Original Research Article

Comparative evaluation of the Modified Mallampati Score (MMC) and Modified Mallampati Score along with Thyromental distance, Anatomical abnormality, and Cervical mobility (M-TAC) in predicting difficult airway

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Abstract

Background: The MMC has been found to be of limited value and cannot be relied on for using in predicting difficult airway. Thus, we used a combination of multiple tests (combining MMC with Thyromental distance, Anatomical abnormality and Cervical mobility [M-TAC] to provide a high index of sensitivity and specificity for prediction of difficult airway.

Methodology: Two hundred patients, scheduled for general anaesthesia (GA) requiring endotracheal intubation for elective surgical procedures were evaluated in this prospective, double blind, case control study. Airway assessment was done first by MMC and then by combination of tests (M-TAC). Anaesthesiologists assessing and managing airway were different and blinded for airway parameter. Difficult intubation was assessed by modified Cormack and Lehane grading (CL) and correlated with pre-operative airway assessment. Patients, failed to be intubated, were intubated by different methods and excluded from the study.

Results: Our results showed that M-TAC in comparison to MMC had higher sensitivity (96.29% vs 74.07%), specificity (81.50% vs 73.41%), positive predictive value (PPV) (44.83% vs 30.30%), and negative predictive value (NPV) (99.30% vs 94.78%). The odd’s ratio (114.60, 95% CI 14.99 to 875.64 vs 7.89, 95% CI) was 3.130 to 19.882, positive likelihood ratio (LR) was (1.20 vs 1.02), negative LR (1.17 vs 0.99) in predicting difficult airway.

Conclusion: M-TAC, as pre operative assessment test gives better prediction of difficult airway and therefore decreases the adverse outcome incidence related to unanticipated difficult airway though requires precision and time.

Keywords: endotracheal intubation, laryngoscopy, airway management, general anaesthesia.
Introduction
Several risk factors for assessing airway difficulties have been identified, yet none have convincing diagnostic accuracy when using in isolation. Combining several risk factors increases the predictive value of the tests, therefore, multivariable risk models for difficult laryngoscopy and intubation have been developed, to provide a high index of sensitivity and specificity for prediction of difficult airway. Mallampati et al. introduced a scoring system based on the visibility of the oropharyngeal structures,[1] and still today remains the most useful clinical assessment method for predicting difficult intubation worldwide, but accuracy of this has been questioned a number of times.
We hypothesized that M-TAC would have better predictive value than MMC in predicting difficult airway.

Methodology
After obtaining clearance from Institutional Ethics Committee, two hundred patients, scheduled for (GA) requiring endotracheal intubation for elective surgical procedures, were enrolled in this prospective, double blinded, case control study. Inclusion criteria were American Society of Anesthesiologists (ASA) physical status I or II and adult patients aged 18-60 years. Exclusion criteria were patient’s refusal, ASA physical status III and IV, cervical spine disorder, obstructive airway tumour, edentulous/irregular dentition, past history of difficult laryngoscopy & intubation, pregnancy, trauma to the airways or cranial, cervical & facial regions, burns to airways & adjacent structures, mouth opening<3 cm, age <18 years &> 60 years. This study was done as per Helsinki Declarations and it was registered in Clinical Trials.gov under registration number NCT02705794.

MMChas a classification of oropharyngeal view where we assessed the size of tongue in relation to oral cavity. While being seated, each patient was asked to open his or her mouth wide and protrude the tongue maximally without phonation. MMC was classified as-Class 0- soft palate, uvula, fauces, tonsillar pillars, epiglottis, class 1 - soft palate, uvula, fauces, tonsillar pillars, class 2- soft palate, uvula, fauces, class 3- soft palate and base of uvula, class 4-soft palate not visible and each class was given a score which was equal to the respective class i.e, class 1 had score 1.

M-TAC consists of MMC and additionally three parameters

Thyromental distance (T) was measured along a straight line from the thyroid notch to the lower border of the mandible (mentum), with the head fully extended and the mouth closed. Thyromental distance (TMD) was classified as Class 0- ≥6.5cm, class 1- 5.5cm-6.4cm , class 2- <5.5cm and each class was given a score which was equal to the respective class i.e, class 1 had score 1.

Anatomical abnormality (A) assessed the anatomical abnormalities of face neck or oral cavity. It was classified as Class 0- No abnormality, class1- Protruding upper incisors or macroglossia or high arched palate, class 2- Micrognathia or inability to align lower with upper incisors and each class was given a score which was equal to the respective class i.e, class 1 had score 1.

Cervical mobility range (C) - the range of cervical mobility was evaluated according to the method suggested by Wilson et al.[11] Patients were asked to extend the neck fully and a pencil was placed vertically on the forehead. While the pencil was held firmly in position, the neck was flexed and the angle was measured. It was classified as class 0 - ≥80°, class 1- 60° - 80°, class 2 - <60° and each class was given a score which was equal to the respective class i.e, class 1 had score 1.

Three anaesthesiologists participated in this study; one performed pre-anaesthetic assessment of the airway in the pre-anaesthesia clinic, and two performed laryngoscopy under GA (having >5 years experience of GA with endotracheal intubation). All information in relation to the pre-anaesthetic check up was shared between the anaesthesiologists, except for the data relating to
airway evaluation specific to this study and M-TAC scoring.

Inside operating room, standard fasting guidelines were confirmed and venous access was established. Non-invasive monitoring including (use full form) was initiated. All patients were premedicated with intravenous (IV). Dexamethasone 8mg, Glycopyrrolate 0.01mg/kg, Midazolam 0.05mg/kg and Fentanyl 2 mcg/kg

Following preoxygenation for 3 minutes, anaesthesia was induced with IV Propofol 2mg/kg and succinylcholine 1.5mg/kg. Laryngoscopy was performed in sniffing position using a Macintosh laryngoscope and the best possible laryngoscopic view was obtained after confirmation by a second anaesthesiologist. In event of disparity regarding CL grading among fellow anaesthesiologist case was excluded from the study.

Maintenance of anaesthesia was done with oxygen, nitrous oxide and isoflurane & muscle relaxation with IV vecuronium 0.1mg/kg. After completion of surgery anaesthesia was reversed with IV neostigmine 0.05mg/kg & glycopyrrolate 0.01mg/kg. Patient was extubated when fully awake and responding to commands.

Difficult laryngoscopy was defined as the view observed corresponding to Grade 3 or 4 of the CL laryngoscopic view [23]. Three attempts at endotracheal intubation were allowed before the act was considered as a failure. In this situation, the participants followed the next step of the ASA difficult airway algorithm using the secondary intubation plan. If the airway could not be secured even with these, laryngeal mask airway (LMA) and other efforts to maintain ventilation and oxygenation were used.

Sensitivity of M-TAC score in a previous study was 96% [18]. Considering 25% difference between M-TAC & MMC and taking alpha error 0.05 and power of the study 80%, we calculated 196 patients were required for the study. So, we recruited a total of 200 patients. The data obtained from the200 patients entered in Microsoft excel sheet, checked for missing errors using SPSS v18.

Results

A total of 233 patients were recruited for the study, out of which 8 didn’t give consent for the study, 7 had cervical spine disorders, 8 were edentulous, 4 had burns to airway/ surrounding structure, 6 had trauma to the airways so were excluded from the study.

Finally a total of 200 patients (108 males and 92 females) were analyzed. The baseline characteristics of both the groups (MMC & M-TAC) were comparable in terms of age, weight, sex, proportion of ASA physical status. (Table 1)

The difficult intubation occurred in 13.5% (n=27) as compared to easy intubation in 86.5% (n=173). (Table 1).

In MMC class the number of patients with score 3 (n=51) & 4 (n=15) with presumed difficult laryngoscopy only 17.65% (n=9) and 73.33% (n=11) had difficult laryngoscopy as confirmed by CL view, respectively. Whereas the score of 4 (n=23) & 5 or more (n=35) in M-TAC class which were predicted to be difficult, only 6 (26.09%) and 20 (57.14%) patients respectively were truly difficult by CL grade 3 & 4. (Table 2) (fig 1).

The sensitivity (96.29%) and specificity (81.50%), positive predictive value (44.83%) and negative predictive value (99.30%) of M-TAC ≥4 were more in comparison with M3 and M4 in predicting difficult laryngoscopy. (Table 3 & 4)

Further, The odds ratio of M-TAC test is also more than MMC test (7.89 vs 114.60). The applicability of both the screening tests, in the presumptive diagnosis of patients having difficult laryngoscopy illustrated by using ROC curve (receiver observer characteristics curve) shows the area under the curve (AUC) for both the tests is more than 0.5. The M-TAC test is comparatively a better test in detecting difficult laryngoscopy in the patients as the AUC is more...
in M-TAC i.e. 0.933 than in MMC test i.e. 0.811. (fig 2, fig 3).

**Table 1: Comparison of demographic & clinical parameters between the easy & difficult intubation groups**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>easy intubation group (CL 1 &amp; 2) (n=173)</th>
<th>difficult intubation group (CL 3 &amp; 4) (n=27)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (in years)</td>
<td>33.26 ± 12.22</td>
<td>33.15 ± 11.91</td>
<td>0.965*</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>56.25 ± 10.46</td>
<td>58.26 ± 12.38</td>
<td>0.367*</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>92/81</td>
<td>16/11</td>
<td>0.555†</td>
</tr>
<tr>
<td>ASA-I/II</td>
<td>99/74</td>
<td>10/17</td>
<td>0.05†</td>
</tr>
</tbody>
</table>

*unpaired student t test, †chi square test

**Table 2: Distribution of patients according to scoring parameters (Modified Mallampati class & M-TAC score) and Cormack- Lehane grading. Data are presented as number or number %.

<table>
<thead>
<tr>
<th>Scoring parameters</th>
<th>Total no. of patients</th>
<th>CL-1 &amp; CL-2 (%)</th>
<th>CL-3 &amp; CL-4 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>37</td>
<td>37 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2</td>
<td>97</td>
<td>90 (92.7)</td>
<td>7 (7.22)</td>
</tr>
<tr>
<td>3</td>
<td>51</td>
<td>42 (82.3)</td>
<td>9 (17.65)</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>4 (26.6)</td>
<td>11 (73.33)</td>
</tr>
<tr>
<td>M-TAC</td>
<td>Total no. of patients</td>
<td>CL-1 &amp; CL-2 (%)</td>
<td>CL-3 &amp; CL-4 (%)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>36</td>
<td>36 (100)</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>69</td>
<td>69 (100)</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>37</td>
<td>36 (97.3)</td>
<td>1 (2.70)</td>
</tr>
<tr>
<td>4</td>
<td>23</td>
<td>17 (73.9)</td>
<td>6 (26.09)</td>
</tr>
<tr>
<td>5 or more</td>
<td>35</td>
<td>15 (42.8)</td>
<td>20 (57.14)</td>
</tr>
</tbody>
</table>

**Table 3: Accuracy/Validity of the Modified Mallampati Score in detecting difficult intubation**

<table>
<thead>
<tr>
<th>Anticipated intubation by MMC</th>
<th>Confirmed intubation by CL method</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult (MMC 3 or 4)</td>
<td>Difficult (CL-III/IV) 20 (TP)</td>
<td></td>
</tr>
<tr>
<td>Easy (MMC 0 or 1 or 2)</td>
<td>Easy (CL-I/II) 46 (FP)</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>173</td>
</tr>
</tbody>
</table>

Sensitivity = 74.07%
Specificity = 73.41%
Positive predictive value (PPV) = 30.30%
Negative predictive value (NPV) = 94.78%
Positive (+) likelihood ratio (LR+) = 1.02
Negative (-) likelihood ratio (LR -) = 0.99

Odd ratio (OR) = 7.89, 95% C.I is 3.130 to 19.882

*TP is true positive, FP is false positive, FN is false negative, TN is true negative

**Table 4: Accuracy of the M-TAC screening test in detecting difficult intubation**

<table>
<thead>
<tr>
<th>Anticipated intubation by MTAC test</th>
<th>Confirmed intubation by CL method</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult (≥ 4 score)</td>
<td>Difficult (CL-III/IV) 26 (TP)</td>
<td></td>
</tr>
<tr>
<td>Easy (&lt; 4 score)</td>
<td>Easy (CL-I/II) 32 (FP)</td>
<td>58</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>173</td>
</tr>
</tbody>
</table>

Sensitivity of M-TAC = 96.29%
Specificity of M-TAC = 81.50%
Positive predictive value (PPV) = 44.83%
Negative predictive value (NPV) = 99.30%
Positive (+) likelihood ratio (LR+) = 1.20
Negative (-) likelihood ratio (LR -) = 1.17

Odd ratio (OR) = 114.60, 95% C.I is 14.99 to 875.64

*TP is true positive, FP is false positive, FN is false negative, TN is true negative
Table 5: Applicability of screening tests in diagnosing difficult laryngoscopy using ROC curve

<table>
<thead>
<tr>
<th>Screening tests</th>
<th>AUC</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMC test</td>
<td>0.811</td>
<td>0.001</td>
</tr>
<tr>
<td>M-TAC test</td>
<td>0.933</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Fig 1: Accuracy of MMC and M-TAC compared to Cormack-Lehane grading in terms of Sensitivity & Specificity.

![Fig 1](image1.png)

x- axis shows - various groups and y- axis shows - %

Fig 2: ROC curve obtained when MMC is used as screening test for predicting laryngoscopy

![Fig 2](image2.png)

Fig 3: ROC curve obtained when MTAC is used as screening test for predicting difficult laryngoscopy

![Fig 3](image3.png)

Discussion

The incidence of difficult laryngoscopy is various studies were of the order of 1.3%- 13% \[^{1-5}\] depending on the criteria used to characterize it. Apparently, no clinical test; the MMC being no exception, can meet these criteria when used alone. Effective and reliable prediction requires a combination of several parameters e.g. age, height, weight, BMI, MMT, head and neck movement, dentition status, upper lip bite test, inter-incisor gap and TMD which increases accuracy but at the cost of time.

We considered three airway parameters along with MMC. TMD, that singly has been advocated as a screening test for predicting difficult laryngoscopy.\[^{6}\] A number of studies defined TMD < 7 cm a predictor of difficult intubation. Schmitt HJ et al found that the TMD when used alone, is unreliable, \[^{7}\] which was supported by other studies also.\[^{8}, \, 9\] Other parameters which affect laryngoscopy are anatomical abnormality of head, neck and face and cervical mobility, which had been taken into account in several studies.\[^{2}, \, 10, \, 11\]. Movement of the cervical spine is an important component of direct laryngoscopy and tracheal intubation. The best position for direct laryngoscopy requires 35\(^\circ\) neck flexion and face plane extension to 15\(^\circ\).\[^{12}\] The MMC, TMD and
mouth opening are all impaired by cervical spine limitation, which suggests the importance of adequate neck movement when predicting difficult tracheal intubation.[13]

In this study, when we used MMC as a single predictor of difficult laryngoscopy and intubation, sensitivity of MMC scoring system was 74.07% which was less than the study done by Khan et al(82.4%),[14] Mahmoodpoor et al(98.40%)[15] but more than that of Bilgin et al(43%),[16] R Bhat (59%)[17] and was comparable with many other studies done by Mallampati et al(71%),[1] Ambesh et al(72%).[18] The specificity of MMC in our study was 73.41% which was more than that of Khan et al(66.8%),[14] and less than that of Mallampati et al(89%),[1] R Bhat (83.5%)[17] and comparable to Ambesh et al (78%).[18] This wide variation in reported sensitivity and specificity in various studies including this study could be explained on the basis of inter observer variability and patients factors. As the visibility of the oropharyngeal structures depend on the patient’s position during examination.

Traditionally, the diagnostic accuracy of a predictive test is denoted by sensitivity and specificity. High sensitivity and specificity would indicate a good predictive test. In this study it was found that although MMC and M-TAC had significant p-value (p< 0.05) indicating both were reliable predictors of difficult laryngoscopy but on comparison M-TAC proved to be superior as sensitivity, specificity, PPV, NPV were greater than of MMC. The PPV of M-TAC, 44.83%, which was consistent with various other studies.[14],[20] The odd’s ratio of M-TAC was 15 times greater than MMC (114.6% vs 7.89%). That signified predicting difficult airway using M-TAC was 15 times more than that of MMC, which has been confirmed in other studies.[18]

The above fact is also supported by the ROC curve analysis. As the area under curve (AUC) for both the tests is more than 0.5, both the tests are useful in diagnosing difficult laryngoscopy. The M-TAC test is comparatively better than MMC in detecting difficult laryngoscopy as the AUC is more in M-TAC

The limitation of the study was that despite standardization of factors the incidence of difficult laryngeal view (DLV) was 13.5%, which is comparable with some of the other studies.[1],[5] The possible explanation can be involvement of different anaesthesiologists for airway assessment and laryngoscopy and BMI.[21,22] Body mass index and height were not included in the study. So, we concluded that, M-TAC is a better predictor of difficult laryngoscopy when used as a bedside screening test in general population. Therefore, we suggest that M-TAC may be used instead of MMC alone as this will aid anaesthesiologists to be prepared for management of a difficult airway and therefore will decrease the adverse outcome incidence related to unanticipated difficult airway. Nevertheless, large multicentric trial in different populations is yet to be performed to claim for the documentation of our results.

References


