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SCIENTIFIC ARTICLE

Comparison of different tests to determine difficult intubation in pediatric patients

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KEYWORDS

Difficult intubation;
Pediatrics;
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Abstract

Background: The difficulties with airway management is the main reason for pediatric anesthesia-related morbidity and mortality.

Objective: To assess the value of modified Mallampati test, Upper-Lip-Bite test, thyromental distance and the ratio of height to thyromental distance to predict difficult intubation in pediatric patients.

Design: Prospective analysis.

Measurements and results: Data were collected from 5 to 11 years old 250 pediatric patients requiring tracheal intubation. The Cormack and Lehane classification was used to evaluate difficult laryngoscopy. Sensitivity, specificity, positive predictive value and AUC values for each test were measured.

Results: The sensitivity and specificity of modified Mallampati test were 76.92% and 95.54%, while those for ULBT were 69.23% and 97.32%. The optimal cutoff point for the ratio of height to thyromental distance and thyromental distance for predicting difficult laryngoscopy was 23.5 (sensitivity, 57.69%; specificity, 86.61%) and 5.5 cm (sensitivity, 61.54%; specificity, 99.11%). The modified Mallampati was the most sensitive of the tests. The ratio of height to thyromental distance was the least sensitive test.

Conclusion: These results suggested that the modified Mallampati and Upper-Lip-Bite tests may be useful in pediatric patients for predicting difficult intubation.

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PALAVRAS-CHAVE

Intubação difícil;
Pediatria;
Testes preditivos

Comparação de diferentes testes para determinar intubação difícil em pacientes pediátricos

Resumo

Justificativa: As dificuldades no manejo das vias aéreas são a principal causa de morbidade e mortalidade relacionada à anestesia pediátrica.

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Objetivo: Avaliar o valor do teste modificado de Mallampati, teste da mordida do lábio superior, distância tireoentoniana e relação altura-distância tireoentoniana para prever intubação difícil em pacientes pediátricos.

Projeto: Análise prospectiva.

Mensurações e resultados: Dados coletados de 250 pacientes pediátricos, com idades entre 5 e 11 anos, submetidos à intubação traqueal. A classificação de Cormack e Lehane foi usada para avaliar laringoscopia difícil. Os valores de sensibilidade, especificidade, preditivo positivo e AUC para cada teste foram registrados.

Resultados: A sensibilidade e especificidade do teste modificado de Mallampati foram 76,92% e 95,54%, enquanto para o ULBT foram 69,23% e 97,32%. O ponto de corte ideal para a relação altura-distância tireoentoniana e distância tireoentoniana para prever laringoscopia difícil foi 23,5 (sensibilidade, 57,69%; especificidade, 86,61%) e 5,5 cm (sensibilidade, 61,54%; especificidade, 99,11%). O teste de Mallampati modificado foi o mais sensível dos testes. A relação entre altura-distância tireoentoniana foi o teste menos sensível.

Conclusão: Esses resultados sugerem que os testes de Mallampati modificado e da mordida do lábio superior podem ser úteis em pacientes pediátricos para a previsão de intubação difícil.

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Introduction

Difficulties with airway management in pediatric patients are a major reason for cardiac arrest, brain injury and death.¹⁻⁴ Thus preoperative evaluation of the difficult intubation is important.

Different predictive tests for difficult laryngoscopy were used in adult patients,⁵⁻¹¹ but there was controversy about the usage of these tests in pediatric patients.

The modified Mallampati test (MMT) is a simple airway assessment method and is widely used.⁵ The upper lip bite test (ULBT) found by Khan et al.⁶ is another predictive test. The measurement of thyromental distance (TMD) remains widely used.⁷ The ratio of height to TMD (RHTMD)⁸ is another method for difficult airway prediction.

The goal of this study was to assess the value of different predictive tests for difficult laryngoscopy in pediatric patients.

Materials and methods

After obtaining Ethics Committee approval for the study, written informed consent was obtained from the parents of each child. Patients aged 5–11 years requiring endotracheal intubation were taken into the study. Patients with limitation of cervical movement or unable to open the mouth were not included in the study.

Preoperatively, the MMT, ULBT, TMD and RHTMD measurements were recorded by an anesthesiologist who was unaware about the study.

The MMT was classified as follows: Class I – soft palate, fauces, uvula, and pillars can be seen; Class II – soft palate, fauces, and uvula visualized; Class III – soft palate and base of uvula can be seen; and Class IV – soft palate not seen.⁵ Class III and IV are accepted as difficult intubation signs.

The ULBT was performed using the following criteria: Class I – lower incisors can bite the upper lip above the vermilion line, Class II – lower incisors can bite the upper

lip below the vermilion line, and Class III – lower incisors cannot bite the upper lip. Classes I and II were accepted as easy intubation, and Class III was accepted as difficult intubation.^{6,7,9}

The TMD, described as the distance between the laryngeal prominence of the thyroid and the mental protuberance of the mandibula, was recorded. The RHTMD was then calculated.

Standard monitoring was used for each patient. Intravenous thiopental (3 mg/kg), fentanyl citrate (1 µg/kg) and atracurium (0.5 mg/kg) were used. Anesthesia was maintained with 2.0% sevoflurane and 1:1 O₂/N₂O at 2 L min⁻¹.

Anesthesiologists, blinded to the study, evaluated the airway by using the Cormack–Lehane classification.¹² Grades I (glottis fully exposed) and II (glottis partially exposed with anterior commissure not seen) were accepted as easy intubations. Grades III (only epiglottis seen) and IV (epiglottis not seen) were accepted as difficult intubations.

Statistical analysis

Results are expressed as mean ± standard deviation or number. Area under the curve (AUC) of the receiver operating characteristic (ROC) curve was calculated. Cut-off points, sensitivity, specificity, and positive and negative predictive values were calculated. AUCs were compared by using z statistics. A *p* value <0.05 was considered as statistically significant.

Results

A total of 250 patients were taken into the study. Of these, 131 (52.4%) were male and 119 (47.6%) were female. The mean age of the patients was 9.34 ± 1.59 years, the mean weight was 33.40 ± 6.76 kg and the mean height of the patients was 134.42 ± 7.11 cm (Table 1).

In all, 220 patients had class I or II MMT while 30 patients had class III or IV MMT; 226 patients had class I or II ULBT

Table 1 Demographic data.

Gender (M/F)	131/119
Age (year)	9.34 ± 1.59
Weight (kg)	33.4 ± 6.76
Height (cm)	134.42 ± 7.11

Table 2 Distribution of laryngoscopic view.

<i>Mallampati class (n)</i>	
1	133
2	87
3	29
4	1
<i>Cormack-Grade view (n)</i>	
1	153
2	71
3	18
4	8
RHTMD	22.12 ± 1.39
TMD (cm)	6.10 ± 0.28

and 24 patients had class III ULBT (Table 1). In 26 patients (10.4%) we detected Cormack and Lehane Grade 3 or 4 airway (Table 2).

Table 3 shows cut-off points, sensitivity, specificity, positive and negative predictive values and AUCs for Mallampati, ULBT, TMD and RHTMD parameters. The sensitivity and specificity of Mallampati test and ULBT were 76.92%, 95.54% and 69.23%, 97.32%, respectively.

The optimal cutoff point for the RHTMD and TMD was 23.5 (sensitivity, 57.69%; specificity, 86.61%) and 5.5 cm (sensitivity, 61.54%; specificity, 99.11%).

AUCs were 0.894 for Mallampati, 0.914 for ULBT, 0.794 for TMD and 0.748 for RHTMD. There was significant difference between AUCs of Mallampati/RHTMD and ULBT/RHTMD ($p < 0.05$).

Discussion

Our aim was to understand the value of different tests for difficult laryngoscopy in pediatric patients. These results suggest that there were significant differences between AUCs of MMT vs. RHTMD and ULBT vs. RHTMD tests. The

MMT test was the most sensitive and the RHTMD was the least sensitive. The TMD had the highest specificity, positive predictive value, and accuracy.

The incidence of difficult airway management in children is rare. Esener et al.¹³ reported airway difficulties of 1.3% in their study, and another study by Gencorelli et al.¹⁴ reported airway difficulties of 1.7%.

The predictive values of ULBT, MMT, TMD, and RHTMD tests have been reported in the adult patients.⁶⁻¹¹ Khan et al.⁶ designed a prospective study to compare the ULBT and MMT for difficult intubation. They reported that the ULBT showed significantly higher specificity and accuracy than the MMT. They also reported that there was no significant difference between sensitivity, positive predictive value, and negative predictive value of the tests. They concluded that the ULBT is an acceptable option for predicting difficult intubation. Another study made by Salimi et al.⁷ compared the ULBT with the TMD. The authors reported higher specificity and positive predictive value with ULBT than the TMD. They concluded that the sensitivities of the ULBT and TMD were not significantly different. Krobbuaban et al.⁸ found that the RHTMD had a higher sensitivity and positive predictive value. The authors concluded that the RHTMD may be a useful test for difficult laryngoscopy. Another study⁹ compared the ULBT and MMT scores and found that both tests are poor predictors. The authors concluded that this result was mainly caused by the large proportion of false-negative ratings in their trial. A similar study by Hester et al.¹⁰ found that the sensitivity, specificity, and positive predictive value of the ULBT test were higher than those of the MMT. Honarmand et al.¹¹ concluded that the RHTMD may be a useful screening test for predicting difficult laryngoscopy in obstetric patients.

To this date there is little data about the usage of these predictive tests in pediatric patients. Baudouin et al.¹⁵ designed a study to assess the value of MMT and TMD in 347 pediatric patients. The authors found that the usage of MMT was impossible in patients below 18 months of age and difficult below 5 years. The authors also reported that a high MMT had poor connection with Cormack and Lehane grade. They also reported that the MMT is not a good test to predict difficult intubation in children. The TMD seemed more reliable. In adults the minimal TMD is 6 cm, while in infants and children it is smaller.¹⁶ It is reported that the TMD is 4.1–5.8 cm in Chinese children aged 4–12 years.¹⁷ We found the optimal cutoff point for the TMD for predicting difficult laryngoscopy to be 5.5 cm. Aggarwal et al.¹⁸ made a study to find the predictors of difficult intubation

Table 3 Cut-off points, sensitivity, specificity, positive, and negative predictive and AUC values.

	True positive	False positive	True negative	False negative	Accuracy	Sensitivity	Specificity	+PV	–PV	AUC
RHTMD	19 (7.6)	87 (34.8)	137 (54.8)	7 (2.8)	62.4	57.69	86.61	48.6	90.3	0.748 ^{a,b}
TMD	16 (6.4)	2 (0.8)	222 (88.8)	10 (4.0)	95.2	61.54	99.11	93.8	92.1	0.794
Mallampati	20 (8.0)	10 (4.0)	214 (85.6)	6 (2.4)	93.6	76.92	95.54	66.7	97.3	0.894 ^b
ULBT	18 (7.2)	6 (2.4)	218 (87.2)	8 (3.2)	94.4	69.23	97.32	75.0	96.5	0.914 ^a

PV, positive predictive value.

^a Different between both groups.

^b Different between both groups.

in 1–5 years old pediatric patients. The authors assessed the usefulness of interincisor gap, MMT, TMD, sternomental distance, neck circumference and RHTMD. The authors concluded that the TMD was the most valuable test in predicting difficult intubation.

The possible limitation of this study is that children do not completely understand the instructions.

In conclusion, the MMT and ULBT tests are useful and their AUC values were higher than those of other tests; thus they can be used for predicting difficult laryngoscopy in pediatric patients.

Conflicts of interest

The authors declare no conflicts of interest.

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