Rev Bras Anestesiol. 2018;68(2):168–173

REVISTA BRASILEIRA DE ANESTESIOLOGIA

Publicação Oficial da Sociedade Brasileira de Anestesiologia
www.sba.com.br

SCIENTIFIC ARTICLE

Difficult laryngoscopy and tracheal intubation: observational study

Rebeca Gonelli Albanez da Cunha Andrade[a,*], Bruno Luís Soares Lima[a], Douglas Kaíque de Oliveira Lopes[a], Roberto Oliveira Couceiro Filho[a], Luciana Cavalcanti Lima[a,b], Tania Cursino de Menezes Couceiro[a,c,d]

[a] *Instituto de Medicina Integral Professor Fernando Figueira (IMIP), Anestesiologia, Recife, PE, Brazil*
[b] *Universidade Estadual Paulista Júlio de Mesquita Filho (Unesp), Anestesiologia, Botucatu, SP, Brazil*
[c] *Universidade Federal de Pernambuco (UFPE), Neuropsiquiatria e Ciência do Comportamento, Recife, PE, Brazil*
[d] *Hospital Barão de Lucena, Recife, PE, Brazil*

Received 7 July 2016; accepted 14 October 2017

KEYWORDS
Difficult airway;
Airway;
Intubation;
Laryngoscopy;
Mallampati test;
Jaw-thrust maneuver

Abstract
Introduction: Since anesthesia complications associated with unexpected difficult airway are potentially catastrophic, they should be avoided. The modified Mallampati test and jaw-thrust maneuver enable the identification of difficult airway. The aim of this study was to associate the modified Mallampati test and the jaw-thrust maneuver with laryngoscopy (Cormack–Lehane) in an attempt to identify a better predictor of difficult airway in an adult population undergoing elective surgery.
Method: A cross-sectional study in which 133 adult patients undergoing elective surgery requiring tracheal intubation were analyzed. The accuracy and specificity of the modified Mallampati test and jaw-thrust maneuver were assessed by correlating them with difficult laryngoscopy (Cormack–Lehane Degrees 3 and 4).
Results: In the 133 patients evaluated the difficult intubation rate found was 0.8%; there was association between the two predictive tests proposed ($p = 0.012$). The values of 94.5% for specificity and 95.4% for accuracy were found for the jaw-thrust maneuver and for the modified Mallampati test, the values found were 81.1% and 81.2%, respectively. Kappa agreement identified a result of 0.240 between jaw-thrust maneuver and Cormack–Lehane, which was considered reasonable. On the other hand, a poor agreement ($\kappa = 0.06$) was seen between modified Mallampati test and Cormack–Lehane test.

* Corresponding author.
E-mail: bekinhagonelli@hotmail.com (R.G. Andrade).

https://doi.org/10.1016/j.bjane.2017.10.010

Conclusion: The jaw-thrust maneuver presented superior accuracy and agreement than the modified Mallampati test, showing the ability to identify a difficult airway. It is necessary to emphasize the association of tests in the evaluation of patients, emphasizing their complementarity to minimize the negative consequences of repeated laryngoscopies.

PALAVRAS-CHAVE
Via aérea difícil;
Via aérea;
Intubação;
Laringoscopia;
Teste Mallampati;
Manobra de protrusão da mandíbula

Dificuldade na laringoscopia e na intubação orotraqueal: estudo observacional

Resumo
Introdução: As complicações anestésicas associadas às vias aéreas difíceis inesperadas por serem potencialmente catastróficas devem ser evitadas. O teste de Mallampati modificado e a manobra de protrusão mandibular possibilitam a identificação da via aérea difícil. O objetivo deste estudo foi associar o teste de Mallampati modificado e a manobra de protrusão mandibular com a laringoscopia (Cormack-Lehane) e tentar identificar um melhor preditor de via aérea difícil na população adulta submetida à cirurgia eletiva.
Método: Estudo corte transversal, foram analisados 133 pacientes adultos submetidos a cirurgias eletivas que necessitavam de intubação orotraqueal. Avaliaram-se a acurácia e especificidade do teste de Mallampati modificado e da manobra de protrusão mandibular, correlacionados com laringoscopia difícil (Cormack-Lehane Graus 3 e 4).
Resultados: Entre os 133 pacientes avaliados, a taxa de intubação difícil encontrada foi 0,8%, houve associação entre os dois testes preditores propostos ($p = 0{,}012$). Foram encontrados os seguintes valores para a especificidade 94,5% e a acurácia 95,4% na manobra de protrusão mandibular. Já para o teste de Mallampati modificado valores de 81,1% e de 81,2% respectivamente. A análise de concordância *Kappa* identificou entre manobra de protrusão mandibular e Cormarck-Lehane um resultado de 0,240; considerado razoável. Por outro lado, observou-se uma fraca ($\kappa = 0{,}06$) concordância entre o teste de Mallampati modificado e o Cormarck-Lehane.
Conclusão: A manobra de protrusão mandibular apresentou acurácia e concordância superiores ao teste de Mallampati modificado, mostrou a capacidade de identificar uma via aérea difícil. Faz-se necessário enfatizar a associação dos testes na avaliação do paciente, destacar a complementariedade deles, minimizar as consequências negativas de laringoscopias repetidas.

Introduction

Airway management remains a major challenge for anesthesiologists.[1] Although advances in the development of new airway devices and well-defined algorithms that guide the approach in emergency situations have reduced difficult airway complications, there has been little change regarding difficult airway predictors, which are essential for the adequate use of these protocols.[2,3]

Laryngoscopy and tracheal intubation are one of the pillars in airway management during general anesthesia and usually are uneventfully performed. However, if tracheal intubation is difficult or impossible after induction of anesthesia, there may be soft tissue injury, trauma and consequent airway edema, dental avulsion, unnecessary surgical airway, inability to maintain tissue oxygenation, brain injury, cardiorespiratory arrest, and even death.[4,5] It is worth noting that anesthetic complications associated with unexpected difficult airway, although potentially catastrophic, may be avoided.

The difficulty of achieving direct laryngoscopy and tracheal intubation ranges from 1.5% to 13% in patients undergoing elective surgery.[6] The great variation seen is justified because some studies that support these data are retrospective, apply different definitions for difficult intubation, in addition to the inter-population variation itself.[7]

There are a number of characteristics that can anticipate a difficult airway, but none of them alone has proved totally reliable after some studies.[6] Among the difficult airway predictors, the modified Mallampati test (MMT) globally known and easily applied has good specificity (95.7%), but low sensitivity (27.1%) and accuracy (80.3%).[1] Thus, its use alone may lead to an unacceptable number of false negatives, having as a great disadvantage its observer dependency nature.

On the other hand, another predictor that becomes interesting in this context is the jaw-thrust maneuver (JTM). According to studies, this maneuver shows greater sensitivity (95.5%) and accuracy (90.1%) with an acceptable specificity (88.4%).[1] Moreover, it has a good reproducibility and does not require specific patient positioning.

Considering the above, since the inability to maintain airway patency after induction of general anesthesia is an important cause of morbidity and mortality related to anesthesia,[4] it is necessary to investigate options of easy execution, good sensitivity and specificity in predicting difficulty laryngoscopy and tracheal intubation.

Therefore, this study aimed to associate MMT with JTM and try to identify a better difficult airway predictor in adult population undergoing elective surgery at IMIP, as well as to correlate the anesthesiologist's experience with the degree of difficult laryngoscopy.

Method

A prospective, descriptive, observational study was conducted involving adults undergoing elective surgeries at the *Instituto de Medicina Integral Professor Fernando Figueira* (IMIP) surgical clinics. After obtaining the Human Research Ethics Committee approval (CAAE No. 47849915.7.0000.5201), the patients were duly informed about the study.

Thus, all patients older than 18 years, physical status ASA I, II or III, who required general anesthesia and orotracheal intubation were included after given written informed consent. Patients undergoing emergency surgery, with a full stomach, tracheostomized, with severe pulmonary diseases, and those not receiving neuromuscular blockers (NMB) for anesthetic induction were excluded.

For sample size calculation, a simple random sample with variance of 5.6, 95% confidence interval, and 0.9 margin of error was used (Fig. 1, equation). A value of 10% was assumed for any losses and the total number of patients was equal to 133.

Data were collected from November 2015 to January 2016. During pre-anesthetic evaluation, a questionnaire was applied to eligible patients and their airways were carefully examined, including measurement of the interincisal and thyromental distances and head extension capacity. In addition, JTM was performed, which consists of the patient's ability to lift the chin or, simply, bite the upper lip with the lower dental arch. Modified Mallampati test was performed and classes 3 and 4 were characterized as possible difficult airway predictors.

Anesthetic induction was performed by the anesthesiologist responsible for the procedure based on patient's clinical indications. However, the use of olfactory position was standardized to allow a better view of vocal chords during orotracheal intubation and rocuronium infusion ($0.6\,mg.kg^{-1}$). Laryngoscopy was performed two minutes (min) after the neuromuscular blocker administration in order to provide adequate relaxation. In addition, it was established that patients whose MMT classification was 3 or 4 would have the first intubation attempt performed by the most experienced resident or anesthesiologist in the room.

$$n = \left(\frac{Z\,\alpha/2\,.\,\sigma}{E}\right)^2$$

Figure 1 Equation used for sample calculation (n, number of individuals in the sample; $Z^{\alpha/2}$, desired confidence interval; σ, population standard deviation; E, margin of error).

After induction, laryngoscopy was performed and patients were classified according to Cormack–Lehane classification. Difficult laryngoscopy was considered as Cormack–Lehane Grade 3 or 4 or more than 3 attempts for tracheal intubation. The experience time (years) of the physician who performed the intubation and the number of attempts were also recorded.

The study data were collected between November 2015 and January 2016. Statistical analysis was performed using Stata 10.0 software (College Station, Tex). Initially, frequency distribution tables of the assessed variables were constructed and mean and standard deviations were calculated for continuous variables. To calculate the association between categorical variables, a bivariate analysis was performed, chi-square test or Fisher's exact test was used when indicated, and a significance level of 95% was used.

Results

A total of 133 patients, whose demographic and clinical characteristics are shown in Table 1 were assessed. Regarding the age group, the studied population was mostly composed of young adults. It is also observed a predominance of female, as well as a homogeneity regarding physical status (ASA).

Table 2 shows the prevalence of predictors for difficult airway in the study population, as well as the outcomes. There was a low incidence of difficult laryngoscopy and difficult intubation, both with values of 0.8%.

It is also important to note that 23 (19.6%) patients had MMT Class 3 or 4. Regarding jaw thrust, only seven patients (5.3%) could not perform such maneuver. These two were the main predictors of difficult intubation. Regarding Cormack–Lehane classification, no patient was classified as Cormack–Lehane Grade 3 and only one patient (0.8%) was classified as Grade 4. As defined previously, a difficult laryngoscopy rate of 0.8% was found in the present study.

When correlating anesthesiologists' experience with MMT, ability to jaw thrust, and number of attempts to perform intubation, there was an association with MMT with a significant p-value of 0.004 (Table 3). Therefore, the more experienced the professional, the smaller the number of attempts required.

Table 1 Sample characteristics.

	n	%
Age (years)		
<65	103	77.4
≥65	30	22.6
Sex		
Male	47	35.3
Female	86	67.7
ASA[a]		
1	43	32.7
2	43	32.7
3	47	35.3

[a] American Society of Anesthesiologists.

Table 2 Preanesthetic and tracheal intubation data.

Variables	*n*	%
Interincisal distance		
<3 cm	1	0.75
>3 cm	132	99.25
Head extension		
No	8	6.01
Yes	125	93.99
Mallampati		
Class 1	58	43.6
Class 2	49	36.8
Class 3	19	14.3
Class 4	7	5.3
Jaw thrust		
Yes	126	94.7
No	7	5.3
Cormack–Lehane		
Grade 1	107	80.5
Grade 2	25	18.8
Grade 3	1	0.8
Anesthesiologist experience time		
< 3 years	59	44.4
> 3 years	74	55.6
Number of attempts		
1	129	97
2	3	2.3
3	0	0
4	1	0.8

Table 3 Correlation between experience time and MMT, JTM, and number of intubation attempts.

	Anesthesiologist experience time		
	<3 years	≥3 years	*p*-value
	Frequency (%)	Frequency (%)	
MMT			
1 and 2	41 (38.3)	66 (61.7)	0.004
3 and 4	18 (69.2)	8 (30.8)	
JTM			
No	3 (42.9)	4 (57.1)	0.934
Yes	56 (44.4)	70 (55.8)	
Nº. of attempts			
1	57 (44.2)	72 (55.8)	0.496
2	2 (66.7)	1 (33.3)	
4	0 (0.0)	1 (100)	

MMT, modified Mallampati test; JTM, jaw-thrust maneuver.

When correlating MMT with JTM, the two assessed difficult airway predictors, there was a significant correlation ($p = 0.012$) (Table 4).

In this prospective study, the values of true positives, false positives, true negatives, false negatives, accuracy, sensitivity, specificity, and positive and negative predictive values are shown in Table 5.

Table 4 Association of MMT with JTM.

	MMT				
	1 and 2		3 and 4		*p*-value
	Frequency	%	Frequency	%	
MPM					
No	3	42.9	4	57.1	0.012
Yes	104	82.5	22	17.5	

MMT, modified Mallampati test; JTM, jaw-thrust maneuver.

Analysis of concordance identified a reasonable agreement between JTM and Cormarck. Agreement is weak between MMT and Cormarck, as well as between JTM and MMT (Table 6).

Discussion

Strategies to obtain better conditions for intubation are proven to be effective, such as direct laryngoscopy with the classic olfactory position, and an adequate degree of muscle relaxation, which guarantee optimum visibility conditions. An adequate airway physical examination for predictors that may alert to a possible difficult airway is very useful in preanesthetic evaluation.[2,8]

However, the search for a predictor that is easy to perform, has good reproducibility, high specificity and particularly high sensitivity to evaluate the airway and is able to independently predict difficult airway reliably is not yet a reality.[9]

In a multicenter study that guided the evaluation of airway evaluating 492,239 anesthetic inductions, the incidence of difficult airway was 5.8%.[9] On the other hand, our study found a low incidence of difficult airway (about 0.8%), which can be justified by the greater anesthesiologist attention to patient positioning, motivated by the investigator's presence in the operating room. In addition, the improved use of neuromuscular blocker to await its peak action, a criterion standardized in this study, may have also contributed to this finding.

Furthermore, it is known that the incidence of difficult airway can be extremely variable, most of the time depending on the classification used in each study.[1] Although most published articles use the Cormack–Lehane Grade 3 or 4 classification to define difficult airway, others authors suggest the need for special techniques for intubation, multiple attempts, or even a combination of these events.[1,10,11] Not to mention the anthropometric characteristics of populations, as there is an extensive variability between population groups regarding thyromental and sternomental distances, as well as degree of mouth opening, which are believed to justify the discrepancies in difficult airway rates between studies.[10]

It is known that a professional with more than two years of clinical practice in anesthesiology can be considered experienced for intubation[12]; moreover, this level of professional experience becomes decisive in the correct classification of MMT and adequate management of difficult airway.[13] Thus, the positive association between MMT and level of professional experience can be explained by

Table 5 Statistical evaluation of MMT and JTM as difficult airway predictors.

Test	TP	FP	TN	FN	Accuracy (95% CI)	Spc (95% CI)	PPV
MMT	1	25	107	0	81.2% (73.5%–87.4%)	81.1% (73.3%–87.4%)	4%
JTM	1	6	126	0	95.4% (90.4%–98.3%)	94.5% (90.3%–98.3%)	14%

Spc, specificity; FN, false negative; FP, false positive; TN, true negative; TP, true positive; PPV, positive predictive value; MMT, modified Mallampati test; JTM, jaw-thrust maneuver.

Table 6 Agreement between MMT, JTM, and Cormack.

Tests	Observed agreement	Expected agreement	Kappa	Agreement
MMT vs. Comarck	81.2%	80.0%	0.060	Weak
JTM vs. Comarck	95.5%	94.1%	0.240	Reasonable
JTM vs. MMT	81.2%	77.2%	0.174	Weak

MMT, modified Mallampati test; JTM, jaw-thrust maneuver.

the fact that those patients previously identified with possible difficult airway were preferentially directed to the most experienced professionals at the operating room to reduce the chance of intubation failure and complications related to repeated laryngoscopy, such as periglottic edema, hypoxia, and bleeding.[5]

As expected, a positive correlation was found between MMT and JTM. It was verified that the use of both tests complements for a more accurate anticipation of a difficult airway; therefore, there is no isolated superiority between them, as declared by another author.[6]

Supporting the findings of an American study in which 300 patients were enrolled,[1] we found that the level of accuracy of JTM was superior to that of MMT, emphasizing the JTM ability to correctly anticipate difficult laryngoscopy. Additionally, JTM showed higher specificity values (94.5%) than MMT (81.1%), a similar result already highlighted in the cited study.[1] It indicates the JTM superior capacity, when present, to adequately eliminate a probable difficulty in intubation compared to MMT (Class 1 and 2).

It is worth noting that the sensitivity value and, consequently, the NPV, is not reliable due to the absence of false negative events in both tests. This study therefore had limitations because there were no patients with MMT Class 1 or 2 or with absent JTM who had Cormack–Lehane Grade 3 or 4. The absence of false negative patients in both tests compromised the analysis of sensitivity and negative predictive value, as we find overestimated values for such analyzes. These findings can be justified by the small number of participants with difficult airway.[1,6]

In line with previous study, we found a higher PPV for ITM (14%) compared to MMT (4%), corroborating the superiority of JTM when properly performed in correctly warding off difficult laryngoscopy.

In the present study, the agreement evidenced between MMT and Cormack–Lehane was weak. It is demonstrated, therefore, that a difficulty can be found in the adequate visualization of structures through MMT (Class 3 or 4) and, nevertheless, we came across an easy intubation. While the agreement between JTM and Cormack–Lehane was reasonable; it indicated that, from a practical point of view, it is expected that in patients who are able to lift the chin, the laryngoscopy and, consequently intubation will be easy.

Through this study, it was not possible to prove the safety of non-using MMT due to the lack of reliable data on the sensitivity of the investigated tests. However, the unpredictability of MMT as a single predictor of a possible difficult airway is notorious. Thus, JTM is more specific and accurate for difficult airway identification[1,4] and presents a higher rate of agreement with Cormack–Lehane classification.

The limitations of this study are due first to the methodological deficiency of a cross-sectional study. Second, both MMT and JTM lack patients' collaboration and understanding. It is not uncommon to have difficulties in correctly understanding the instructions related to these tests, involuntary phonation occurs during the modified Mallampati test application, as well as difficulty in performing JTM.[1,14] In addition to the short time to assess patients' airway, the absence of neuromuscular blockade monitoring to ensure that all patients had complete blockade at the time of laryngoscopy was another barrier noted in the study.

The search for a single parameter with high accuracy, good reproducibility, and easy execution persists. A thorough evaluation of the airway should be emphasized for anesthesiologists to become familiar with the studied predictors (MMT and JTM) associated with others proposed in the literature and thus reduce the number of unexpected difficult airway, as well as reduce the negative consequences of a large number of intubation attempts and not predispose patients to unnecessary procedures.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Khan Z, Ebrahimkhani E. A comparison of the upper lip bite test (a simple new technique) with modified mallampati classification in predicting difficulty in endotracheal intubation: a prospective blinded study. Anesth Analg. 2003;96:595–9.

2. Frerk C, Mitchell VS, Mcnarry AF, et al. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth. 2015;115:827–48.
3. Artime CA, Sanchez A. Preparation of the patient for awake intubation. Benumof and Hagberg's airway management. 3rd ed. Philadelphia: Elsevier; 2017. p. 243–64.
4. Domino KB, Posner KL, Caplan RA, et al. Airway injury during anesthesia: a closed claims analysis. Anesthesiology. 1999;91:1703–11.
5. Cook T, Woodall N, Frerk C. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society, Part 1. Br J Anaesth. 2011;106:617–31.
6. Wilson ME, Spiegelhalter D, Robertson JA, et al. Predicting a difficult intubation. Br J Anaesth. 1988;61:211–6.
7. Lee H, Yun M, Hwang J, et al. Higher operating tables provide better laryngeal views for tracheal intubation. Br J Anaesth. 2014;112:749–55.
8. American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology. 2003;98:1269–77.
9. Shanks AM, Freundlich RE, Linton F, et al. Incidence, predictors, and outcome of difficult mask ventilation combined with difficult laryngoscopy. Anesthesiology. 2013;119:1360–9.
10. Shiga T, Zen'ichiro W, Tetsuo I, et al. Predicting difficult intubation in apparently normal. Anesthesiology. 2017;103:429–37.
11. Kheterpal S, Martin L, Shanks AM, et al. Prediction and outcomes of impossible mask ventilation. Anesthesiology. 2009;110:891–7.
12. Cattano D, Killoran PV, Iannucci D, et al. Anticipation of the difficult airway: preoperative airway assessment, an educational and quality improvement tool. Br J Anaesth. 2013;111:276–85.
13. Law JA, Broemling N, Cooper RM, et al. The difficult airway with recommendations for management – Part 1 – Difficult tracheal intubation encountered in an unconscious/induced patient. Can J Anesth. 2013;60:1089–118.
14. Connor C, Segal S. Accurate classification of difficult intubation by computerized facial analysis. Anesth Analg. 2011;112:84–93.