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Original Article

A combination of the modified Mallampati score, thyromental distance, anatomical abnormality, and cervical mobility (M-TAC) predicts difficult laryngoscopy better than Mallampati classification

Sushil Prakash Ambesh [1], Neha Singh [2*], Parnandi Bhaskar Rao [3], Devendra Gupta [1], Prabhat Kumar Singh [1], Uttam Singh [4]

[1] Department of Anesthesiology, Intensive Care and Pain Medicine, SGPGIMS, Lucknow, India
[2] Department of Anesthesiology and Critical Care, P.I.M.S, Pondicherry, India
[3] Department of Anaesthesiology, All India Institute of Medical Sciences, Bhubaneswar, Orissa, India
[4] Department of Biostatistics, SGPGIMS, Lucknow, India

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ABSTRACT

Objective: Unanticipated difficult tracheal intubation is a significant source of morbidity and mortality in anesthetized patients. A number of modules have been developed to predict difficult airways, but they are often complex in nature. We combined the modified Mallampati score (M), thyromental distance (T), anatomical abnormality (A), and cervical mobility (C) into a single scoring system with the acronym M-TAC, and evaluated it against Mallampati scoring.

Methods: We prospectively analyzed 500 adult patients of the American Society of Anesthesiologists (ASA) class I or II, scheduled for elective surgery under general anesthesia. Preoperative airway assessments using M-TAC were performed, all of which were given a score. Anesthesiologists, blinded to the pre-anesthetic airway assessment, performed laryngoscopy and graded the laryngoscopic view as per Cormack and Lehane's classification. For the study purpose, difficult laryngoscopy was defined as Cormack and Lehane Grade 3 or 4 of laryngoscopic view.

Results: An M-TAC score ≥ 4 had a significantly higher sensitivity (96% vs. 72%) and specificity (86% vs. 78%) with a high positive predictive value (44% vs. 28%) and a very low false negative value (2% vs. 15%) in comparison with Mallampati scoring ($p < 0.05$). Analysis of the receiver operating characteristic (ROC) curve for predicting difficult laryngoscopy revealed an area under the curve of 0.83 (95% CI = 0.78–0.88) for Mallampati scoring and 0.94 (95% CI = 0.92–0.96) for M-TAC scoring system.

Conclusion: The M-TAC scoring system has provided a higher sensitivity and specificity in predicting difficult laryngoscopy in comparison with Mallampati classification.

1. Introduction

Unanticipated difficult intubation is not only a threat to patient's life, but often evaluates the skill of an experienced anesthesiologist. Even though the reported incidence of unanticipated difficult intubation in anesthesia is rare, it often leads to disastrous respiratory complications.[1] Thus, to predict a possible difficult intubation in time is of the essence. Many scoring systems have hitherto been developed to identify possible difficult intubation, none of which stands out to be solely the best.[2–9] Thus, suggestions for a combination of these tests have evolved over time for a better prediction.[10–15]

We ventured to combine Mallampati score with some other anatomical factors to develop a new and simpler clinical prediction model for a better predictive ability.

2. Methods

We designed a scoring system, modified Mallampati score (M), thyromental distance (T), anatomical abnormality (A), and cervical mobility (C) (M-TAC), by assembling four of the most widely practiced tests for evaluation of difficult airways. 'M' denotes

* Corresponding author. Department of Anesthesiology and Critical Care, P.I.M.S, Pondicherry 605014, India.
E-mail address: drneha.com@gmail.com (N. Singh).

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modified Mallampati class of oropharyngeal view.[3,16] While being seated, each patient was asked to open his or her mouth wide and protrude the tongue maximally without phonation; the view was classified as shown in Table 1.[4]

TAC consists of three other factors: T = thyromental distance; A = anatomical abnormality of face/neck/oral cavity, and C = cervical mobility range (flexion and extension). Thyromental distance (T) was measured along a straight line from the thyroid notch to the lower border of the mandibular mentum, with the head fully extended and the mouth closed.[17] The range of cervical mobility was evaluated according to the method suggested by Wilson et al. [2] 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. Thereafter, T, anatomical abnormalities (A) of face, neck or oral cavity, and cervical mobility were each classified into three grades as shown in Table 1. The allotted grades were the respective scores of M-TAC (i.e., Grade II means score 2) (Table 1). Therefore, on evaluation of the airway, if we found Mallampati Grade 2, T Grade 1, anatomical abnormality Grade 0, and cervical mobility Grade 2, then this airway was documented as $M_2T_1A_0C_2$ or M-2 TAC-3 with a total M-TAC score of 5.

The study protocol was approved by the "Ethics Committee for Human Studies" of Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow (India) and informed written consent was obtained from all the participants. Five hundred consecutive adult patients aged 18–72 years, irrespective of sex, of the American Society of Anesthesiologists (ASA) physical status I or II, scheduled for elective surgeries under general anesthesia from December 2008 to February 2010, were enrolled for the study. Patients with an obvious difficult airway (fractured mandible or cervical spine disorder, obstructive airway tumor, edentulous patients, mouth opening <3 cm etc.), or those who refused to participate, were excluded.

Four fellow anesthesiologists participated in this study; two performed pre-anesthetic assessment of the airway, and two performed laryngoscopy under general anesthesia. All information in relation to the pre-anesthetic check up was shared between the anesthesiologists, except for the data relating to airway evaluation specific to this study and M-TAC scoring. For safety reasons, the anesthesiologists providing anesthesia in the operation theatre were always equipped with a difficult airway cart and Difficult Airway Society guidelines.[18]

All patients were premedicated with oral lorazepam (0.04 mg/kg) and ranitidine (150 mg) the night before and 2 hours before anesthesia, respectively. Standard fasting guidelines were observed in all patients. Monitors for electrocardiogram (ECG) lead II and V, noninvasive blood pressure, heart rate and peripheral oxygen saturation were applied before induction. Following preoxygenation for 3 minutes, anesthesia was induced with intravenous midazolam (0.04 mg/kg) and fentanyl (2 μg/kg) and propofol (2–2.5 mg/kg). Adequacy of mask ventilation was assessed under 1–2% sevoflurane in 100% oxygen. When the anesthesia level was satisfactory, vecuronium bromide (0.1 mg/kg) was administered intravenously and IPPV continued for 3 minutes. Laryngoscopy was performed in sniffing position using a Macintosh laryngoscope and the best possible laryngoscopic view was obtained after confirmation by a second anaesthesiologist. Difficult laryngoscopy was defined as the view observed corresponding to Grade 3 or 4 of the Cormack and Lehane (CL) laryngoscopic view.[19]

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 algorithm using the secondary intubation plan. If the airway could not be secured even with these, we continued with laryngeal mask airway (LMA) and other efforts to maintain ventilation and oxygenation. If intubation and ventilation could not be achieved, cricothyrotomy was reserved as the last resort.

2.1. Statistical analysis

The sensitivity, specificity, positive predictive value, and negative predictive value in each group were calculated. The data were analyzed using the Student *t* test for continuous variables and Fisher's Exact test or Yates Chi-square test, as appropriate, for noncontinuous variables. The predictive accuracy of the studied parameters was compared by measuring the area under the receiver operating characteristic (ROC) curve (AUROC). The package SPSS 11.5 (SPSS Inc., 233 South Wacker Drive, 11th Floor, Chicago, IL 60606-6412) was used for statistical analysis and statistical significance was defined as $p < 0.05$.

Table 1
Mallampati score, T, anatomical abnormality, and cervical mobility (M-TAC) scoring system.

Tests	Score
Mallampati (modified) class	
Class 0 (soft palate, uvula, fauces, tonsillar pillars, epiglottis)	0
Class 1 (soft palate, uvula, fauces, tonsillar pillars)	1
Class 2 (soft palate, uvula, fauces)	2
Class 3 (soft palate and base of uvula)	3
Class 4 (soft palate not visible)	4
Thyromental distance (T)	
Grade 0: T ≥ 6.5 cm	0
Grade 1: T 5.5–6.4 cm	1
Grade 2: T < 5.5 cm	2
Anatomical abnormalities of head, neck or oral cavity	
Grade 0: no abnormality	0
Grade 1: protruding upper incisors or macroglossia or high arched palate	1
Grade 2: micrognathia or inability to align lower incisor with upper incisors	2
Cervical mobility	
Grade 0: ≥80°	0
Grade 1: 60°–80°	1
Grade 2: <60°	2

3. Results

A total of 500 patients (292 males and 208 females) were analyzed. The median age = 46 years (range = 18–72 years), weight = 54 kg (range = 42–110 kg), and height = 159 cm (range = 146–186 cm).

Following induction of anesthesia, ventilation with a bag and mask was easy in 496 patients and assistance from a second person was required in four (0.8%) patients. Fifty-three (10.6%) patients had a difficult laryngoscopic view; CL-3 grade in 45 (9.0 %) and CL-4 grade in eight (1.6%) patients were noted (Table 2).

One hundred and thirty five patients had a modified Mallampati class of 3 and 4, of whom only 38 had difficult laryngoscopy (28%). In contrast, 15 out of 365 patients (4.1%) had difficult laryngoscopy with a modified Mallampati class of 0, 1 or 2. In comparison, none of the 279 patients with an M-TAC score of ≤2 had CL-3 or 4. Again, none of the patients had difficult laryngoscopy with a modified Mallampati class 3 and a TAC score of 0 (M_3TAC_0), whereas all had difficult laryngoscopy when a modified Mallampati class 3 was associated with a TAC score of ≥3 (M_3TAC_3).

Again, 40% of the patients had a difficult laryngoscopic view with a Mallampati class 4 and a TAC score of 0, whereas all patients had a difficult view when a Mallampati class 4 was associated with a TAC score of >1.