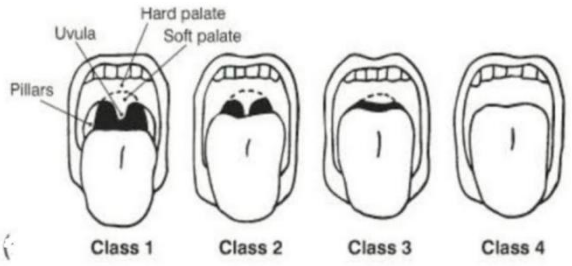


**Figure 1: Modified Mallampati classification of pharyngeal appearance**


**Figure 2: Cormack and Lehane grading of laryngoscopic views**

## RESULTS

A total of 250 patients were recruited into the study. There were 25 (10.0%) males and 225 (90.0%) females. The age range of the patients was between 20 and 70 years, mean 45.76 ± 12.65 years. The mean weight was 68.69 ± 13.63 kg, mean height 1.64 ± 0.08 m. Three patients (1.2%) had failed intubation.

The distribution of MMP classes and CL grading among patients is shown in Table I. In the MMP classification, the highest number of patients were in class II with 114 (45.6%) and the lowest were in class IV with 12 (4.8%) patients. In the CL grading, the highest number of patients were in grade 1 with 107 (42.8%) patients while the lowest were in grade 4 with 33 (13.2%) patients.

The laryngoscopic views CL as predicted by MMP were: True Positive (TP) 37 (14.00%), False positive (FP), 36 (15.20%), True negative (TN) 131(52.40%) and False negative (FN) 46 (18.4%). This distribution is shown in Table II where 73 patients were predicted by MMP to have difficult laryngoscopy (MMP III and IV); out of these 73 patients, 37 (50.68%) were found to be difficult (CL 3 and 4) while 36 (49.32%) were found to be easy (CL 1 and 2). In the remaining 177 patients who were predicted to have easy laryngoscopy (MMP I and II), 46 (25.99%) of them were found to be difficult (CL 3 and 4), while 131 (74.01%) were found to be easy (CL 1 and 2). The Pearson's correlation coefficient (r) between Modified Mallampati class and Cormack and Lehane grade in this study was found to be 0.192, p = 0.002 which was significant.

Table III shows that the sensitivity of the MMP test was 50.68% (95% CI 38.72 - 62.60%), specificity 74.01% (95% CI 66.90 - 80.30%), positive likelihood ratio 1.95 (CI 1.39 - 2.73), negative likelihood ratio 0.67 (CI 0.52 - 0.85), positive predictive value (PPV) 49.22% (95% CI 38.07 - 60.43%) and negative predictive value (NPV) 75.12% (95% CI 67.85 - 81.48%) and diagnostic accuracy 66.27% (60.04 - 72.10%). Among the 73

patients that were predicted to have difficult laryngoscopy by the MMP (classes III and VI), 37 (50.68%) actually had difficult laryngoscopy (Cormack and Lehane grades 3 and 4).

**Table I: Distribution of Modified Mallampati classes and Cormack and Lehane grading among patients.**

| MMP Class/(CL grade) | MMP no (%) n=250 | CL no (%) n=250 |
|---|---|---|
| I (1) | 63 (25.2) | 107 (42.8) |
| II (2) | 114 (45.6) | 60 (24.0) |
| III (3) | 61 (24.4) | 50 (20.0) |
| IV (4) | 12 (4.8) | 33 (13.2) |
| Total | 250 (100.0) | 250 (100.0) |

**Table II: Outcomes of laryngoscopic view (Cormack and Lehane) as predicted by Modified Mallampati test.**

| | | Modified Mallampati (n=250) | | |
|---|---|---|---|---|
| | | Difficult | Easy | r |
| Laryngoscopic View | Difficult | 37 (CL 3, 4) | 46 (CL 3, 4) | 0.192 (p= 0.002) |
| | Easy | 36 (CL 1, 2) | 131 (CL 1, 2) | |
| Total | | 73 | 177 | |

CL- Cormack and Lehane grades.
r- Pearson's Correlation Coefficient

**Table III: Predictive values of the Modified Mallampati test.**

| Parameter | Value | 95% CI |
|---|---|---|
| Sensitivity | 50.68% | 3.72-62.60% |
| Specificity | 74.01% | 66.90-80.30% |
| Positive likelihood ratio | 1.95 | 1.39-2.73 |
| Negative likelihood ratio | 0.67 | 0.52-0.85 |
| Positive Predictive Value | 49.22% | 38.07-60.43% |
| Negative Predictive Value | 75.12% | 67.85-81.48% |
| Diagnostic Accuracy | 66.27% | 60.04-72.10% |

## DISCUSSION

The Modified Mallampati test (MMP) is a commonly used tool for airway assessment by anaesthetists in our environment because it is simple to perform at the bedside and less time consuming. This is particularly important with the anaesthesia manpower challenge in our environment where patients scheduled for surgery are reviewed in late evenings or at nights by those who had worked earlier in the day on elective surgery cases. However, the airway assessment test chosen should be able to predict difficult and easy laryngoscopies, must be highly sensitive, specific and have a good positive predictive value.

Our results showed that the MMP had a low sensitivity of 50.68% and moderately high specificity of 74.01% with a very low positive predictive value (PPV) of 49.22% and a moderately high negative predictive value (NPV) of 75.12% in goitre patients scheduled for thyroidectomy. The sensitivity of the MMP is its ability to detect difficult laryngoscopy. Hence the MMP was able to predict only 50.68% or about half of the patients who had difficult laryngoscopy. However, with a moderately high specificity of 74.01%, MMP was able to predict about three-quarters of patients who had easy laryngoscopy. The PPV is the probability that there is difficult laryngoscopy when the test is positive and we found this to be 49.2% which was low. While Narang et al[11] reported a very low PPV of 22.85%, Sen et al[10] reported PPV of 57.0% with both groups of researchers using elective general surgical patients undergoing procedures under general anaesthesia.

We did not find in our literature search, previous studies in which predictive tests for difficult laryngoscopy was carried out specifically in goitre patients scheduled for thyroidectomy. While some studies of predictive tests of difficult laryngoscopy excluded patients with obvious anatomical or pathological causes of difficult laryngoscopy, other studies were carried out on patients with acromegaly, obese and pregnant patients.[11,12,17,18,19] The results of Narang et al[11] differ from our findings with high sensitivity of 72.72%, low PPV of 22.85% while our results for the same parameters were 50.68% and 49.2% respectively. These researchers used patients undergoing various surgical procedures unlike our study where all patients had only thryroidectomy. Yildrim et al[19] reported higher sensitivity (73.08%), lower specificity (57.69%) and somewhat similar PPV (47.5%) in pregnant women compared to our results of 50.68%, 74.01% and 49.2% respectively. The variations in results of these studies could be due to rank or experience of the researchers performing the predictive tests, and the different groups of patients enrolled in the studies.

Sanyal et al[20] found a low sensitivity of 42.86%, high specificity of 82.56%, a low or poor PPV of 28.57% and a high NPV of 89.87% using the MMP in predicting difficult laryngoscopy in Indian population. They found a lower sensitivity and PPV when compared with our results while they had higher specificity and NPV. The differences in some of the results may be due to the fact while they included patients weighing 45-80 kg in their study, we did not specify the weight range in the inclusion criteria. Also, these authors[20] recruited general elective surgical patients scheduled for surgery under general anaesthesia, while we used only goitre patients. Sen et al[10] reported a low sensitivity of 54.81% and moderately high specificity of 89.14% with a low PPV of 57.0% using MMP in predicting difficult laryngoscopy in patients scheduled for elective surgery under general anaesthesia. While we had almost similar sensitivity results, their specificity and PPV were higher than our findings. These authors also recruited general surgical patients scheduled for various surgeries for their study. The authors did not however, indicate the exclusion criteria for their study. Yildirim et al[19] using pregnant women scheduled for Caesarean sections under general anaesthesia, found that the MMP had a moderate sensitivity of 73.08% and specificity of 57.69% with PPV of 47.5% and NPV of 96.67%. The results they obtained showed higher sensitivity and NPV than our

results but similar PPV. A high sensitivity in their results indicated that the MMP had the ability to detect a high number of obstetric patients with difficult laryngoscopy.

Narang et al[11] recruited 250 elective general surgical patients scheduled for various procedures under general anaesthesia and found the following results: sensitivity72.72%, specificity 88.0% and PPV 22.85%. Their sensitivity and specificity results were higher than our results while they recorded a much lower PPV.

The studies of Sen et al[10], Narang et al[11] and Sanyal et al[20] showed variations in their findings of the MMP in predicting difficult laryngoscopy. The variations may be due to inter-observer differences in reporting the MMP class and inappropriate performance of the MMP.[10,21] While Sen et al[10] and Sanyal et al[20] stated the rank or experience of the anaesthesiologist who performed laryngoscopy, Narang et al[10] did not mention such. The MMP in our study were performed by the consultants involved in our study.

Evaluation of difficult laryngoscopy was done based on the Cormack and Lehane grading.[9] As shown in Table I in this study, 167 (66.8%%) patients had easy laryngosopic grading (CL 1 and 2) while 83 (33.2%) had difficult laryngoscopic grading (CL 3 and 4). Narang et al[11] found that 95.6% of their patients had easy laryngoscopic grading while 4.4% had difficult laryngoscopic grading. Sen et al[10] reported easy laryngoscopic grading in 79.2% and difficult laryngoscopic grading in 20.8% of patients recruited into their study. Nasir et al[12] found easy laryngoscopic grading in 83.61% and difficult laryngoscopic grading in 16.39% of their patients. The results of these studies show much higher number of patients with easy laryngoscopy and much lower number of patients with difficult laryngoscopy compared to our findings. The presence of an anterior neck mass contributing to higher number of patients with difficult laryngoscopy may be the reason for the differences with our findings.

Researchers have advocated that when airway assessment tests are combined they give better prediction for difficult laryngoscopy.[10,22] Sen et al[10] concluded in their study that though both the MMP and TMD were more or less equally potent in predicting difficult airway, the combination of these two tests were definitely a much better predictor of difficult airway. Shiga et al[22] in a meta-analysis of 35 studies involving 50,760 patients, found that a combination of the MMP and TMD most accurately predicted difficult intubation. The TMD was not feasible in some of our patients because of the anterior neck masses, hence MMP which is routinely done in our patients was used in predicting difficult laryngoscopy. Among the bedside tests, Salman et al[23] reported that the MMP and TMD showed the highest sensitivity of 62.5% with variable specificities of 91.6% and 34.7% respectively while upper lip bite test had low sensitivity of 12.5%, high specificity 90.2%, inter-incisor distance, palm print test and prayer's sign all had low sensitivity of 0% and low specificity 1% respectively. The Wilson risk score[7] is time consuming for busy schedules with manpower challenge. In a retrospective study on tracheal configuration in predicting difficult intubation in goitre patients using neck X-rays, Abdulkadir et al[24] showed that patients who had coronal and sagittal tracheal diameters less than 7 mm all had difficult intubation while those who had less than 5 mm had failed intubation. Ezri et al[18] used ultrasound to quantify anterior neck soft tissue as a predictor of difficult intubation in obese patients and found that it was a good predictor of difficult laryngoscopy. Though CT scan and MRI can be used for the same purpose, they are expensive and may involve risks to patients. What may be practical in our environment for predicting difficult laryngoscopy in goitre patients presenting for thyroidectomy is the combination of MMP, ultrasound quantification of the anterior neck mass[18] and neck X-ray measurements of the tracheal lumen[24] especially when MMP done in the pre-anaesthesia clinic indicates difficult laryngoscopy or when the goitre is huge. Both the neck ultrasound and neck X-rays are routinely done for all goitre patients, hence the measurements required can be obtained.

The incidence of failed intubation in this study was 1.2%. We had previously reported incidences of failed intubation in goitre patients to be 1.2% and 1.6% respectively in two studies.[3,24] Our results of incidence of failed intubation have remained consistent over a period of 13 years in three studies which includes the present study. The incidence of failed intubation in general anaesthetics is as high as 1 in 1,000 – 2,000 (0.05 – 0.1%).[25] Jayaraj et al[26] reported incidence of failed intubation in 42,805 general surgical patients to be 0.03%. Our results show that the incidence of failed intubation in goitre patients scheduled for thyroidectomy under general anaesthesia is 1.2-1.6%, which is higher than what obtains in the general population.

Although the Pearson's correlation coefficient (r) between MMP and CL in this study was found to be 0.19 ($p = 0.002$) which was a positive correlation, the size of the correlation was negligible. A correlation size between 0.00 to 0.30 is negligible correlation.[27,28] Though the correlation coefficient was negligible, it was significant, suggesting that as MMP class increases or decreases, CL grading may also increase or decrease, moving in the same direction. Nasir et al[12] also found a value of correlation coefficient between MMP and CL to be 0.335 with p value of 0.001.

## CONCLUSION

The Modified Mallampati test which is frequently used in our environment to predict difficult laryngoscopy had low sensitivity of 50.68% and low positive predictive value of 49.22% in goitre patients scheduled for thyroidectomy under general anaesthesia. However, it had a moderately high specificity of 74.01% to detect easy intubation. Although the correlation between the modified Mallampati class and the Cormack and Lehane grading was found to be positive, it was negligible in this study. It is hereby recommended that the MMP should

be combined with ultrasound quantification of neck mass and measurements of tracheal lumen diameters in neck X-rays to improve its predictive accuracy when there is a high index of suspicion of difficult laryngoscopy in goitre patients.

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