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Comparison of Mallampati test in supine and upright positions with and without phonation in predicting difficult laryngoscopy and intubation in age groups 3-10 years

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Keypoints

Pediatric airway management is always a difficult task for anaesthesiologist. Different studies and test have been done for management of difficult airway however evaluation of airway in supine position without phonation with Modified Mallampati test can be equally good alternative to upright position without phonation for predicting difficult airway in bedridden patients and in emergency cases.

Abstract

Introduction

Unanticipated difficult laryngoscopic intubation has been a major concern for anaesthesiologist in pediatric patients. Failure to maintain the patency of airway after induction of anesthesia can lead to catastrophic sequalae such as hypoxemia, irreversible brain damage and death. There are important anatomical and physiological differences that occur during development which requires a different approach and technique. We designed this study to compare the effect of phonation on the Mallampati test in upright and supine position against the traditionally employed test without phonation in serving to predict difficult laryngoscopy and intubation in paediatric age group. Aims and Objectives are To evaluate the effect of phonation on Mallampati test in supine and upright position and correlation of it with laryngoscopic view using Cormack and Lehane score and difficulty in endotracheal intubation.

Material and methods

In this prospective study, 100 patients aged 3-12 years were recruited. The Mallampati test was conducted on patients with and without phonation in upright and supine position. A blind trained observer then performed laryngoscopy and intubation. Difficult intubation was assessed according to the Cormack-Lehane Grading scale and intubation difficulty score. Diagnostic statistical measures were calculated: sensitivity, specificity, positive and negative predictive values.

Results

In this study, the ROC curve analysis found Mallampati test in upright without phonation (AUC=0.959, Z=5.68, $p<0.001$) is the most significant in predicting difficult laryngoscopy compared to other positions. In upright without phonation, the sensitivity and specificity of Mallampati test and laryngoscopy was the highest compared with phonation. In upright without phonation group sensitivity and specificity for difficulty laryngoscopy were 71.43% and 94.62% respectively. Sensitivity and specificity for difficulty intubation were 80%, 93.68% respectively in this position. In upright with phonation, sensitivity and specificity for difficulty laryngoscopy were 28.57% and 98.92% respectively. Sensitivity and specificity for difficulty intubation were 40%, 98.95% respectively in this position. In supine without phonation group, sensitivity and specificity for difficulty laryngoscopy were 85.71% and 78.49% respectively. Sensitivity and specificity for difficulty intu-

bation were 80%, 76.84% respectively in this position. In supine with phonation group, sensitivity and specificity for difficulty laryngoscopy were 57.14% and 94.62% respectively. Sensitivity and specificity for difficulty intubation were 60%, 93.68% respectively in this position.

Conclusions

Evaluation of airway in supine position without phonation with Modified Mallampati test is equally good alternative to upright (sitting) position without phonation for predicting difficult airway in bedridden patients and in emergency cases.

Keywords

Cormac lehane grade, difficult intubation score, Mallampati test, supine position, sitting position

Introduction

Unanticipated difficult laryngoscopic intubation has been a major concern for anaesthesiologist. Failure to maintain the patency of the airway after induction of anesthesia can lead to catastrophic sequel, such as irreversible brain damage and death. Difficult tracheal intubation accounts for 17% of the respiratory related injuries and results in significant morbidity and mortality. In fact up to 28% of all anaesthesia related deaths are secondary to the failure of mask ventilation or intubation [1]. One of the fundamental skills of an anaesthesiologist is the management of the airway. To be successful in this task, it is important for the provider to have knowledge of the important anatomical, physiological, and pathological features related to the airway as well as knowledge of the various tools and methods that have been developed for this purpose. In this context most anaesthesia providers are very familiar and skilled at managing the adult airway successfully. However, children are not merely small adults. There are important differences that occur during development that require a different approach or technique [2]. A difficult airway in anaesthesia is defined as the clinical situation in which a conventionally trained anaesthetist experiences difficulties with facemask ventilation, tracheal intubation, or both [3]. In 1985, Mallampati and colleagues [4] proposed a classification system (Mallampati score) to correlate the view of the oropharyngeal space with the view of direct laryngoscopy and tracheal intubation. They classified the airway according to the visible structures on oropharyngeal inspection**.** Mallampati et al [4] described three classes, while Samsoon and Young described a fourth class [5]. Mallampati test shows the proportion of the tongue's size in the mouth space [6]. In clinical situations, there are instances in which the evaluation of the patient's airway is not possible in the upright position such as situations in which the patient has a traumatic injury of the cervical vertebrae or else has a fractured vertebra in the thoracic, lumbar or the sacral regions. In these circumstances, the Mallampati test is proposed in the supine position. Supine position and phonation has been shown to affect Mallampati classification and no clear cut direction exist regarding the utilization or non- utilization of phonation during the test performance. In one study, no difference was found between the Mallampati tests conducted in the supine position or else in the upright position [7]. But in another study, it was shown that the patient's position has a meaningful effect on the width of mouth opening and the Mallampati score was found to be higher in the supine position than in the upright position [8]. All the above studies were done in adult patients and none of the study has been performed in paediatric patients till date. In view of above, the present study was performed to compare the effect of phonation on Mallampati score in supine and upright position in predicting difficulty in laryngoscopy and intubation in paediatric patients.

Material and Methods

After Institutional Ethical Committee approval from King George's Medical University, the data for the present study was collected on 100 paediatric patients (3years to12 years of age) of either sex, scheduled to receive general anaesthesia and endotracheal intubation. The children having a known difficult airway as mentioned below were excluded from the study. An infor-

med consent was taken from the parents/ guardians of the children. A detailed preoperative assessment including age and weight of the patient was recorded. During the airway assessment the patient was placed in upright position and supine position to determine oropharyngeal structures visualized with and without phonation according to Mallampati test score [8]. The oropharyngeal structure during each of the four categories was classified as below:

CLASS 0 - The ability to visualize any part of epiglottis on mouth opening.

CLASS 1- Soft palate, fauces, uvula and pillars seen

CLASS 2 - Soft palate, Fauces, uvula seen

CLASS 3 - Softpalate, base of uvula seen

CLASS 4 - Soft palate not visible at all

Mallampati score 0,1,2 is declared to be easy and class 3,4 is considered to be difficult. Difficult Laryngoscopy was accessed by using Cormack and Lehane grading [9]:

GRADE 1 - Full view of glottis

GRADE 2 - Only posterior view of glottis

GRADE 3 - Only epiglottis seen

GRADE 4 - Neither epiglottis nor glottis seen.

INTUBATION DIFFICULTY SCORE [10] Difficult intubation was assessed by using intubation difficulty score (Table 1). It is a function of seven parameters, resulting in a progressive, quantitative determination of intubation complexity. The hypothesis was that intubation difficulty may be defined as a measure of the degree of divergence from a predefined "ideal" intubation, that is, one performed without effort, on the first attempt, practiced by one operator, using one technique, with full visualization of the laryngeal aperture and vocal cords abducted. Such an intubation was accorded an IDS value of 0. Each variation from this "ideal" intubation increased the degree of difficulty, the overall score being the sum of all variations from this definition. Number of additional attempts were noted. Adequate preoxygenation was given in between each attempt. External manipulation of larynx to facilitate intubation was noted. Sellick's manoeuvre in emergency cases was not taken as a point relating to application of laryngeal pressure. Data were analyzed using SPSS version 17.00. For quantitative data, maximum, minimum and mean ± SD and for qualitative data, the number (percentage) were reported. The Chi-square test was used for the relationship between qualitative variables. Sensitivity, specificity, positive and negative predictive values and accuracy were calculated for each of the situations. A P-value <0.05 was considered to be significant.

Results

The present study deals with comparison of modified Mallampati test in supine and upright (sitting) position with and without phonation in predicting difficult laryngoscopy and (Cormack-Lehane) intubation (IDS) in pediatric patients. Total 100 asymptomatic patients were recruited. 91% patients were less than 10 years of age and 9% patients were more than 10 years of age in our study. The prediction of difficult laryngoscopy using Cormack-Lehane grading and difficult intubation using IDS score is summarized in Table 2. Of total, 7 patients (7.0%) had difficult laryngoscopy and 5 patients (5.0%) had difficult intubation. In contrast, Mallampati test in upright without phonation, sitting with phonation, supine without phonation and supine with phonation assessed both the difficulty (laryngoscopy and intubation) in 10 patients (10.0%), 3 patients (3.0%), 26 patients (26.0%) and 9 patients (9.0%) respectively (Table 2).

On comparing, $\chi 2$ test showed significant ($p<0.01$ or $p<0.001$) and association between IDS and Mallampati test in all position and phonation suggesting Mallampati test may be a predictor for difficult intubation (Table 3 and Table 4) To confirm the Mallampati test in different position and phonation be the predictors for difficult laryngoscopy and intubation, ROC curve analysis was done between findings (easy/difficult) of Mallampati test and Cormack-Lehane and IDS and summarized in Table 5 and Table 6 respectively. Sensitivity, specificity, positive predictive value and negative predictive value of Mallampati test during different position as asse-

sed during laryngoscopy revealed the best sensitivity, specificity and negative predictive value in upright position without phonation as depicted in Table 5. We found that Mallampati test both during laryngoscopy and during intubation fared well in both supine and upright position without phonation and created highest sensitivity whereas this sensitivity was lower when phonation was done in upright position. This test has the higher specificity both during laryngoscopy and intubation in upright position with and without phonation (as depicted in Table 6) but upright position without phonation was more statistically significant than other. Positive predictive value in both position and situation was low,on the other hand negative predictive value was above 95% in all four situations and it had a good correlation with test , but the highest correlation was found in upright position without phonation. When compared with other situation the correlation was not so significant.

Table 1. Intubation difficulty score

PARAMETERS	**SCORE**
No. of attempts>1	N1
No. of operators>1	N2
Number of alternative techniques	N3
Cormac Grade-1	N 4
Lifting force required Normal Increased	 N5=0 N5=1
Laryngeal Pressure Applied Not applied	 N6=0 N6=1
Vocal cord mobility Abduction Adduction	 N7=0 N7=1
TOTAL: IDS=SUM OF SCORES	N1-N7

0	Easy
IDS≤5	Slight difficulty
IDS>5	Moderate to major difficulty
IDS=∞	Impossible intubation
N1	Every additional attempt adds 1 point
N2	Each additional operator adds 1 point
N3	Each alternative technique adds 1 point: 1. Repositioning of patient 2. Change of material (blade, tube, using a stylet) 3. Change in approach (orotracheal/ nasotracheal) 4. Use of another technique (fiberscopy, intubation through a laryngeal mask)
N4	Apply Cormack grade for 1st oral attempt For successful blind intubation N4=0
N5	Sellick's manoeuvre adds no points
Impossible intubation: IDS takes the value attained before abandonment of intubation attempts	

Table 2. Prediction of difficult laryngoscopy (Cormack-Lehane) and intubation (IDS) and both using Mallampati test in supine and upright position with and without phonation

Test	**Position**	**No. of patients (n=100) (%)**
Cormack-Lehane	Easy	93 (93.0)
	Difficult	7 (7.0)
IDS	Easy	95 (95.0)
	Difficult	5 (5.0)
Mallampati	Sitting without phonation:	
	Easy	90 (90.0)
	Difficult	10 (10.0)
	Sitting with phonation:	
	Easy	97 (97.0)
	Difficult	3 (3.0)
	Supine without phonation:	
	Easy	74 (74.0)
	Difficult	26 (26.0)
	Supine with phonation:	
	Easy	91 (91.0)
	Difficult	9 (9.0)

Table 3. Comparison of outcomes of Mallampati test with outcomes of Cormack-Lehane (n=100)

Mallampati test	**Cormack-Lehane**		χ^2 **value**	**P Value**
	Easy (n=93) (%)	**Difficult (n=7) (%)**		
Upright without phonation: Easy	88 (94.6)	2 (28.6)	31.56	<0.001
Difficult	5 (5.4)	5 (71.4)		
Upright with phonation:				
Easy	92 (98.9)	5 (71.4)	16.91	<0.001
Difficult	1 (1.1)	2 (28.6)		
Supine without phonation:		1 (14.3)	13.95	<0.001
Easy	73 (78.5)	6 (85.7)		
Difficult	20 (21.5)			
Supine with phonation:				
Easy	88 (94.6)	3 (42.9)	21.30	<0.001
Difficult	5 (5.4)	4 (57.1)		

Table 4. Comparison of outcomes of Mallampati test with outcomes of IDS (n=100)

Mallampati test	IDS		χ^2 value	P Value
	Easy (n=95) (%)	Difficult (n=5) (%)		
Upright without phonation: Easy Difficult	89(93.7) 6(6.3)	1 (20.0) 4(80.0)	28.66	<0.001
Upright with phonation: Easy Difficult	94(98.9) 1 (1.1)	3 (60.0) 2 (40.0)	24.76	<0.001
Supine without phonation: Easy Difficult	73 (76.8) 22 (23.2)	1 (20.0) 4 (80.0)	7.98	0.005
Supine with phonation: Easy Difficult	89(93.7) 6 (6.3)	2 (40.0) 3 (60.0)	16.72	<0.001

Table 5. Diagnostic of Mallampati test in supine and upright position with and without phonation in predicting difficult laryngoscopy (Cormack-Lehane) using ROC curve analysis. +PV: positive predictive value, -PV: negative predictive value, AUC: area under the curveSensitivity, specificity, positive predictive value and negative predictive value of Mallampati test during different position as accessed during laryngoscopy revealed the best sensitivity, specificity and negative predictive value in upright position without phonation as depicted in this table

Mallampati test	Sensitivity (95% CI)	Specificity (95% CI)	+PV	-PV	AUC	Z value	P value
Upright without phonation	71.43 (29.3-95.5)	94.62 (87.9-98.2)	50.0	97.8	0.830	3.40	<0.001
Upright with phonation	28.57 (4.5-70.7)	98.92 (94.1-99.8)	66.7	94.8	0.637	1.18	0.239
Supine without phonation	85.71 (42.2-97.6)	78.49 (68.8-86.3)	23.1	98.6	0.821	3.24	0.001
Supine with phonation	57.14 (18.8-89.5)	94.62 (87.9-98.2)	44.4	96.7	0.759	2.39	0.017

Table 6. Diagnostic of Mallampati test in supine and upright position with and without phonation in predicting difficult intubation (IDS) using ROC curve analysis. +PV: positive predictive value, -PV: negative predictive value, AUC: area under the curve

Mallampati test	Sensitivity (95% CI)	Specificity (95% CI)	+PV	-PV	AUC	Z value	P Value
Upright without phonation	80.00 (28.8-96.7)	93.68 (86.8-97.6)	40.0	98.9	0.868	3.54	<0.001
Upright with phonation	40.00 (6.5-84.6)	98.95 (94.3-99.8)	66.7	96.9	0.695	1.45	0.147
Supine without phonation	80.00 (28.8-96.7)	76.84 (67.1-84.9)	15.4	98.6	0.784	2.30	0.022
Supine with phonation	60.00 (15.4-93.5)	93.68 (86.8-97.6)	33.3	97.8	0.768	2.13	0.034

Discussion

The present study was done in 100 patients to predict difficult laryngoscopy and intubation in pediatrics patients to show the effect of body position and phonation on Mallampati grade. Airway assessment was performed in upright and supine position with and without phonation in each patient. Further discussion is based on observations in children in upright and supine position with and without phonation. Modified Mallampati test was done in each patient in 4 different groups as described upright without phonation, upright with phonation, supine without phonation, supine with phonation respectively and compared these position with Cormack Lehane laryngoscopic grade and Intubation difficulty score. The prediction of difficult laryngoscopy using Cormack-Lehane grading and difficult intubation using IDS score showed that out of 100 number of patients, 7 patients (7.0%) had difficult laryngoscopy and 5 patients (5.0%) had difficult intubation. In contrast, Mallampati test in upright without phonation, sitting with phonation, supine without phonation and supine with phonation assessed both the difficulty (laryngoscopy and intubation) in 10 patients (10.0%), 3 patients (3.0%), 26 patients (26.0%) and 9 patients (9.0%) re-

spectively. Be the predictors for difficult laryngoscopy and intubation, the Mallampati test was performed in different position with and without phonation, ROC curve analysis was done between findings (easy/difficult) of Mallampati test , Cormack Lehane and IDS. In upright without phonation group sensitivity and specificity for difficulty laryngoscopy were 71.43% and 94.62% respectively. Sensitivity and specificity for difficulty intubation were 80%, 93.68% respectively in this position. In upright with phonation, sensitivity and specificity for difficulty laryngoscopy were 28.57% and 98.92% respectively. Sensitivity and specificity for difficulty intubation were 40%, 98.95% respectively in this position. The cause of improved view on phonation on which the Mallampati classification is based is because of the flattening of the tongue, the paired levator velipalatini muscles contraction during phonation and the soft palate being pulled upwards and backwards. In supine without phonation group, sensitivity and specificity for difficulty laryngoscopy were 85.71% and 78.49% respectively. Sensitivity and specificity for difficulty intubation were 80%, 76.84% respectively in this position. In supine with phonation group, sensitivity and specificity for difficulty laryngoscopy were 57.14% and 94.62% respectively. Sensitivity and specificity for difficulty intubation were 60%, 93.68% respectively in this position. In Santos et al study [11] Mallampati index showed a significant correlation with the Cormack-Lehane index. The sensitivity and specificity of the Mallampati index were 75.8% and 96.2% respectively and they concluded that the Mallampati index was proved to be applicable in children 4 to 8 years old. Mehmet et al done study 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. Data were collected from 5 to 11 years old 250 pediatric patients requiring tracheal intubation. The sensitivity and specificity of modified Mallampati test were 76.92% and 95.54%. The modified Mallampati was the most sensitive of the tests. Their result suggested that the modified Mallampati may be useful in pediatric patients for predicting difficult intubation. Oates et al [8] also reported that phonation improves the predictability of laryngoscopic view and showed that Mallampati grading with phonation reduced the correlation coefficient with laryngoscopic view score in adults. Amadusunetal study showed that oropharyngeal view (Mallampati test score) is affected by both position and phonation. Smita and prakash observed that the incidence of difficult laryngoscopy and intubation was 9.7% and 4.5%, respectively in adult patients Modified Mallampati test significantly worsen in supine position compared to upright position however airway assessment in both position without phonation equally predict difficult laryngoscopy and intubation. So airway evaluation using Modified Mallampati test in supine position can be routinely applied in bedridden patient and in patient requiring emergency surgery. Evaluation of airway in supine position without phonation with Modified Mallampati test is equally good alternative to upright (sitting) position without phonation for predicting difficult airway in children.

Conclusion

Evaluation of airway in supine position without phonation with Modified Mallampati test is equally good alternative to upright (sitting) position without phonation for predicting difficult airway in children.

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