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SCIENTIFIC ARTICLE

Correlation between oro and hypopharynx shape and position with endotracheal intubation difficulty

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Abstract
Background and objective: Prediction of intubation difficulty can save patients from major preoperative morbidity or mortality. The purpose of this paper is to assess the correlation between oro–hypo pharynx position, neck size, and length with endotracheal intubation difficulty. The study also explored the diagnostic value of Friedman Staging System in prediction cases with difficult intubation.
Method: The consecutive 500 ASA (I, II) adult patients undergoing elective surgery were evaluated for oro and hypopharynx shape and position by modified Mallampati, Cormack and Lehane score as well as Friedman obstructive sleep apnea classification systems. Neck circumference and length were also measured. All cases were intubated by a single anesthesiologist who was uninformed of the above evaluation and graded intubation difficulty in visual analog score. Correlation between these findings and difficulty of intubation was assessed. Sensitivity, Specificity, Positive and Negative Predictive Values were also reported.
Results: Cormack–Lehane grade had the strongest correlation with difficulty of intubation followed by Friedman palate position. Friedman palate position was the most sensitive and had higher positive and negative predictive values than modified Mallampati classification. Cormack–Lehane grade was found to be the most specific with the highest negative predictive value among the four studied classifications.
Conclusion: Friedman palate position is a more useful, valuable and sensitive test compared to the modified Mallampati screening test for pre-anesthetic prediction of difficult intubation where its involvement in Multivariate model may raise the accuracy and diagnostic value of preoperative assessment of difficult airway.

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PALAVRAS-CHAVE
Intubação;
Vias aéreas;
Faringe;
Classificação;
Correlação;
Valor

Correlação entre os formatos da orofaringe e hipofaringe e posicionamento em intubação endotraqueal difícil

Resumo
Justificativa e objetivo: A previsão de intubação difícil no período pré-operatório pode salvar pacientes de morbidade e mortalidade graves. O objetivo deste estudo foi avaliar a correlação entre intubação endotraqueal difícil e a posição oro-hipofaríngea, circunferência e comprimento do pescoço. O estudo também avaliou o valor diagnóstico do Sistema de Classificação de Friedman para prever casos de intubação difícil.
Método: Avaliamos consecutivamente o formato oro-hipofaríngeo e a posição de 500 pacientes adultos (ASA I-II) submetidos à cirurgia eletiva, usando o escore de Mallampati modificado, escore de Cormack e Lehane, bem como o sistema de classificação de Friedman para apneia obstrutiva do sono. A circunferência e comprimento do pescoço também foram mensurados. Todos os casos foram intubados por um único anestesiologista que desconhecia o estudo e classificou a intubação difícil em escala visual analógica. A correlação entre os achados e intubação difícil foi avaliada. Sensibilidade, especificidade e valores preditivos positivos e negativos também foram registrados.
Resultados: A classificação em graus de Cormack e Lehane apresentou uma correlação mais forte com intubação difícil, seguida pela posição palatal de Friedman. A posição palatal de Friedman foi a mais sensível e apresentou valores preditivos positivos e negativos mais altos que a escala de Mallampati modificada. Descobrimos que o grau de Cormack e Lehane foi o mais específico e apresentou o maior valor preditivo negativo entre as quatro classificações estudadas.
Conclusão: A posição palatal de Friedman é um teste mais útil, valioso e sensível comparado ao teste modificado de triagem de Mallampati para prever intubação difícil pré-anestesia e o seu envolvimento no modelo multivariado pode aumentar a precisão e o valor diagnóstico da avaliação pré-operatória de via aérea difícil.

Introduction

Successful intubation and securing airway requires leveling the oropharynx cavity in line with the pharyngeolaryngeal structures. This is done to allow good visualization of the vocal cords and supraglottic area.

Several studies have focused on one or more patient-related factors and proposed anatomical structure grading classifications to predict difficult tracheal intubation. Among these, the modified Mallampati score and the Cormack and Lehane classification are commonly used by anesthesiologist to evaluate airway difficulty.

Results of studies evaluating the correlation between these classifications and the ease to intubate are controversial. In a recent meta-analysis, Lundstrøm et al. found that the modified Mallampati score is inadequate as a stand-alone test of a difficult laryngoscopy or tracheal intubation. Their recommendation was the development of multivariate model to predict difficult intubation in daily anesthetic practice.[1] Shiga et al. conducted a meta-analysis study to systematically determine the diagnostic accuracy of bedside tests for predicting difficult intubation in patients with no airway pathology. The conclusion of this study was that the current available screening tests for difficult intubation had only poor to moderate discriminative power when used alone. Combinations of tests add some incremental diagnostic value in comparison to the value of each test alone.[2]

The results of these studies could be hard to interpret by the methods used in their conduction, since, the risk factors studied were analyzed by many investigators or the intubation was performed by more than one anesthesiologists. Also, the degree of intubation difficulty was assessed as a cut point difficult or not using direct laryngoscopy view or miscellaneous multifactorial indices.

Tonsils, soft palate and base of tongue are major components in the oro and hypopharynx. Their prominence or laxity may affect the oropharynx size and deeper structures visualization. Also short and fat neck had been associated with difficult ventilation and intubation. In fact, these structures are commonly cited as causes of obstructive sleep apnea (OSA) syndrome. Friedman et al. had validated a staging system using the size of the tonsil and the position of soft palate and base of tongue to predict subjective and objective improvement after OSA treatment.[3,4] Moreover, Liistro et al. studied the association between Mallampati score and OSA. They found significant correlation between the Mallampati score and apnea/hypopnea index and concluded that a high Mallampati score represents a predisposing factor for OSA syndrome.[5] To our best knowledge, the correlation between Friedman Staging System and the difficulty of intubation has not been studied before.

In this study we compared Friedman Staging System with previously studied scaling systems for preoperative assessment of airway and prediction of ease of tracheal intubation.

Method

The consecutive ASA (I, II) adult patients undergoing elective surgery between April and July 2012 were enrolled in this study. Pregnant, facial trauma or facial abnormality, cervical spine disorders, upper airway obstructed pathology as well as patients with known history of difficult intubation were excluded.

At preoperative assessment area, all patients had general medical examination and assessment for pharynx and neck size by single trained investigator. The pharynx size was assessed using modified Mallampati as well as Friedman palate position and tonsillar size scoring system.[3] The neck length was measured between two bony points: mastoid process and ipsilateral suprasternal notch. The neck circumference was measured at two levels: Upper-neck (the level of hyoid bone) and Mid-neck (the level of cricothyroid membrane).

All patients were intubated by the first author, who was blinded to the above measurements, in a standard induction protocol including muscle relaxation with different sizes curved blade Macintosh laryngoscope. The difficulty of intubation was scaled using visual analog score (VAS) ranging from 0 to 10 with 10 being very difficult intubation. At time of intubation Cormack and Lehane laryngoscopic grading system was documented.

For the purpose of calculating sensitivity, specificity, and positive and negative predictive values, we considered patients with more than four VAS as difficult intubated cases.

Hospital ethical committee had approved our research protocol and a signed consent form was obtained from all patients.

Pearson correlation coefficient was used for the statistical analysis. Categorical data were analyzed by chi square test or Fisher's exact test, as appropriate. A p value of <0.05 was accepted as statistically significant.

Results

500 consecutive patients were included in this study. Patients' characteristics and summary of the tested results are reported in Table 1. Table 2 presents the Pearson correlation coefficient between the difficulty of intubation and different studied risk factors. Cormack–Lehane grade had the strongest association followed by Friedman palate position and modified Mallampati score. Mid neck circumference had the weakest correlation. Friedman palate position was the most sensitive and had higher positive and negative predictive values than modified Mallampati classification, whereas Cormack and Lehane scoring was the most specific with the highest predictive values among the four studied classifications as shown in Table 3.

Discussion

Modern changes in anesthesia medications, equipment and monitors have allowed safe anesthesia practice and outcome; however, unexpected difficult intubated cases with serious reported complications are still challenges in the daily anesthesia experience.

Table 1 Patients demographics and characteristics.

Age
Average 41.43
Stander deviation (14.75)
Gender:
Male: 223
Female: 277
Weight (kg)
Average 79
Stander deviation (17)
Body mass index
Average 28
Stander deviation (6)
Type of surgery
General surgery: 230
Orthopedic: 109
Gynecology: 68
Otolaryngology: 59
Urology: 34
Degree of Intubation difficulty:
Average: 2.7
Stander deviation (1.2)
Friedman palate position
Average: 2.2
Stander deviation (0.6)
Friedman tonsillar size
Average: 1.6
Stander deviation (0.9)
Modified Mallampati score
Average: 2
Stander deviation (0.7)
Cormack and Lehane classification
Average: 1.8
Stander deviation (0.7)
Upper neck circumference (cm)
Average: 43
Stander deviation (2.8)
Middle neck circumference (cm)
Average: 41
Stander deviation (2)
Neck length (cm)
Average: 16.7
Stander deviation (1.6)

Table 2 Correlation coefficient between different studied variables and difficulty of intubation.

Variables	Correlation coefficient
Age	0.22
Weight	0.29
Height	−0.05
BMI	0.32
Neck length	−0.17
Modified Mallampati score	0.40
Cormack and Lehane classification	0.61
Friedman Tonsillar size	0.16
Friedman palatine view number	0.42
Upper neck circumference	0.38
Middle neck circumference	0.10

Table 3 Sensitivity, specificity, positive and negative predictive values of the four studied classification systems.

Classification System	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Association with difficult intubation (p)
Modified Mallampati score 3 and 4	0.47	0.91	0.57	0.86	<0.0001
Cormack and Lehane score 3 and 4	0.34	0.95	0.67	0.95	<0.0001
Friedman's tonsillar size 3 and 4	0.37	0.89	0.47	0.83	<0.0001
Friedman's palate position 3 and 4	0.59	0.87	0.60	0.87	<0.0001

In a recent audit of the four royal colleges of anesthesia societies, the mortality rate associated with airway management was one per 22,000 general anesthetics, brain damage one in 180,000 anesthetics, intensive care admission one in 29,000, and emergency surgical airway one in 50,000 general anesthetics.[6] Rose and Cohen studied the methods, risk factors and outcomes of airway management in 18,205 patients. Mortality in difficult intubated cases was not common but included desaturation and hypertension on induction, esophageal intubation, and dental injury. These patients also had a higher rate of unexpected intensive care unit admission and longer lengths of hospital stay.[7]

Because of these potential serious complications associated with failed intubation, researchers had tried to identify preoperative factors that could predict difficult intubated cases. Mallampati and co-workers in1985 proposed a grading system based on the ability to visualize pharyngeal structures and correlate this with tracheal intubation difficulty in 210 patients. The degree of difficulty in visualizing these structures was an accurate predictor of direct laryngoscopy difficulty with sensitivity of 50% and specificity of 100%.[8] However, subsequent larger studies have shown only modest degrees of accuracy using the original and even the modified versions of the test.[9] Additionally, the accuracy of these tests was found to vary with gender and ethnic variations.[10–12] Because it is unlikely that a single anatomical parameter could accurately predict intubation difficulty, several multivariate models were developed. These models included different anatomical measurements at different level in the airway, neck and jaw movement, age, gender, pathology in upper airway and some other factors. These models provide more sensitive and specific date for prediction of unanticipated difficult tracheal intubation.[13–16] Although modified Mallampati and Freidman palate position scales are very similar, a major difference between them is the condition of the tongue. In the classic and all Mallampati modifications, the oropharynx is examined while the tongue is protruded whereas in Freidman classification it is not. In fact, during direct laryngoscopy and intubation, the tongue position in the pharynx is more likely to be in the non-protruded location. The results of study showed stronger correlation between Freidman classification and intubation difficulty than modified Mallampati scale.

In most published studies, difficult laryngoscopy has been defined as a view of the larynx corresponding to grade 3 or 4 in the classification by Cormack and Lehane or by adapting the American Society of Anesthesiologists definition.[17] This approach causes the division of studied patients into fixed and limited outcome subgroups. In this study, continuous scale (VAS) has been used to assess difficulty of intubation and was graded by an experienced anesthesiologist who was blinded to patients' studied risk factors.

Sensitivity and specificity are dependent parameters with negative correlation. When the sensitivity increases, the specificity usually decreases and vice versa. The preanesthetic evaluation of the airway should be mainly aimed at identifying as many patients with difficult intubation to minimize the risk of unanticipated difficult/failed intubation.[14] From this perspective, the sensitivity of a test may be a more valuable parameter for prediction difficult intubation than its specificity.

Although Cormack and Lehane score were found to be the most specific and had the highest positive and negative predictive values, its clinical significance in predicting pre-anesthetic difficult intubated cases may be late since this classification is evaluated while the patient has been paralyzed.

In this prospective single blinded study, identification of the correlation between anatomical size and shape of the pharynx as well as the neck length and circumference with the difficulty of intubation has been considered. The study showed the Friedman classification to be superior to modified Mallampati scale in predicting difficulty of airway intubation. However, more studies with larger number of patients are needed to properly evaluate the value of this classification in the anesthesiology field.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Lundstrøm LH, Vester-Andersen M, Møller AM, et al. Danish Anaesthesia Database Poor prognostic value of the modified Mallampati score: a meta-analysis involving 177 088 patients. Br J Anaesth. 2011;107:659–67.
2. Shiga T, Wajima Z, Inoue T, et al. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. Anesthesiology. 2005;103:429–37.
3. Friedman M, Ibrahim H, Joseph NJ. Staging of obstructive sleep apnea/hypopnea syndrome: a guide to appropriate treatment. Laryngoscope. 2004;114:454–9.
4. Friedman M, Ibrahim H, Bass L. Clinical staging for sleep-disordered breathing. Otolaryngol Head Neck Surg. 2002;127:13–21.
5. Liistro G, Rombaux P, Belge C, et al. High Mallampati score and nasal obstruction are associated risk factors for obstructive sleep apnoea. Eur Respir J. 2003;21:248–52.
6. Cook TM, Woodall N, Frerk C. Fourth National Audit Project 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: anaesthesia. Br J Anaesth. 2011;106:617–31.
7. Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. Can J Anaesth. 1994;41:372–83.
8. Mallampati SR, Gatt SP, Gugino LD, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J. 1985;32:429–34.
9. Lee A, Fan LT, Gin T, et al. A systematic review (meta-analysis) of the accuracy of the Mallampati tests to predict the difficult airway. Anesth Analg. 2006;102:1867–78.
10. Pilkington S, Carli F, Dakin MJ, et al. Increase in Mallampati score during pregnancy. Br J Anaesth. 1995;74:638–42.
11. Wong SH, Hung CT. Prevalence and prediction of difficult intubation in Chinese women. Anaesth Intensive Care. 1999;27:49–52.
12. Butler PJ, Dhara SS. Prediction of difficult laryngoscopy: an assessment of the thyromental distance and Mallampati predictive tests. Anaesth Intensive Care. 1992;20:139–42.
13. Reed MJ, Dunn MJ, McKeown DW. Can an airway assessment score predict difficulty at intubation in the emergency department? Emerg Med J. 2005;22:99–102.
14. Naguib M, Scamman FL, O'Sullivan C, et al. Predictive performance of three multivariate difficult tracheal intubation models: a double-blind, case-controlled study. Anesth Analg. 2006;102:818–24.
15. Wilson ME, Spiegelhalter D, Robertson JA, et al. Predicting difficult intubation. Br J Anaesth. 1988;61:211–6.
16. Arné J, Descoins P, Fusciardi J, et al. Preoperative assessment for difficult intubation in general and ENT surgery: predictive value of a clinical multivariate risk index. Br J Anaesth. 1998;80:140–6.
17. Practice guidelines for management of the difficult airway: a report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology. 1993;78:597–602.